Monitoring financial integration by using price-based indicators.

Empirical applications on European stock market data.

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Abstract

We measure EU integration using stock market prices. We review the relevant literature and provide two separate empirical applications to measure the financial integration in the European stock markets. The first application is based on a purely data driven methodology. Our aim is that of extracting a statistically sound measure of integration across EU countries based on Principal Component Analysis. By using European stock market returns from January 2005 to December 2016, we observe a decrease in price integration during the European sovereign crisis and a recovery thereafter especially in the euro-area. We find that the behavior of EA distressed countries, with their high share of idiosyncratic risk during the sovereign crisis, shape the whole EU28 measure of integration. The second approach is based on a theoretical model characterizing and assessing the degree of integration of European equity markets vis-à-vis the world market. Using monthly returns from 1995 to 2016 we find that the main European stock markets become more integrated with the world market especially in recent years. Finally, we compute a country specific time-varying measure for the cost of non-integration.

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Executive summary

The past thirty years have shown a growing liberalization of world financial markets. The international circulation of capital has been favored by the progressive dismantling of capital and exchange controls, the sharp decrease in telecoms costs and improved technology, the increased cross border trade, the intensification in securitization and institutionalization of savings and investments, and the improvement of payment and settlement system (Mussa and Goldstein, 1993).

In Europe, the Economic and Monetary Union (EMU) has been an important driver for financial market liberalization (Berben and Jansen, 2009), together with financial reforms aimed to liberalize the financial market like, for example, the Financial Service Action Plan (1999), the directives and regulations easing the trade of financial instruments (MIFID I 2004, MIFID II and MIFIR, 2014) or reducing the risk in financial operations (EMIR I in 2012 and EMIR II in 20171).

However, financial liberalization is not, per se, a synonymous of financial integration. In the past years, indeed, a rising global risk aversion and bouts of political uncertainty brought a slowdown in the financial integration process, in spite of the expanding liberalization. Large share of domestic investment in Europe is still financed by domestic savings (Darvas et al., 2015), and retained earnings are important source of financing for European firms (Giovannini et al., 2015).

The dichotomy between integration and liberalization warrants a viable definition of financial integration and a set of tools for its monitoring. The definition of financial integration used throughout this report is that of European Central Bank (ECB) and is based on the idea that integration in a given market for financial instruments is achieved when all market participants with the same relevant characteristics (i) face identical rules when they decide to deal with those financial products; (ii) have equal access to them and (iii) are treated equally when active in the market (see Baele et al., 2004).

The literature has proposed two main approaches to measuring financial integration, one based on price comparisons and the other based on the analysis of cross-border movements of capital. According to the first stream of studies if two countries are integrated then identical assets should be traded at the same price in different locations (Law of One Price). According to the second, integration would imply a large share of cross-border flows of capital in form of direct and portfolio investments and in form of banking flows.

In this report we deal with the first approach: measuring EU integration using stock market prices. We review the literature on the methodology, and provide two separate empirical applications to measure the financial integration in the European stock markets.

The first application is based on a purely data driven methodology. Our aim is that of extracting from the data a (statistically) sound measure of integration. Using European countries’ stock market returns from January 2005 to December 2016 we observe a decrease in price integration during the European sovereign crisis and a recovery thereafter especially in the euro-area. We single out the share of integration (or lack of it) due to country-specific aspects, the idiosyncratic risk, from the share of integration that is due to common trends (influencing the global markets). We find that EA distress countries behavior, with their high share of idiosyncratic risk during the sovereign crisis, shaped the whole EU28 measure of integration. Not surprisingly country’s credit rating is among the main drivers behind the degree of EU integration. The other main driver is financial deepness, i.e. the development of financial markets, particularly low in Eastern countries displaying very low level of price integration.

1Following the adoption by the Commission of a Report on the review of EMIR on November 2016, the Commission released on May 2017 its proposed draft update of the EMIR regulation (EMIR II), see COM(2017) 208 final.
The data driven approach, however, is unfitted to analyse the presence of asymmetric barriers to capital circulation unless data on the removal of a specific barrier are made available. When these data are not accessible, or when confounding factors prevent to fully capture the effects of barriers’ removal, the theoretical framework of a model is needed. Moreover, when dealing with barriers the appropriate scale of the analysis become the world equity market.

We construct a theoretical model and provide a characterization and an assessment of the degree of integration of European equity markets, framing EU integration within the world tendencies. Our model is fully compliant with the ECB definition of integration and with the Law of One Price and supplies a time varying integration index. Using monthly returns from 1995 to 2016 we find that, especially in recent years, the main European stock markets become more integrated with the world market. We estimate that with the recovery from the 2008-2012 crisis, country specific risk factors do not seem to be crucial in shaping European markets’ trends. The driving force of integration in the European equity market in recent years is actually the world market, making EU potentially vulnerable to influences from outside.

Our model allows us to compute, for each country, a statistically sound measure for the cost of non-integration. This cost is the implied risk premium, i.e., the financial compensation asked for bearing systematic risk (modelled as the sum of the risk premium from global and local factors). For each EU28, country we characterize the empirical time-varying pattern of this cost.

Putting together the two approaches (formal analysis is left for future work) seems to suggest that the strength of the EU system, in terms of integration of equity markets, has to be evaluated with respect to the world market and it is proportional to the strength of its weakest component.
1 Introduction

According to ECB integration in a given market for financial instruments is achieved when all market participants with the same relevant characteristics face identical rules when they decide to trade, have equal access to the products and are treated equally when active in the market (see Baele et al., 2004). This definition has several implications. The first is that integration is independent from the financial structure of a region or country. In other terms, financial integration is not necessarily determined by the convergence across countries/regions of financial structures, convergence should be a product of integration and not a pre-requisite (see, e.g., Hartmann et al., 2003). Secondly, only asymmetric frictions are a barrier to financial integration². A workable definition of financial integration, therefore, has to do with assessing asymmetric barriers to the trade of financial services. Obviously, as listing and analyzing the effects of all possible frictions and barriers is virtually impossible, the literature proposed indirect ways to assess the presence of barriers to integration.

The degree of financial integration among equity markets affect decisions of policymakers, investors, and households. More financially integrated markets should lower the cost of capital, increase investment opportunities of local and foreigner investors and lead to significant welfare gains from higher savings and growth rate made possible by international risk sharing (see, e.g., Pericoli et al., 2016; Suzuki, 2014). On the other hand, an high level of market integration induces strong positive correlations across equity returns and decreases the benefits of portfolio diversification (see Christoffersen et al., 2012).

Considering the degree of market integration, Table 1 provides a summary of the integration models, highlighting the determinants of excess returns, i.e. the systematic risk factors, and the portfolio composition for each degree of market integration. Under perfectly integrated markets, portfolios will be fully differentiated and only global factors will drive pricing, hence investment incentives. On the contrary with segmented markets, portfolios will be exclusively based on local assets and local risk factors will determine prices and incentives. The issue of market integration is therefore linked to the portfolio allocation problem (see Appendix 1 for a review on linear factor models for market integration).

<table>
<thead>
<tr>
<th>Market integration</th>
<th>Portfolio allocation</th>
<th>Systematic factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely segmented</td>
<td>Only domestic assets</td>
<td>Local risk factors</td>
</tr>
<tr>
<td>Partially segmented</td>
<td>World market portfolio and domestic assets $\rightarrow$ Diversification degree</td>
<td>Global and local risk factors</td>
</tr>
<tr>
<td>Perfectly integrated</td>
<td>International portfolio $\rightarrow$ Full diversification</td>
<td>Global risk factor</td>
</tr>
</tbody>
</table>

Table 1: Market integration models. Degree of integration, assets in portfolio allocation and systematic factors.

A large part of the literature proposes several methodologies to measure the degree of financial integration among equity markets. The measures of financial integration can be classified in two main categories:

- **price-based indicators**: these indicators invoke the law of one price (see Adam et al., 2002). The law of one price postulates that identical assets should be traded at the same price in different locations. In other terms, if financial markets are integrated, there should not be space for unexploited international arbitrage and the prices of the same item in different currencies would only reflect the differences in exchange rates. Notice that the definition of integration given by ECB actually encompasses the law of one price: if the law of one price holds, then no arbitrage opportunities can arise and

²Another implication is the separation between supply and demand of financial products. Not only all market participants should face the same set of rules and access opportunities, but the supply of financial products should not a priori discriminate participants on the basis of their location of origin.
market participants will be unconstrained by rules and access conditions. If financial investment is non-discriminatory, then investors will be free to exploit any arbitrage opportunity restoring the law of one price (see, Baele et al., 2004, page 7). In other terms, in equilibrium, prices reflect all the information available to market players, hence also the existence of unexploited arbitrage opportunities. This helps in deriving operational measures of integration.

- **quantity-based indicators**: these indicators are based on stocks and flows of asset (see, e.g. Guiso et al., 2004). The seminal paper of Feldstein and Horioka (1980) looks at the relationship between domestic investments and savings. The idea is that under perfect integration at the world level, there should be no relation between domestic saving and domestic investment. Domestic savings would depend on worldwide opportunities and domestic investments would be financed by the worldwide pool of savings (see Blanchard and Giavazzi, 2002, for a comprehensive discussion). Darvas et al. (2015), instead, show for Euro area countries a negative cross-country savings-investment correlation between 1999 and 2007 and a strong positive correlation in the period 2008-2014.

