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Financial integration in Europe through the lens of composite indicators

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Abstract

This paper develops composite indicators of financial integration within the euro area for both price-based and quantity-based indicators covering money, bond, equity and banking markets. Prior to aggregation, individual integration indicators are harmonised by applying the probability integral transform. We find that financial integration in Europe increased steadily between 1995 and 2007. The subprime mortgage crisis marked a turning point, bringing about a marked drop in both composite indicators. This fragmentation trend reversed when the European banking union and the ECB's Outright Monetary Transactions Programme were announced in 2012, with financial integration recovering more strongly when measured by price-based indicators. In a growth regression framework, we find that higher financial integration tends to be associated with an increase in per capita real GDP growth in euro area countries. This correlation is found to be stronger the higher a country's growth opportunities.

JEL classification: F36, F43, F45, G01, G15

Keywords: composite indicator, economic growth, European Monetary Union, financial integration, financial stress

Non-technical summary

This paper develops a novel conceptual framework for measuring financial integration within the euro area. We build composite indicators by aggregating information from different market segments into a single statistic, thereby providing a comprehensive view on the state of financial integration within the monetary union. These composite indicators come in two forms: The price-based indicator relies on measures of cross-country asset return dispersion (e.g., the cross-country standard deviation of certain interest rates), while the quantity-based composite indicator aggregates data on cross-border holdings for different asset classes (e.g., bonds or equities) across different sectors. We keep these two composite indicators separate because of their different nature and due to their different frequency of observation. Both composite indicators present complementary views about the extent to which euro area countries are mutually financially integrated.

Building composite indicators of financial integration faces the challenge that, prior to aggregation, different indicators have to be i) homogenised, and ii) measured relative to a benchmark of full integration. This paper offers a novel framework to address both issues. First, raw indicators of financial integration are homogenised (both in terms of scale and distribution) by applying the probability integral transform, i.e., by replacing any observation of a raw indicator by its percentage rank within the data sample. The reference to a theoretical benchmark of perfect integration is achieved by multiplying the transformed indicators with a market-specific scaling factor. The transformed and rescaled individual indicators are then aggregated into the two composite indicators using weights reflecting average relative market size.

Developments in both composite indicators suggest that euro area countries became gradually more financially integrated after the introduction of the euro in 1999. This trend strongly reverted with the onset of the financial crisis in 2007. Decisive policy interventions in 2012 and thereafter helped stabilise financial markets and spur a gradual recovery in financial integration.

As an application of the (price-based) composite indicator, we investigate whether financial integration has affected economic growth in euro area countries. We indeed find that higher financial integration tends to be associated with higher growth, ceteris paribus.

1 Introduction

In this paper we develop composite indicators of financial integration for the euro area with the purpose of capturing the evolution and the current state of financial integration within the monetary union across different financial market segments. We build separate composite indicators for prices and quantities, relying on the aggregation of homogenised cross-country price dispersion measures and cross-border security holdings, respectively. We keep these two composite indicators separate mainly because of their different nature but also because of their different frequency of observation and publication lags.[1] The information contained in the price-based and the quantity-based composite indicators thus present complementary views about the extent to which euro area countries are mutually financially integrated.

Building composite indicators of financial integration faces the challenge that prior to aggregation, different types of indicators have to be homogenised in a way that the state of integration is measured relative to a benchmark of perfect integration. This paper offers a novel framework to address this issue. We build on elements of the methodology developed in Holló et al. (2012) in the context of a composite financial stress indicator. In our application, raw indicators of financial integration are homogenised both in terms of scale and distributional properties by applying the probability integral transform. This transformation delivers indicators which follow, asymptotically, a standard uniform distribution. The reference to a theoretical benchmark of perfect integration is achieved by multiplying the transformed indicators with a market-specific scaling factor. The transformed and rescaled individual indicators are then aggregated into composite subindices for money, bond, equity and banking markets by averaging with equal weights. In a final step, the subindices are further aggregated into a price-based and a quantity-based composite indicator, respectively, by computing market size-weighted averages of the respective subindices.