Along the same lines, an indirect way to look at integration barriers is measuring the extent of domestic consumption smoothing via cross-border links, namely risk sharing. If financial markets are indeed integrated, then in case of idiosyncratic shocks international markets would help smoothing domestic consumption by using cross-border channels. Pericoli et al. (2016) compute country measures of risk sharing for all the countries within the EU showing that the cross-border capital markets are playing a small but increasing role in achieving risk sharing in case of domestic shocks. In the same vein, Vo and Daly (2007) shows that poor quality institutions act as effective barriers to income insurance in case of country-specific shocks. Bai and Zhang (2012) find a similar result considering default risk as an implicit barrier to international risk-sharing. The importance of institutions in explaining international links is also found by Kalemli-Ozcan et al. (2010), who identify the removal of currency risks as the main driver of integration in Euro-area countries after the introduction of the common currency. However, cross-border locational financial statistics are limited or very difficult to compile, making the analysis of cross border investment flows rather cumbersome.

In this report, we focus our study on the price-based indicators and we provide evidence on time-varying equity market integration, employing alternative econometric methodologies.

A large part of the literature exploits the idea that co-movements of stock market prices/returns are indicators of integration. The easiest way to measure co-movements is to calculate correlations between prices or returns, i.e., compute the Pearson’s correlation coefficient. To summarize co-movements in a group of markets, the usual practice is to compute the average of correlation coefficients estimated for each country-pair (see Quinn and Voth, 2008). Brooks and Del Negro (2004); Candelon et al. (2008); Lucey and Zhang (2009), among others, show that the degree of co-movements is not constant over time and it is increasing during the last decades of years. Indeed, the integration of equity markets is evolving in time and depends on structural reforms that affect not only the financial sector but the entire economy as well. Based on this issue, Brooks and Del Negro (2004) provide an average correlation indicator estimated through a rolling windows. However, Billio et al. (2015); Carriera et al. (2017); Pukthuanthong and Roll (2009) show that the correlation coefficient tends to underestimate the integration degree. Furthermore, Forbes

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The limited effect on integration of EU regulatory reforms is probably due to the limited time perspective of the analysis (1978-2007). The main set of reforms started in the 1990s with the Financial Service Action Plan and all the associated legislative measures that were ratified and introduced in national legislations at a very different pace in the EA countries.

One of the main data problems is that what country A declares to give to country B does not usually coincide with what B declares to receive from A making bilateral analysis complicated. Furthermore, data are recorded considering the first recipient entity (i.e. the first beneficiary) and not the last one. This makes round-tripping for tax purposes difficult to detect.

Other variables have been also used to verify the law of one price: the cost of interbank funds denominated in the same currency (Enoch et al., 2014); the covered interest-rate parity (no interest rate arbitrage opportunities between two currencies; see, e.g., Ferreira and Dionisio, 2015). See also Kearney and Lucey (2004); King et al. (1994); Lin et al. (1994); Longin and Solnik (2001).
and Rigobon (2002) state that the integration degree is overestimated during crises due to the higher volatility on the stock market. The standard correlation methodology has been subjected to severe criticism. Bekaeart et al. (2009) conclude that

Correlations are an important ingredient in the analysis of international diversification benefits and international financial market integration. Of course, correlations are not a perfect measure of either concept.

Pukthuanthong and Roll (2009) write

The simple correlation between broad financial market index returns from two countries can be a poor measure of their economic integration.

And finally, Volosovych (2011) say

[...] a conventional measure of co-movement, the coefficient of correlation, has limited applicability as a measure of economic integration.

In the first part of this report, based on these arguments and following Pukthuanthong and Roll (2009), we propose an alternative methodology to measure the association between domestic and global variability.

We identify a set of common factors that can be interpreted as integration drivers and we formalize domestic integration by measuring how distant the common drivers are from the domestic returns’ variability (see, also, Berger and Pukthuanthong (2012); Berger et al. (2011); Pukthuanthong and Roll (2009)). For the empirical analysis, we consider the equity market returns for EU28 countries from January 2005 to December 2016, and we estimate the integration degree for two subsamples w.r.t. the European sovereign crisis. We also investigate which are the possible drivers of integration in the equity market relating integration to several macroeconomic variables, institutional variables, measures of governance and credit ratings. This work extends the analysis presented in Nardo et al. (2016a).

According to the literature, we find that market integration in EU decreased during the European sovereign crisis. The integration index among the EU28 follows, over time, a similar pattern of that of Euro area distressed countries, indicating that EA distressed countries (namely Cyprus, Greece, Ireland, Italy, Portugal and Spain) actually determine the pace of EU integration. Not surprisingly the main drivers of integration results to be the deepness of the domestic financial market and the country’s credit rating.

In this context, the non-parametric methodology that we propose for identifying EU global factors, involves exclusively extracting information from data, avoiding data manipulation due to e.g. data pre-processing or to the specific functional form and estimation procedure chosen. Although easy to apply, this methodology does not allow us to assess asymmetric barriers: it can only provide a heuristic approximation of the link between market integration and portfolio allocation. Indeed, with a data driven approach, the absence of integration cannot be attributed to a specific economic reason. In order to recognize asymmetric barriers from data, we should have either a large number of time-series observations (to cover the time period with and without the barrier) or a natural experiment that constitutes a break in series clearly identifiable (e.g. Brexit). In any case the presence of trade barriers needs to be verified on a case-by-case basis, with the potential problem of disentangling confounding factors.

This is why, in the second part of the report, we switch to a model driven approach that allow us to formalize the presence of asymmetric barriers to the circulation of capitals. We rely on an asset pricing model in line with the definition of financial integration adopted by ECB. More specifically, we formalise and analyse investment barriers using the international asset pricing theory (IAPT, see Koedijk et al., 2002), opening up our geographical perspective so as to include other non EU markets and thereby recognizing the potential links across world markets.

The advantage to use an established framework resides in the possibility to have a theoretical formalization for the definition of integration, to model disequilibrium outcomes (asymmetric barriers) and test alternative assumptions. Our chosen framework, IAPT, assumes that assets with identical risk should command for the same expected return in
countries that are fully integrated. Any deviation from this assumption is a symptom of barriers to capital movement. We model and estimate the degree of financial integration assuming the presence of asymmetric barriers (see Errunza and Losq, 1985). The asymmetric barrier is modeled as follows: we suppose that a class of domestic investors is unable to trade a subset of securities as a result of portfolio (inflow) restrictions imposed by the domestic country.

Errunza and Losq (1985) provide a model that accommodates the evolving market structure from segmentation to integration, as well as intermediate cases, depending on the existence of barriers to investments and the availability of substitute assets. If a barrier is present, then the domestic variability of returns would be unrelated to that of other countries (i.e., the market is segmented). From the technical point of view, this means that the covariance of domestic and foreign returns will be low. Our measure of integration is therefore based on the degree of similarity across covariances: a low covariance will imply the presence of a barrier to the circulation of capital.

Our main theoretical contribution is that of supplying several estimates of the covariances, to capture different ways in which the presence of barriers could influence portfolio allocation. We employ the specifications based on the multivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) to model the conditional second moments as a function of the past variances and covariances. In our empirical application we analyze the degree of integration of European markets with the rest of the world, and its variation from January 1995 to August 2016. We show that the estimated time-varying integration index is stable across the analyzed period with the exception of the financial crisis years. Our analysis provides evidence that with the recovery from the crisis most of European Markets become more integrated with the world market.

Figure 1: Price based indicators of financial integration.
and Losq (1985). Section 4 concludes. Technical details and additional empirical results are in Appendices. This report is the final delivery of the Administrative Arrangement FISMA/2016/086/B2/ST/AAR.
2 Data driven integration: A common factor approach to measure integration

In this Section, we provide evidence on the equity market integration among the EU28 countries from January 2005 to December 2016. We derive a measure of integration based on a data driven approach and we identify drivers of integration.

2.1 Theoretical framework

In our framework, the returns of country \( c \) at date \( t \), denoted by \( R_{c,t} \), are affected by two component of risk: the systematic and idiosyncratic risk. Idiosyncratic risk is country-specific, while systematic risk includes a set of common factors that characterize the returns of a group of countries. This set of common factors are interpreted as integration drivers. We formalize this setting as follows.

We consider \( C \) countries. For each country \( c \) with \( c = 1, \ldots, C \), the stock index return \( R_{c,t} \) at date \( t = 1, \ldots, T \) satisfies the linear factor structure

\[
R_{c,t} = \beta'_c F_t + \varepsilon_{c,t}, \tag{1}
\]

where \( \beta_c \) is a vector of factor loadings, \( F_t \) is a vector of \( r \) common factors so that \( \beta'_c F_t = \beta_{c,1} F_{t,1} + \ldots + \beta_{c,r} F_{t,r} \), and \( \varepsilon_{c,t} \) is the idiosyncratic term (for technical details on properties of \( \varepsilon_{c,t} \) see Nardo et al., 2017). The \( r \) factors \( F_t \) are not directly observable and must be extracted from the observable returns \( R_t \) using a statistical approach, e.g., the Principal Component Analysis (PCA, see Jolliffe, 2002).