Developments in both the price-based and the quantity-based composite indicators suggest that euro area countries became gradually more financially integrated after the introduction of the euro in 1999. This trend strongly reverted with the onset of the financial crisis in 2007. Decisive policy interventions in 2012 and thereafter helped stabilise financial markets and spur a gradual recovery in financial integration.

We complement our descriptive evidence with some econometric analysis. Within a standard growth regression framework, we study the effects of financial integration on real growth in euro area countries. We restrict this analysis to the price-based composite indicator due to

[1] Since 2015, both composite indicators have become an integral part of the ECB's Financial Integration in Europe report (European Central Bank, 2015).

the availability of a longer time series (including a few pre-EMU observations). We investigate whether economic growth, measured as per capita real GDP growth, varies systematically with financial integration. Our results indeed suggest a statistically significant positive association between financial integration and economic growth which is found to be robust to several model specifications. In all regressions, we try to address potential endogeneity issues by controlling for exogenous growth opportunities as suggested by Bekaert et al. (2005), among other things.

The paper is organised as follows. Section 2 relates this paper to the relevant literature. Section 3 describes how individual market-specific measures of financial integration are first transformed and then aggregated into the two composite indicators. Section 4 presents the raw input variables and also derives the theoretical benchmarks for the state of perfect integration which are different for price-based and for quantity-based indicators. Section 5 describes and interprets the empirical developments of both composite indicators and also briefly touches robustness issues. Section 6 contains the econometric analysis of the potential real effects of financial integration in euro area countries, while Section 7 concludes.

2 Related literature

While the literature proposes a variety of indicators measuring financial integration for individual market segments, there have been, to our knowledge, few attempts to aggregate the information from different market segments into a composite indicator. Babecký et al. (2010) compute measures of convergence in asset prices for four market segments (money, foreign exchange, government bond and equity markets) and for five countries (Czech Republic, Hungary, Poland, Sweden and the UK) vis-à-vis the euro area over the sample January 1999 to July 2010. They first normalise and rescale the three convergence measures so that a value of zero indicates a state of full integration, and then aggregate them into a single convergence measure by taking the arithmetic mean. The authors finally compute composite indicators of financial integration for each country across the four market segments, and for each market segment across the five countries, as equal or weighted means. Abascal et al. (2013) compute a composite indicator of financial integration based on measures of price dispersion (coefficient of variation) for eleven euro area countries and for four market segments (interbank, government bond, financial CDS and equity markets) over the period from January 2005 to November 2012. The four market-specific price dispersion indicators are standardised, and then aggregated into the composite indicator based on weights proportional to time-varying spillovers across the four dispersion indicators estimated on the basis of generalised forecast-error variance decompositions following Diebold and Yilmaz (2012).

To our knowledge, we are the first to compute a composite indicator of financial integration for quantity-based indicators. In addition, our novel approach to harmonise and rescale the original indicators has certain advantages over simple statistical standardisation: first, the probability integral transform ensures that original integration indicators of any nature are not only homogenised in terms of scale, but also in terms of distribution (here we draw on Holló et al., 2012); and second, we also rescale the indicators so that the maximum attainable value refers to an ideal state of perfect integration.

The individual measures of financial integration considered in this paper are based on the definition given by Baele et al. (2004), according to which an economic area is financially integrated if market participants with similar characteristics have equal market access, face the same rules and are treated equally, regardless of their location. This definition can be interpreted both in terms of prices and in terms of quantities. First, it implies the law of one price, which in this context says that assets with identical risk and return characteristics should have the same price irrespective of where they are traded. Second, the definition also implies that economic agents residing in a financially integrated area and sharing similar preferences, should also hold similarly allocated portfolios of assets issued within the economic area. Put differently, the portfolio allocation of an economic agent should not display a home bias towards assets of its own country vis-à-vis assets issued in other member countries of the monetary union. These two different interpretations suggest that financial integration can be measured on the basis of both price-based and quantity-based indicators.