In this context, financial integration is defined as the proportion of a country’s returns that can be explained by common factors, namely the systematic component \( \beta'_c F_t \). The markets are perfectly integrated when their assets returns are completely and exclusively driven by the same global factors \( F_t \). If the returns of a group of countries are explained by the same global influences, there will be a high degree of integration. If, instead, the proportion explained by common factors is small, country’s returns will be dominated by local and domestic trends, and the idiosyncratic component \( \varepsilon_{c,t} \) will describe \( R_{c,t} \) (see, e.g., Errunza and Losq, 1985; Stulz, 1981, 1987).

In order to measure the distance between volatility of common trends and volatility of domestic return, we provide an integration index based on the fraction of unexplained variance, namely the coefficient of determination (i.e., R-squared of Eq. (1)) of the linear multi-factor model in Eq. (1) with estimated factors. Our estimation methodology is strictly related to the approach in Pukthuanthong and Roll (2009). In other words, this indicator measures how each country interfaces with the global trend.

Finally, we identify the source of integration expressing the R-squared in term of systematic and idiosyncratic risk (see, e.g., Greene, 2007). Let us define the following two measures: (i) the systematic risk \( SystRisk_c = \left( \frac{ESS_c}{T} \right)^{1/2} \), where the explained sum of squared return is \( ESS_c = \sum_t (\hat{R}_{c,t} - \bar{R}_c)^2 \) and (ii) the idiosyncratic risk \( IdiRisk_c = \left( \frac{RSS_c}{T} \right)^{1/2} \) (i.e., the square root of residual variance), with \( RSS_c = \sum_t \hat{\varepsilon}_{c,t}^2 \) and \( \hat{\varepsilon}_{c,t} = \hat{R}_{c,t} - R_{c,t} \). Then, the R-squared for each country \( c \) can be written as:

\[
R^2_c = \frac{SystRisk^2_c}{SystRisk^2_c + IdiRisk^2_c}. \tag{2}
\]

The Eq. (2) is in line with the definition of financial integration above. Indeed, the integration degree is positively affected by the proportion of systematic risk. If integration is low, we should expect a higher proportion of idiosyncratic volatility. This means that domestic returns will be mainly explained by local (domestic) factors and will not be highly connected with the \( r \) global factors. By dividing systematic from idiosyncratic risk, therefore, integration will be explained in terms of the different weights of local or global factors (the next section offers an empirical example).

6Technical details on the estimation procedure are reported in Appendix 2. We also refer to Nardo et al. (2017). Finally, the numerical computations are all performed with MATLAB©.
2.2 Financial integration among EU28 equity markets

Our empirical analysis is based on stock exchange price indexes for the EU28 countries\(^7\). We obtain a balanced dataset (i.e., no-missing data) of daily continuously compounded returns that covers the period from January 2005 to December 2016. Table 8 in Appendix B.2 contains the list of price indexes involved in the empirical analysis. We distinguish the Euro Area (EA) and non-Euro Area (not-EA) countries. For the EA, we also consider the subsamples of core Euro Area (EA core) and distressed Euro Area (EA distressed)\(^8\). This last category includes the countries that were more affected by the sovereign debt crisis (see Lane, 2012).

In this section, we provide two empirical exercises based on a data-driven approach to highlight how the financial integration among the European countries evolves over time.

1. For each country, we split the sample in two subsamples with respect to the sovereign European crisis. In particular, the first subsample, from January 2005 to December 2009\(^9\), covers the US/EU financial crises of 2007-2008. The second subsample is defined from January 2010 to December 2016, and includes the European sovereign debt crisis. For each subsample, we estimate the integration index.

2. We compute the integration index over time by applying the estimation procedure over the panel of data at each calendar year. This allows us to perform the analysis on drivers of financial integration in Section 2.3.

In Table 9 in Appendix B.2, we report the preliminary descriptive statistics of the index returns for the two subsamples studied in the first exercise. The statistics highlight the large effect of the sovereign debt crisis on the equity markets, in particular in the distressed EU area. As indicated in the introduction, the correlation is a preliminary tool for the analysis of international integration. Nardo et al. (2017) study the pairwise correlation index across countries over the two subsamples. They show that the correlation between EA core and distressed countries decreases after the crisis. They also observe that the rest of EA countries (Estonia, Latvia, Lithuania, Malta, Slovakia and Slovenia) show a small correlation among them and between the rest of the EU28. UK is highly and positively correlated with the EA core and distressed countries.

In Table 2, we report the average cross-countries correlation among the country clusters at each calendar year. Focusing on the EA distressed, the correlation slightly increases from 2005 to 2010, and then starts to slowly decrease. A similar pattern is also observed for the countries belonging in the EA core. The correlation among the countries in the rest of Euro Area is low and positive, and it does not vary substantially over time.

With the purpose of estimating the integration index, for each country \(c\), we perform the PCA to estimate the global, latent factor \(F\) on the matrix of standardized returns by excluding country \(c\). In this way, we avoid that country’s return \(c\) is biased by heavy weights in the principal components for the selected country.

In order to select the number of common factors explaining the integration, we use the BIC criteria (see Appendix B.1)\(^10\). The number of latent factors is on average equals two for the first sample (January 2005 to December 2009) and the exposures corresponding to the first factor are positive for all countries. Only few countries have small loadings on the first factors (e.g., Malta and Slovenia). The first factor seems therefore to reflect the European dimension of stock markets. Evaluating the second factor (which captures the residual variance of the data) is more difficult because the contrasting signs and the

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\(^7\)Source: Bloomberg Database.

\(^8\)Euro Area includes Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain. Non-EA includes Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, and United Kingdom. EA core includes Austria, Belgium, Finland, France, Germany, Luxembourg, and Netherlands. EA distressed includes Cyprus, Greece, Ireland, Italy, Portugal and Spain. Non-EA core includes Denmark, Sweden and UK.

\(^9\)The long-term interest rates of all European countries have started to increase since the end of 2009 (see Lane, 2012)

\(^10\)Bai and Ng (2002) show that BIC criteria estimates consistently the number of common factors when the cross-section is smaller than time-series dimension.
differentiated exposures across countries. It captures peculiar dynamics happening to single or group of countries. The second part of the sample is only affected by one global factor\textsuperscript{11}, again reflecting the common driver of the sovereign crisis.

The median across countries of adjusted R-squared of the model in Eq. (1) is the indicator of financial market integration\textsuperscript{12}. In Table 3, we report the $R^2_{c,adj}$, $SystRisk_c$, and $IdiRisk_c$ for each country $c$. The regressions are computed on the panels of the returns of the two cohorts over time. We observe that a positive relation exists between the systematic risk and the integration index, as expected: systematic volatility is higher than idiosyncratic volatility for high levels of the Integration index (i.e., larger than 0.7). This means that domestic returns are well explained by the selected common factors. We obtain high integration in both subsamples over time for EA core countries, Italy, Portugal, Spain, Denmark, Sweden and United Kingdom (a similar pattern is also observed for non-EA core). Instead, estimated common factors fail to capture the large bulk of domestic returns for countries belonging to the cluster labeled rest-EA (i.e., Estonia, Latvia, Lithuania, Malta, Slovakia and Slovenia). These returns are clearly affected by the idiosyncratic components. The integration levels among the EA distressed countries slightly decreases (on average) during the sovereign crisis. In particular, the volatility of the integration index is higher in the second part of the samples, reflecting the economic situation of the countries.

In order to better understand the role of systematic and idiosyncratic risk w.r.t. the integration index, Figure 2 displays the integration index, the systematic and idiosyncratic volatilities computed on yearly data for Germany and Spain as examples. The integration index for Germany is constant over time and is mostly affected by the systematic volatility of EU (global) factors. The opposite case is Spain where idiosyncratic volatility affects its Integration index causing a plunge after 2012.

Figure 3 plots the integration index, the systematic and idiosyncratic volatilities estimated on yearly panel data. Each plot reports results for several cross-sectional clusters of countries. Again, we observe the positive correlation between the integration index and the systematic volatility of the panel. Patterns of idiosyncratic volatility are clearly specular w.r.t. systematic ones. The integration index among the EU28 has a pattern which depends on the financial and sovereign crisis, decreasing in the topical years of the crisis.

The pattern of integration index among the EU28 is similar to the one among EA-

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|c|}
\hline
\hline
EU28     & 0.447 & 0.381 & 0.222 & 0.302 & 0.413 & 0.530 & 0.410 \\
EA       & 0.423 & 0.364 & 0.234 & 0.311 & 0.409 & 0.496 & 0.369 \\
EA core  & 0.782 & 0.814 & 0.606 & 0.723 & 0.788 & 0.820 & 0.749 \\
EA distressed & 0.639 & 0.500 & 0.338 & 0.479 & 0.598 & 0.707 & 0.634 \\
rest EA  & 0.189 & 0.111 & 0.014 & 0.074 & 0.159 & 0.289 & 0.130 \\
non-EA   & 0.505 & 0.421 & 0.223 & 0.290 & 0.408 & 0.607 & 0.514 \\
\hline
2010     & 0.437 & 0.454 & 0.338 & 0.266 & 0.336 & 0.366 & 0.385 \\
2011     & 0.413 & 0.426 & 0.314 & 0.276 & 0.343 & 0.356 & 0.365 \\
2012     & 0.806 & 0.872 & 0.830 & 0.740 & 0.772 & 0.817 & 0.801 \\
2013     & 0.669 & 0.594 & 0.415 & 0.345 & 0.435 & 0.438 & 0.577 \\
2014     & 0.100 & 0.189 & 0.013 & 0.072 & 0.124 & 0.119 & 0.089 \\
2015     & 0.494 & 0.519 & 0.389 & 0.259 & 0.327 & 0.373 & 0.427 \\
2016     &       &       &       &       &       &       &       \\
\hline
\end{tabular}
\caption{Average correlation index among cluster of EU countries. Average correlations computed on the two subsamples: (i) Jan.2005-Dec.2009 and (ii) Jan.2010-Dec.2016, and on each calendar year.}
\end{table}

\textsuperscript{11}For more details, see Nardo et al. (2017)

\textsuperscript{12}We perform a similar estimation approach as in Pukthuanthong and Roll (2009), but we do not apply the out-of-sample PCA. However, we check that the out-of-sample analysis affects the results in a residual way. We get that the patterns of integration index are similar, and the out-of-sample analysis produces levels that are slightly slow.
distressed. The rest of EA countries are not sensitive to global factors, which mainly capture the Euro Area core markets dynamics.

Figure 2: Integration index, systematic and idiosyncratic volatilities of Germany and Spain. The panels plots the adjusted coefficient of determinations, the systematic and idiosyncratic components of risk over years for Germany and Spain, respectively.
Table 3: Results from regression Eq. (1) over the subsamples (i) and (ii). The table reports the adjusted R-squared of linear regression Eq. (1) for each country. Systematic and idiosyncratic volatilities are also reported. Descriptive statistics (mean, median and standard deviations) are computed by clustering the countries.
Figure 3: Integration, systematic and idiosyncratic indexes among EU28. The upper panel plots the median of adjusted coefficient of determinations by clustering the EU28 in EA core, EA distressed, rest EA and non-EA core. The median of systematic and idiosyncratic components of risk are plotted in the second and third panel, respectively.
2.3 Drivers of financial integration

In this section, we focus on the drivers behind integration for the EU28. We consider a large set of variables related to country’s financial development, macro-economic profile, and business characteristics\(^{13}\). The data are downloaded from the World Bank. Buttner and Hayo (2011) focus on the EU countries. As the EU28 countries are all under the same regime of free movement of capital (at least on paper) and most of them have also the same currency the elimination of foreign exchange risk is not considered (for an analysis see Carrieri et al., 2007; Vo and Daly, 2007).

Following the literature, in our model we consider measures of trade in goods across EU countries such as trade openness\(^{14}\), the amount of merchandise trade, foreign direct investment (FDI) outflows and inflows (in of GDP). The idea is that a country open to trade and with a large share of FDI outflows/inflows should be more integrated as those variables are indicators of cross-border capital mobility. Vo and Daly (2007), among others, uses the aggregate stock of FDI and portfolio investment as measures of financial integration.

The second set of determinants reflects the country’s macroeconomic profile. These indicators are especially relevant when studying the factors affecting integration during the recent financial and sovereign crises. Inflation is used as a possible driver since it is closely related to competitiveness, growth and financial development. Volosovych (2011) shows that both policy related variables (e.g., inflation, government deficit) as well as the global market environment are associated with the evolution process of financial integration. Current account balance (in % of GDP) is used as an indicator for the overall strength of the economy. We use tax revenue (in % of GDP) as an indicator of government tax policies.

A well-documented literature (see Lane and Milesi-Ferretti, 2008) shows that financial integration depends on the development of the domestic financial market and of the overall economy, therefore we include GDP and GDP per capita to capture financial deepness. We also consider net inflows from equity securities in the domestic market (i.e., portfolio equity) and the amount of transactions in equity and debt securities. Both variables are expected to have a positive impact on the degree of integration.

Finally, to capture the country’s overall riskiness, the sovereign long term rating is also used. Ratings are downloaded from the Moody’s rating agency. All rating classes are transformed into a numerical scale varying from one to twenty-one, the last class corresponds to the best rating category. Christiansen (2014) examining the degree of integration of EU government bonds concludes that EMU countries with a higher rating results to be integrated while for non-EMU countries, the credit rating are not significant factors. Finally, we include a set of governance indicators capturing the idea that countries with a better governance quality could more easily attract foreign investors, and thus exhibit a higher degree of integration. Our indicators capture various dimensions of the quality of governance such as the control of corruption, the overall effectiveness of the government, general political stability, confidence in the rules, how well governments policies and regulations promote the private sector development and citizens’ freedoms.

In order to investigate on the possible drivers of integration across EU28 countries, we consider the dataset of yearly integration degree estimated in the previous section. We choose the better combination of explanatory variables that affect integration by performing a stepwise procedure. This methodology is based on a forward and backward threshold \(p\)-value, that we fix at 5%.

In Table 4, we report the results obtained by regressing the integration index of the EU28 and EA countries over the set of variables describe above. We perform the exercise distinguishing between the two set of countries. Our results show that the most significant variables to explain integration are: (i) the integration degree of previous year, (ii) the market capitalization and (iii) the country’s rating. Integration therefore depends on

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\(^{13}\)For a definition of the variables used see Nardo et al. (2016b).

\(^{14}\)Trade openness is defined as the sum of exports and imports of goods and services measured as a share of the gross domestic product. This variable is often used in the literature as a globalization driver (e.g. Lane and Milesi-Ferretti, 2008; Volosovych, 2011).
the menu of available investment opportunities and on past levels of integration. In our model integration tends to be cumulative: an integrated country (as for example EA core countries) is most likely to continue being integrated. Finally, countries with a higher credit rating are also more integrated suggesting that investors seek for a low riskiness level for their investment environment. This is especially important under the recent financial and/or sovereign crisis. Other macro-economic variables and governance indicators in our estimations do not affect the degree of integration among the EU28.

<table>
<thead>
<tr>
<th>Panel A: EU28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Int. degree</td>
</tr>
<tr>
<td>Market Cap.</td>
</tr>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>lnGDP</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>R-squared:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: EA countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Int. degree</td>
</tr>
<tr>
<td>Current account balance</td>
</tr>
<tr>
<td>Market Cap.</td>
</tr>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>lnGDP</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>R-squared:</td>
</tr>
</tbody>
</table>

Table 4: Drivers of integration degree among EU28 countries and EA countries. Table reports the results from the stepwise procedure over the set of variables described in Section 2.3. All regressors are lagged to the previous year. Panel A and B report results obtained from regress the integration indexes of EU28 and EA countries, respectively.
3 Model driven integration: IAPT to measure financial integration

In this section, we provide evidence on time-varying equity market integration based on IAPT. We analyze the degree of integration between a sample of EU countries and the rest of the world and its variation over time.\(^{15}\)

3.1 Theoretical framework

We provide a model that accommodates the evolving market structure from segmentation to integration as well as intermediate cases, depending on the existence of barriers to investments and the availability of substitute assets.\(^{16}\)

We assume that the set of investors is divided in two subsets:

i. the *unrestricted investors* can trade in all the securities available in the market (domestic and cross-border);

ii. the *restricted investors* can only trade in a subset of the domestic securities, the so-called *eligible* securities.

The no-eligible or *ineligible* securities can be held only by the unrestricted investors.

Consider the example of two countries. Investors are restricted in country 1 while investors are unrestricted in country 2. Country 1 securities are therefore fully eligible (by investors in country 1 and 2), while country 2 securities are ineligible for country 1 investors (but eligible for country 2 investors). Specifically, suppose that portfolio inflow restrictions imposed by the government of country 2 prevent country 1 investors from holding country 2 securities; whereas such controls are not imposed by the government of country 1. Table 5 provides a representation of the mild segmentation model. In this framework, the restricted investors can duplicate returns on ineligible assets through homemade diversification, i.e. the so-called diversified portfolio.

<table>
<thead>
<tr>
<th>Country 1</th>
<th>Country 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted investors</td>
<td>Unrestricted investors</td>
</tr>
<tr>
<td>Eligible assets</td>
<td>Ineligible assets</td>
</tr>
<tr>
<td>Investors can trade only in a subset of the securities.</td>
<td>Investors can trade in all the securities available.</td>
</tr>
</tbody>
</table>

Table 5: Representation of the mild segmentation model. The table provides the main characteristics of the two countries in the Errunza and Losq (1985)’s model.

Errunza and Losq (1985) propose to measure the financial integration through an aggregate measure of substitution between ineligible securities and the eligible assets of the world market. We borrow this idea and consider the correlation index between the portfolios returns of ineligible assets and eligible securities to measure for the financial integration between two countries:

\[
II = 1 - \frac{\text{Var}[R_I|R_e]}{\text{Var}[R_I]}, \tag{3}
\]

where \(R_I\) is the returns of market portfolio of ineligible securities and \(R_e\) is the vector of returns on all securities that can be bought by all investors irrespective to their nationality.

The measure in Eq. (3) is the ratio between the unspanned\(^{17}\) and the total variance of the country index. The integration index \(II\) is empirically similar to the R-squared of

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\(^{15}\) Technical details on the theoretical framework and estimation procedure are reported in Appendix 3. We also refer to Ossola and Rossi (2017a,b).

\(^{16}\) We link to the mild segmentation of capital markets model proposed by Errunza and Losq (1985).

\(^{17}\) The unspanned variance is the non-observed variance of the returns for unrestricted securities conditional to the variance of returns for eligible assets. For a detailed derivation see Ossola and Rossi (2017a).
a regression of \( R_I \) on \( R_e \) and ranges between 0 and 1, by definition. The extreme values correspond to the two polar cases of integration degree. In particular, when \( II = 1 \), i.e. \( \text{Var}[R_I|R_e] = 0 \), the markets are fully integrated. In this case, there exists a portfolio of eligible securities that is perfectly correlated with the return on market portfolio of ineligible securities (see Eq. (6) in Appendix C.1). Looking at Table 5, the market are fully integrated when we are not able to distinguish the investors of country 1 and 2, and the only measure of risk would be the risk defined for the world market portfolio. The opposite situation is when \( II = 0 \), i.e. \( \text{Var}[R_I|R_e] = \text{Var}[R_I|I] \), the markets are completely segmented. The following table summarizes the interpretation of index \( II \).

| \( II = 0 \) | \( \text{Var}[R_I|R_e] = \text{Var}[R_I] \) | Completely segmented market |
| \( 0 < II < 1 \) | \( \text{Var}[R_I|R_e] > 0 \) | Partially segmented market |
| \( II = 1 \) | \( \text{Var}[R_I|R_e] = 0 \) | Perfectly integrated market |

**Table 6:** Interpretation of the financial integration index in Eq. (3).

Index \( II \) in Eq. (3) can be extended in a time-varying setting. Modeling the expected returns on each local equity market as a function of conditional covariances, and under the normality assumption of returns, we obtain the following equation:

\[
II_t = 1 - \frac{\text{Var}_{t-1}[R_I|R_e]}{\text{Var}_{t-1}[R_I]} = \frac{\text{Cov}_{t-1}[R_I, R_e]' \text{Var}_{t-1}[R_e]^{-1} \text{Cov}_{t-1}[R_I, R_e]}{\text{Var}_{t-1}[R_I]}. \tag{4}
\]

To derive an estimator for the integration index in Eq. (4), we need to take into consideration that:

- the portfolio of eligible assets \( R_e \) is not observable, thus we need to provide an approximation (i.e., diversified portfolios);
- the covariances are not observable and therefore we need to provide a model for them. In particular, we introduce a law of motion for the conditional covariances, and we link it to the multivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models (see, e.g., Bollerslev and Wooldridge, 1992).

The empirical application, provided in the next section, follows these two main points.

### 3.2 Time-varying integration of European stock markets and the world market

Our study focuses on a set of European countries: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (GE), Ireland (IE), Italy (IT), Netherlands (NL), Norway (NO), Portugal (PT), Spain (ES), Sweden (SE), United Kingdom (UK).\(^\text{18}\) Our data set includes the following groups of data:

(i) daily data on returns of European and World market indexes (MSCI) used to compute the realized covariances (see Ossola and Rossi, 2017a);

(ii) monthly data on returns of European stock market and world market indexes. The world market portfolio is approximated by the MSCI value-weighted world index whereas the European stock market returns are computed starting from the MSCI indexes for each country;

(iii) a set of monthly data on macroeconomic and financial variables are used to explain the prices of risks and to construct the diversified portfolio. In particular, we employ the monthly returns of 11 MSCI industry portfolios (see Table 10 in Appendix C.2), the default spread (Moody’s BAA-AAA bond yields) and the 30-day Eurodollar rate.

The data cover the period from January 1995 to August 2016. The monthly returns are defined as \( R_{i,t} = \log(P_{i,t}/P_{i,t-1}) \). The monthly excess return of each index is calculated using

\(^{18}\)Due to data shortage, other EU countries are not considerate in the empirical application.
the one-month Eurodollar rate as a proxy of the risk free rate.

The *Diversified portfolio* (DP) is the most highly correlated portfolio with the market portfolio of ineligible securities (see Appendix C.1). To get an estimates for it, we regress $R_{it}$ on the MSCI world index and the MSCI global industry portfolios\(^{19}\). In this way, the diversification portfolio is constructed using past information.

Hereafter, we analyze the time-varying integration of EU stock markets with respect to the world market. We estimate the integration index $II_t$ in Eq. (4). We also assess the risk premium, i.e., the financial compensation asked for bearing systematic risk. This measure of total risk premium is particularly appealing in this context as it can be interpreted as a measure of the cost of non-integration. In particular, we express the implied risk premium as the sum of the risk premium of global and local factors. If integration index decreases over time, the financial compensation for bearing risk increases. In particular, the risk premium for local (global) factors increases (decreases) when the integration index reduces (expands). Accordingly to the theoretical model, fluctuations in risk premium come from three different sources of variation: the price of risk, the degree of segmentation, and the covariance moments.

The general theoretical model described in the previous section and in Appendix C.1, allows us to build several representations that differ w.r.t. the conditional covariance model used, the assumption on prices of risk (i.e., time-invariant or time-varying) and the frequency of data involved in the computation. Table 11 in Appendix C.2 gives the model taxonomy arising from our theoretical framework and the availability of empirical data. For each European country, we provide results for models that employ monthly data\(^{20}\). We then select the more robustness specification using a statistical criterion\(^{21}\).

Below, we report results assuming time-varying prices of risk\(^{22}\). For all countries, the best specifications for conditional covariances are the ones provided by the complete specification (i.e., namely GARCH(1,1) and GARCH-X models). This specifications includes the past realized covariances and realized covariances, respectively.

In Table 7, we report the summary statistics (average and standard deviation) of the estimated integration degree and total, global and local risk premium. For each country, Figures 4 to 17 plot the estimated integration index and the associated risk premium. It is evident from the figures that the estimates of $II_t$ vary across countries, in some cases strikingly. This is due to the reduced length of the time series within a model that is computationally demanding.

We can recognize in the plots of the estimated $II_t$ a common pattern, which essentially can be described as the occurrence of a peak in the integration process just before the financial crisis of 2008 and a subsequent decrease in the following years. Not surprisingly, the risk premium is larger when markets enter in turmoil periods, like in 2008-2009.

Further, it should be noted that the local risk premium is very small. In terms of portfolio allocation, this means that the excess returns depend only on the world factor risk. Whereas in terms of financial integration this means that the European countries are largely integrated with the World. This result is in line with the literature (see, e.g., Alotaibi and Mishra, 2017; Boubakri et al., 2016; Devereux and Yu, 2014), as expected, which stresses that developed markets are much more integrated in the world economy than emerging markets.

\(^{19}\)See Ossola and Rossi (2017a,b) for technical details on the estimation methodology and results of the diversified portfolio.

\(^{20}\)For robustness purposes the GARCH models have been estimated also with daily data.

\(^{21}\)It worth mentioning that complete GARCH models include a far larger number of parameters to be estimated. This could pose problems in terms of convergence of numerical algorithms used to maximize the log likelihood function.

\(^{22}\)Results for models assuming time-invariant prices of risk are available in Ossola and Rossi (2017a) and updated in Ossola and Rossi (2017b).
Table 7: Summary statistics of integration index and risk premia. For each European country, the table reports the average estimated integration index and its standard deviation, denoted by $\bar{II}_t$ and $sd(\bar{II}_t)$, respectively. Moreover, we report the average estimates of total $\bar{TOTPR}_t$, global $\bar{GPR}_t$, and local risk premium $\bar{LPR}_t$.

<table>
<thead>
<tr>
<th>Country</th>
<th>$\bar{II}_t$</th>
<th>$sd(\bar{II}_t)$</th>
<th>$\bar{TOTPR}_t$</th>
<th>$\bar{GPR}_t$</th>
<th>$\bar{LPR}_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>0.538</td>
<td>0.095</td>
<td>1.020</td>
<td>1.020</td>
<td>0.000</td>
</tr>
<tr>
<td>BE</td>
<td>0.494</td>
<td>0.079</td>
<td>1.590</td>
<td>1.590</td>
<td>0.000</td>
</tr>
<tr>
<td>DK</td>
<td>0.433</td>
<td>0.107</td>
<td>1.493</td>
<td>1.493</td>
<td>0.000</td>
</tr>
<tr>
<td>FI</td>
<td>0.472</td>
<td>0.126</td>
<td>2.168</td>
<td>2.168</td>
<td>0.000</td>
</tr>
<tr>
<td>FR</td>
<td>0.662</td>
<td>0.120</td>
<td>1.787</td>
<td>1.735</td>
<td>0.052</td>
</tr>
<tr>
<td>GE</td>
<td>0.620</td>
<td>0.082</td>
<td>1.949</td>
<td>1.949</td>
<td>0.000</td>
</tr>
<tr>
<td>IE</td>
<td>0.390</td>
<td>0.110</td>
<td>1.665</td>
<td>1.665</td>
<td>0.000</td>
</tr>
<tr>
<td>IT</td>
<td>0.470</td>
<td>0.110</td>
<td>1.799</td>
<td>1.799</td>
<td>0.000</td>
</tr>
<tr>
<td>NL</td>
<td>0.577</td>
<td>0.129</td>
<td>1.675</td>
<td>1.670</td>
<td>0.005</td>
</tr>
<tr>
<td>NO</td>
<td>0.641</td>
<td>0.111</td>
<td>1.661</td>
<td>1.661</td>
<td>0.000</td>
</tr>
<tr>
<td>PT</td>
<td>0.377</td>
<td>0.145</td>
<td>1.391</td>
<td>1.391</td>
<td>0.000</td>
</tr>
<tr>
<td>ES</td>
<td>0.533</td>
<td>0.154</td>
<td>1.963</td>
<td>1.959</td>
<td>0.003</td>
</tr>
<tr>
<td>SE</td>
<td>0.601</td>
<td>0.116</td>
<td>1.763</td>
<td>1.763</td>
<td>0.000</td>
</tr>
<tr>
<td>UK</td>
<td>0.661</td>
<td>0.128</td>
<td>1.312</td>
<td>1.307</td>
<td>0.005</td>
</tr>
</tbody>
</table>
Figure 4: II and total risk premium of Austria (AT). The first panel shows the integration degree estimated over the model (6). The second panel plots the corresponding estimates of total risk premium.

Figure 5: II and total risk premium of Belgium (BE). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.
**Figure 6:** II and total risk premium of Denmark (DE). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

**Figure 7:** II and total risk premium of Finland (FI). The first panel shows the integration degree estimated over the model (9). The second panel plots the corresponding estimates of total risk premium.
Figure 8: II and total risk premium of France (FR). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

Figure 9: II and total risk premium of Germany (GE). The first panel shows the integration degree estimated over the model (9). The second panel plots the corresponding estimates of total risk premium.
**Figure 10:** II and total risk premium of Ireland (IE). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

![Integration Degree](image)

![Risk Premium](image)

**Figure 11:** II and total risk premium of Italy (IT). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

![Integration Degree](image)

![Risk Premium](image)
**Figure 12:** II and total risk premium of Netherlands (NL). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

**Figure 13:** II and total risk premium of Norway (NO). The first panel shows the integration degree estimated over the model (6). The second panel plots the corresponding estimates of total risk premium.
**Figure 14:** II and total risk premium of Portugal (PT). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

**Figure 15:** II and total risk premium of Spain (ES). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.
**Figure 16:** II and total risk premium of Sweden (SE). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

![Integration Degree](image1)

![Risk Premium](image2)

**Figure 17:** II and total risk premium of United Kingdom (UK). The first panel shows the integration degree estimated over the model (10). The second panel plots the corresponding estimates of total risk premium.

![Integration Degree](image3)

![Risk Premium](image4)
4 Conclusions

In this report, we focus our study on the price-based indicators and we provide evidence on time-varying equity market integration, employing two alternative econometric methodologies.

- We provide a data driven application, improving the framework in Pukthuanthong and Roll (2009). We consider the equity market returns for EU28 countries from January 2005 to December 2016 and we estimate the integration degree for two subsamples w.r.t. the European sovereign crisis. We also identify the possible drivers of integration in the equity market.

- We provide a model driven application. Based on the asset pricing theory and the model in Errunza and Losq (1985), we estimate a time-varying integration index. In order to model conditional second moments, we employ specifications including past variability of returns. We analyze the degree of integration of European markets with the rest of the world, and its variation from January 1995 to August 2016.

The following results come out from the empirical applications:

1. The market integration decreased during the European sovereign crisis but recovered afterwards. The integration index among the EU28 follows over time a similar pattern of the integration index of countries belonging the EA distressed area.

2. The main drivers of integration results to be the development of the domestic financial market and the country’s credit rating.

3. Most of European markets integrate with the world market. Moreover, local risk factors do not seem to heavily affect integration in the European markets.

Several open issues warrants future research. Besides the technical improvement of the theoretical model that could include tackling the presence of multiple factors instead of only one, a promising avenue of research is the refinement of our measure for the cost of non-integration in order to produce an aggregate indicator.
Appendix

A Linear factor model for market integration

In this section, we provide a short review of the literature on financial market integration. We focus mainly on linear factor models introduced to provide an explanation of the financial integration based on the equilibrium approach. The literature distinguishes between full integration, complete segmentation, and the intermediate case of mild segmentation. Several equilibrium models, based on the assumption that there exists an equilibrium relationship between portfolio risk and expected return of assets, have been introduced to model and measure financial integration.

The market is said to be completely segmented when the asset pricing restriction is country specific and the returns are only function of domestic risk factors. In this case, the portfolio allocation is constrained to domestic assets. The asset pricing theory applied to a single country suggests several models for completely segmented market. The workhorse model is the CAPM proposed by Sharpe (1964), Lintner (1965) and Black (1972). In this case, the market portfolio of country $C$, denoted by $R_C$, is the only systematic source of risk:

$$E[R_C^i] = R_C^f + \beta_i(E[R_C] - R_C^f) = R_C^f + \lambda_C \text{Cov}[R_C^i, R_C],$$

where $E[R_C^i]$ is the expected return on asset $i$, $R_C^f$ is the risk free rate in country $C$ and $\beta_i$ is the market loading of asset $i$. The domestic price of market risk in country $C$ is $\lambda_C = (E[R_C] - R_C^f) / \text{Var}(R_C)$. At a country level, we have $E[R_C] = R_C^f + \lambda_C \text{Var}(R_C)$. Several extensions of the domestic CAPM has been considered. The Arbitrage Pricing Theory by Ross (1976) introduces several systematic sources of risk to explain the stock prices. For example, Acharya and Pedersen (2005); Fama and French (1993, 2015); Merton (1987) introduce additional risk factors in the specification of excess returns.

The second polar case is the full integration of the market. Market is perfectly integrated when the same asset pricing restriction holds in every country and the expected returns are function of only global risk factors. Investors can benefit from all international investment opportunities. This definition is in line with that provided by the report of the European Central Bank (ECB) (2007). Grauer et al. (1976); Solnik (1974, 1983) provide the International CAPM based on the assumption that Law of One price holds, i.e. identical assets have the same price regardless of the country they are traded. For an asset $i$, the classical International CAPM states that:

$$E[R_i] = R_f + \beta_i(E[R_W] - R_f) = R_f + \lambda_W \text{Cov}[R_i, R_W],$$

where $R_W$ is the expected return on the world market and $\lambda_W = (E[R_W] - R_f) / \text{Var}(R_W)$ is the world price of market risk. In this framework, the domestic risk is not rewarded because it is eliminated by the diversification. Dumas and Solnik (1995); Harvey (1991) provide a conditional framework allowing for time-varying market risk premium and time-variation in the rewards of exchange rate risk, respectively. However, the assumption of perfectly integrated market is too strong w.r.t. the empirical evidence (e.g., Jorion and Schwartz, 1986; Karolyi and Stulz, 2002 show the theoretical failures of the International CAPM).

Errunza (1992) test the hypothesis of full integration and complete segmentation for a group of emerging markets. The results provide strong evidence in favor of a mild segmentation structure. In a more general framework, Arouni et al. (2012) establish that if some investors do not hold all international assets because of direct and/or indirect barriers, the world market portfolio is not efficient and the traditional international CAPM must be augmented by a new factor reflecting the local risk undiversifiable internationally.

Bekaert and Harvey (1995) provide an extension of the static model by Errunza and Losq (1985), assuming that the degree of integration is variable over time. They propose a conditional regime switching model where countries are allowed to shift from segmentation to integration according transition probability. Most recent papers provide empirical
assessment about the evolution of market integration showing that emerging markets are partially segmented, whereas developed markets are highly integrated into the world market (see, e.g, Adler and Qi, 2003; Bali and Cakici, 2010; Bhattacharya and Daouk, 2002; Carrieri et al., 2007; Frijns et al., 2012; Hardouvelis et al., 2006; Pukthuanthong and Roll, 2009).

In the real world, the markets are partially integrated or mild segmented. Black (1974) put forward a model of capital market equilibrium with explicit barriers to international investment in the form of a tax on foreigner holdings of assets. Cooper and Kaplanis (2000); Stulz (1981) extend the Black’s model showing that the tax level is the main variable that affects the portfolio asset allocation and the resulting market segmentation. A more general approach to deal with the mild segmentation of domestic markets is proposed in Errunza and Losq (1985). They consider a two-country capital market model. They assume that foreign (or unrestricted) investors can trade on both domestic and foreign assets, whereas the domestic (or restricted) investors can only invest in domestic assets. In this model, the authors show that the eligible assets (assets from the domestic country) are priced as in the classical International CAPM (see Section 3).

Alternatively to this literature, Chen and Knez (1995) propose a general arbitrage approach to define a test for integration, avoiding referring to a particular asset pricing model. They define a market perfectly integrated if the Law of One price in not violated and there are not arbitrage opportunities. In this context, markets are fully integrated if only stochastic discount factor model prices assets in every country. It follows that measures of market integration are developed using a general definition of stochastic discount factor (see also Flood and Rose (2005)).

B Data driven integration: Technical details and additional tables

B.1 Approximate factor structure for country’s index returns

In this section, we specify the linear factor structure of returns in Eq. (1). In matrix notation, we have

$$R_t = BF_t + \varepsilon_t, \quad (7)$$

where $R_t = [R_{1,t}, ..., R_{C,t}]'$ and $\varepsilon_t = [\varepsilon_{1,t}, ..., \varepsilon_{C,t}]'$ are $C \times 1$ vectors, and $B = [\beta_1, ..., \beta_C]'$ is a $C \times r$ matrix. We impose the standard conditions on matrices $F_t$ and $B$ in linear latent factor models (see Nardo et al., 2017).

Let $\Sigma_\varepsilon$ denote the $C \times C$ conditional variance-covariance matrix of the error vector $\varepsilon_t$. Importantly, we impose an approximate factor structure for the error terms, i.e. the largest eigenvalue of $\Sigma_\varepsilon$ is bounded as $C$ approaches infinity (see Assumption C in Bai and Ng, 2002 and Assumption APR.3 in Gagliardini et al., 2016, see also Chamberlain and Rothschild, 1983).

The number of factors $r$ is unknown and can be determined from the data. Since we have $C << T$, we propose to use the Bayesian Information Criterion estimator $BIC_3(r)$ studied in Bai and Ng (2002). Others criteria in order to define the number of latent factors are available in the literature (see, e.g., Ahn and Horenstein, 2013; Gagliardini et al., 2017), we link to $BIC_3(r)$ because of the small cross-sectional dimension.

The estimated factor matrix, denoted by $\hat{F}_t = [\hat{F}_{1,t}, ..., \hat{F}_{r,t}]'$, corresponds to the first $r$ principal components. The corresponding matrix of factor loading is estimated via OLS regression from the time series regression. Pukthuanthong and Roll (2009) apply an out-of-sample Principle Components, i.e. the index returns of year $t$ are regressed on global factors estimated on the covariance matrix in the previous calendar year. In this approach, the resulting regressors could suffer from a multicollinearity problem and we lose a one year of information (see, e.g., Pena and Yohai (2015) for a dynamic implementation of PCA). In order to avoid these limitations, we propose to apply an in-sample PCA and we use the whole information available.
B.2 Additional tables

In this section, we provide additional empirical results on the application in Section 2. Additional results non included here are available in Nardo et al. (2017).

Table 8 contains the list of price indexes involved in our empirical analysis in Section 2.2. We distinguish the countries that belong in the Euro Area (EA) and non-Euro Area (not-EA). For the EA countries, we also consider the subsamples of core Euro Area (EA core) and distressed Euro Area (EA distressed). This last category includes the countries that were more affected by the sovereign debt crisis (see Lane, 2012).

<table>
<thead>
<tr>
<th>Country</th>
<th>Index</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria (AT)</td>
<td>AUSTRIAN TRADED ATX INDEX</td>
<td>EA</td>
</tr>
<tr>
<td>Belgium (BE)</td>
<td>BEL 20 INDEX</td>
<td>EA</td>
</tr>
<tr>
<td>Bulgaria (BG)</td>
<td>SOFIX INDEX</td>
<td>non-EA</td>
</tr>
<tr>
<td>Croatia (HR)</td>
<td>CROATIA ZAGREB CROBEX</td>
<td>non-EA</td>
</tr>
<tr>
<td>Cyprus (CY)</td>
<td>GENERAL MARKET INDEX CSE</td>
<td>EA</td>
</tr>
<tr>
<td>Czech Republic (CZ)</td>
<td>PRAGUE STOCK EXCH INDEX</td>
<td>non-EA</td>
</tr>
<tr>
<td>Denmark (DK)</td>
<td>OMX COPENHAGEN INDEX</td>
<td>non-EA</td>
</tr>
<tr>
<td>Estonia (EE)</td>
<td>OMX TALLINN OMXT</td>
<td>EA</td>
</tr>
<tr>
<td>Finland (FI)</td>
<td>OMX HELSINKI INDEX</td>
<td>EA</td>
</tr>
<tr>
<td>France (FR)</td>
<td>CAC 40 INDEX</td>
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<tr>
<td>Germany (DE)</td>
<td>DAX INDEX</td>
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<tr>
<td>Greece (EL)</td>
<td>ATHEX COMPOSITE SHARE PR</td>
<td>EA</td>
</tr>
<tr>
<td>Hungary (HU)</td>
<td>BUDAPEST STOCK EXCH INDX</td>
<td>non-EA</td>
</tr>
<tr>
<td>Ireland (IE)</td>
<td>IRISH OVERALL INDEX</td>
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<tr>
<td>Italy (IT)</td>
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<tr>
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<td>OMX RIGA OMXR</td>
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</tr>
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<td>Lithuania (LT)</td>
<td>OMX VILNIUS OMXV</td>
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</tr>
<tr>
<td>Luxembourg (LU)</td>
<td>LUXEMBOURG LuxX INDEX</td>
<td>EA</td>
</tr>
<tr>
<td>Malta (MT)</td>
<td>MALTA STOCK EXCHANGE IND</td>
<td>EA</td>
</tr>
<tr>
<td>Netherland (NL)</td>
<td>AEX-Index</td>
<td>EA</td>
</tr>
<tr>
<td>Poland (PL)</td>
<td>WSE WIG INDEX</td>
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</tr>
<tr>
<td>Portugal (PT)</td>
<td>PSI 20 INDEX</td>
<td>EA</td>
</tr>
<tr>
<td>Romania (RO)</td>
<td>BUCHAREST BET INDEX</td>
<td>non-EA</td>
</tr>
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<td>Slovakia (SK)</td>
<td>SLOVAK SHARE INDEX</td>
<td>EA</td>
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<tr>
<td>Slovenia (SI)</td>
<td>SLOVENIAN BLUE CHIP IDX</td>
<td>EA</td>
</tr>
<tr>
<td>Spain (ES)</td>
<td>IBEX 35 INDEX</td>
<td>EA</td>
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<tr>
<td>Sweden (SE)</td>
<td>OMX STOCKHOLM 30 INDEX</td>
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<tr>
<td>United Kingdom (UK)</td>
<td>FTSE 100 INDEX</td>
<td>non-EA</td>
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</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Index</th>
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<td>EU</td>
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<td></td>
</tr>
<tr>
<td>US</td>
<td>S&amp;P 500 INDEX</td>
<td></td>
</tr>
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</table>

Table 8: Stock prices indexes of the 28 EU countries sample. From these data, we build a balanced dataset by dropping the years for which the time-series observations are not available for all the countries and trading days corresponding to national holidays.

Table 9 reports the descriptive statistics of the index returns for the two subsamples. Due to the international financial crises, the European returns on average are negative and proximately to zero in the first period. On the other hand, the sovereign debt crisis had a large effect on the equity markets in few countries of the Euro Area. For example, the average returns of Greece and Spain are negative and more volatile in the second subsample than in the first one. Normality tests are rejected for all countries. Indeed, data show a high level of kurtosis.
### Table 9: Summary statistics of daily returns of EU28. Table reports descriptive statistics for two subsamples over time. Mean and standard deviations are in annualized percentage terms. The test for kurtosis coefficient has been normalized to zero, JB is the Jarque-Bera test for normality based on skewness and excess kurtosis.
C Model driven integration: Technical details and additional tables

C.1 Specification of the mild segmentation model in Errunza and Losq (1985)

In this Section, we describe in details the mild segmentation model proposed by Errunza and Losq (1985). We introduce the following assumptions:

(i) Unequal Access Assumption. The investing population is divided in two subsets: the unrestricted and restricted investors. Restricted investors can trade only eligible assets (denoted by $e$). The ineligible (denoted by $i$) securities can be held only by the unrestricted investors.

(ii) Perfect Capital Market Assumption. The capital markets are perfect and frictionless. This assumption includes equal access to information by all market participants, completely rational economic actors, and no transaction costs.

(iii) Mean-Variance Assumption. The expected utility of an investor is function of the expected value of returns and its variance.

(iv) Free Lending and Borrowing Assumption. Investors can borrow or lend any amount of money at the same risk-free rate of return.

Let us define the vector of returns $R = [R_i', R_e']'$, where $R_i$ and $R_e$ are the vector of returns on the ineligible and eligible securities, respectively. The returns are supposed to be normally distributed with covariance matrix

$$
\Sigma = \begin{bmatrix}
\Sigma_{ii} & \Sigma_{ie} \\
\Sigma_{ei} & \Sigma_{ee}
\end{bmatrix}.
$$

In a similar way, the vector of aggregate market values is $P = [P_i', P_e']'$. To account for the partial integration of the market, we introduce the following portfolios (and their corresponding notation):

1. the World Market Portfolio: market value $M$, rate of return $R_W$, representative vector $WMP = P = [P_i', P_e']'$;

2. the Market Portfolio of Ineligible Securities: market value $M_I$, rate of return $R_I = R_iP_i$, representative vector $MPIS = [P_i', 0]'$;

3. the Market Portfolio of Eligible Securities: market value $M_E$, rate of return $R_E = R_eP_e$, representative vector $MPES = [0', P_e']'$.

Since, the portfolio of eligible assets $R_e$ is not observable, we estimate the diversified portfolio $DP$, that is the portfolio most highly correlated with the market portfolio of ineligible assets $R_I$. Errunza et al. (1999) estimate $DP$ from the set of industry portfolios. Carrieri et al. (2007) consider also the country funds (CF) and the American Depository Receipts (ADRs) to generate highly correlated return with the market portfolios of their ineligible assets. Given the assumption of normality, $DP$ is the portfolio that minimize $\text{Var}[R_I - \alpha^* R_e]$ w.r.t. to $\alpha^*$, i.e., the optimal is $\alpha^* = \Sigma_{ee}^{-1}\Sigma_{ie}$, where $\Sigma_{ie} = \text{Cov}[R_I, R_e]$. Since $R_I = R_iP_i$, $\Sigma_{ie} = \text{Cov}[R_iP_i, R_e] = \Sigma_{ei}P_i$ follows. The dollar amounts invested in the various securities are given by

$$
DP = \begin{bmatrix}
\Sigma_{ee}^{-1}\Sigma_{ie}P_i \\
0
\end{bmatrix}.
$$

Thus, the restricted investors can duplicate returns on unavailable assets through homemade diversification.

Errunza and Losq (1985) show that under market segmentation, the expected return on the $i$-th ineligible security in the $I$-th market is

$$
E[R_i] = R_I + AM \text{Cov}[R_i, R_W] + (A_u - A)M_I \text{Cov}[R_i, R_I|R_e] = R_I + \lambda_W \text{Cov}[R_i, R_W] + \lambda_I \text{Cov}[R_i, R_I|R_e],
$$

where asset $i$ in the $I$-th market is accessible only to nationals. $A$ is the aggregate risk aversion coefficient with $A^{-1} \equiv A_f^{-1} + A_u^{-1}$. $A_u$ is the absolute risk aversion coefficient for
unrestricted investors on the $I$-th market and $\lambda$, is the absolute risk aversion coefficient for restricted investors. The prices of risk $\lambda_w$ and $\lambda_I$ are functions of the relative risk aversions of restricted and unrestricted investors, as showed in Errunza and Losq (1985). The expected return on the potentially segmented market is proportional to the covariance with a global factor and to the conditional market risk\textsuperscript{23}. The expected excess return on the ineligible security market index can be obtained aggregating over the ineligible set of securities:

$$E[R_I - R_f] = AM Cov[R_I, R_W] + (A_u - A)M I Var[R_I|R_e].$$

Under the assumption that returns are jointly normally distributed, we have

$$Var[R_I|R_e] = Var[R_I] - Cov[R_I, R_e]'Var[R_e]^{-1}Cov[R_I, R_e]$$

and

$$\rho^2(R_I, R_e) = \frac{Cov[R_I, R_e]'Var[R_e]^{-1}Cov[R_I, R_e]}{Var[R_I]}.$$

$\rho$ is the multiple correlation coefficient that can be interpreted as the correlation coefficient between $R_I$ and that portfolio of eligible securities which is most correlated with $R_I$, i.e., the DP portfolio. When $\rho = 0$ the extreme form of market segmentation takes place, i.e. when no correlation exists between $R_I$ and the return on any eligible security and the market are completely segmented:

$$E[R_I] - R_f = A_u M I Cov[R_I, R_I].$$

Let use define $r_{I,t},* = \{I, DP, W\}$ the excess return on the $R_{*,t}$ return index. From the Errunza and Losq (1985) model, the following system of equations must hold at any point in time,

$$\begin{align*}
E_{t-1}[r_{I,t}] &= \lambda W_{t-1} Cov_{t-1}[r_{I,t}, r_{W,t}] + \lambda_{I,t-1} Var_{t-1}[r_{I,t}|r_{DP,t}] \\
E_{t-1}[r_{DP,t}] &= \lambda W_{t-1} Cov_{t-1}[r_{DP,t}, r_{W,t}] \\
E_{t-1}[r_{W,t}] &= \lambda W_{t-1} Var_{t-1}[r_{W,t}].
\end{align*}$$

(10)

The first equation in the system is the pricing of the local market index, where two factors are priced: the world market covariance risk and the super risk premium, proportional to the conditional local risk represented by $Var_{t-1}[r_{I,t}|r_{DP,t}]$. The second equation prices the $DP$ through the covariance risk with the world portfolio return. Finally, the last equation is the pricing equation for the world index portfolio. The theory predicts that the world price of risk should be the same for each country.

The model needs the specification of the law of motion of the conditional covariance matrix. To this purpose we consider alternative specifications in the multivariate GARCH family, see Bauwens et al. (2006). The GARCH model are usually appropriate for modeling conditional variances and covariances for stock market. Assuming a conditional Gaussian distribution of stock returns, the GARCH models allow components of variances and covariances vary over time depending on the shocks at time $t - 1$ and on the past values of variances and covariances terms (see Bollerslev, 1986; Engle, 1982). The model’s parameters are estimated by Quasi Maximum Likelihood (QMLE), see Bollerslev and Wooldridge (1992).

\section*{C.2 Additional tables}

This Section contains additional tables that allow to give an exhaustive description of empirical applications.

Table 10 lists the regressors included in the estimation procedure for the diversified portfolio. Table 12 reports the summary statistics for the monthly excess returns of European countries and the World market index. To analyze these data, we consider two subsamples: from January 1995 to July 2007, the so-called pre-crises sub-sample, and from August 2007 to August 2016. The European returns on average are positive and large in the pre-crises subsample. The returns display high volatility in the second subsample, as expected. In the full sample, the difference between the two subsamples are mitigate. The data for

\textsuperscript{23}The conditional market risk is defined as the conditional covariance between the return of asset $i$ and the return on the market portfolio of all ineligible securities $I$, given the returns on all eligible securities. The conditional market risk can be interpreted as a measure of substitutability between a specific ineligible security and the eligible segment of the world market.
Austria and Belgium show a high level of kurtosis and normality test are rejected. The normality tests are not rejected for Italy. We also provide results for the Engle’s ARCH test for heteroskedasticity. For most of the countries, this test is rejected. Table 12 also provides the descriptive statistic for the world market index and the correlation index between data on European stock market \((r_I)\), diversified portfolios \((r_D)\) and the world index \((r_W)\). On average, the correlation index \(\text{Corr}(r_I, r_W)\) is 0.70, thus the data are positive correlated.

\[
x_1 \quad \text{MSCI world index},
\]
\[
x_2 \quad \text{energy index},
\]
\[
x_3 \quad \text{materials index},
\]
\[
x_4 \quad \text{industrials index},
\]
\[
x_5 \quad \text{consumer discretionary index},
\]
\[
x_6 \quad \text{consumer staples index},
\]
\[
x_7 \quad \text{health care index},
\]
\[
x_8 \quad \text{financials index},
\]
\[
x_9 \quad \text{information technology index},
\]
\[
x_{10} \quad \text{telecommunication services index},
\]
\[
x_{11} \quad \text{utilities index},
\]
\[
x_{12} \quad \text{real estate index}.
\]

**Table 10:** Regressors to estimate the diversified portfolio. List of variables involved in the stepwise regressions to determine the diversified portfolio for each country.

Table 11 shows the model taxonomy that arises from our theoretical framework and the availability of empirical data. We consider two conditional covariance models: the GARCH(1,1) model and GARCH models with cross-sectional market volatility. The GARCH(1,1) model involves the true conditional covariance matrix by mean zero errors in its parameterization. This model is the most used in the literature. On the opposite, the GARCH(1,1)-X model involves an estimate of the matrix of quadratic covariations based on the monthly realized variances and covariances.\(^{24}\)

<table>
<thead>
<tr>
<th>Model</th>
<th>Representation</th>
<th>Price of risk</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete</td>
<td>Diagonal</td>
<td>(\lambda_s)</td>
</tr>
<tr>
<td>1</td>
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<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2</td>
<td>x</td>
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</tr>
<tr>
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<td>x</td>
<td>x</td>
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<tr>
<td>4</td>
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<tr>
<td>6</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Table 11:** Model taxonomy.

\(^{24}\)Technical details on the parametrization of conditional covariance models and estimation of realized covariances are reported in Ossola and Rossi (2017a).
Table 12: Summary statistics of excess returns. Monthly data on returns of European and World market indexes are in excess of the 30-day Eurodollar deposit rate. The full sample covers the period from January 1995 to August 2016. We also report some descriptive statistics for two subsamples. Mean and standard deviations are in annualized percentage terms. The test for kurtosis coefficient has been normalized to zero, JB is the Jarque-Bera test for normality based on skewness and excess kurtosis. LB(.) is the Ljung-Box test for autocorrelation of order 2, 4 and 8. ARCH(.) is the Engle’s ARCH test for residual heteroscedasticity of order 2, 4 and 8. Pairwise correlations for the excess portfolio returns $r_I, r_D$ and $r_W$ are also reported.
References


COM (2017) 208 final European Commission. Regulation of the european parliament and of the council amending regulation (eu) no 648/2012 as regards the clearing obligation, the suspension of the clearing obligation, the reporting requirements, the risk-mitigation techniques for otc derivatives contracts not cleared by a central counterparty, the registration and supervision of trade repositories and the requirements for trade repositories. 2017.


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