A rich literature is dedicated to the development of such indicators, which allows us to build on already established measures that we use as input for our composite indicators. Hartmann et al. (2003), Manganelli et al. (2008), as well as Adam et al. (2002) provide a good overview and comparison of the most commonly used indicators. Other papers develop in more detail financial integration indicators in specific markets. Bekaert et al. (2011b) develop a segmentation index for equity markets which is based on valuation differentials in all the different sectors of the economy. Baele et al. (2004) suggest that financial integration, meaning no barriers to international investment, should eliminate "local" risks, since these can be diversified by investing in assets from different regions. They make this point in the context of equity markets, looking at the effects of global versus euro area shocks on equity returns. The idea that diversification increases in an integrated financial market is also developed by Adjaouté and Danthine (2003) who use it as an argument for a higher specialisation of national industrial structures. Investors hold internationally diversified portfolios in such a way that sectoral or geographical factors are not priced, which reduces the cost of increasing specialisation. A paper that focuses on the banking market is Gropp and Kashyap (2010) who reinterpret the law of one price in the context of financial integration, which they translate into convergence in profitability. They apply this concept to the retail banking sector, developing an indicator based on bank's return on assets.

Our paper is also related to the empirical literature that investigates the link between financial liberalisation — a precondition of de-facto financial integration — and the real economy. Bekaert et al. (2001, 2005) find a positive impact of equity market liberalisations on real output growth. In Bekaert et al. (2011a), the authors decompose the growth effect of financial openness and find that it is more important in the case of factor productivity growth than for capital growth. Moving from the country to the industry level, Gupta and Yuan (2009) find that after a stock market liberalisation takes place, there is an increase in industry value-added growth. Measuring openness to foreign investors at the firm level, Mitton (2006) finds a positive relation between stock market liberalisation and firm operating performance in terms of growth, investment and profitability.

Other papers focus on the impact of financial integration on cross-border risk sharing and consumption smoothing respectively. Imbs (2006) finds that international GDP correlations increase with financial integration more than consumption correlations do, suggesting that the "quantity puzzle"—denoting the stylised fact that aggregate consumption tends to be less correlated across countries than output, which is at odds with the risk sharing theory (Backus el al. 1994)—may not reflect a lack of risk sharing but a stronger impact of finance on business cycle synchronisation than on consumption smoothing. Bekaert et al. (2006) find that an increase in financial integration is associated with lower consumption growth volatility and a lower ratio between consumption and GDP volatility, suggesting an improved risk sharing through a more efficient international capital allocation and portfolio diversification.

3 Methodology

This section focuses on the methodological contribution of our paper, namely on our proposed method for how different indicators of financial integration ("raw indicators") are aggregated into a composite indicator. The selection of our specific set of raw indicators will be discussed in Section 4.

3.1 Transformation of raw indicators

Building composite indicators of financial integration faces the challenge that prior to aggregation, different types of indicators—with potentially differing units of measurement and distributional properties—have to be homogenised in such a way that the state of integration in a particular point in time and in a particular market segment is measured relative to a benchmark of perfect integration. We address this challenge by proceeding in two steps.

First, in order to achieve homogeneity among the input series in terms of scale and distribution, we transform each raw indicator of financial integration by applying the "probability integral transform" (PIT), building on the approach suggested in Holló et al. (2012) for the construction of composite financial stress indicators. The theorem of the probability integral transform states that for any continuous random variable X with cumulative distribution function (CDF) $F(x)$, the random variable defined by $Y = F(X)$ has a uniform distribution over the range $(0, 1)$ regardless of the form of the original distribution $F(x)$, i.e.:[2]

$$Y = F(X) \sim U(0, 1).$$

In the empirical implementation of the PIT, we have to work with the discontinuous sample analogue of the CDF, the empirical CDF. Assume we have a data sample of T observations of a raw indicator $x = (x_1, x_2, ..., x_T)$. The observations are first ranked in ascending order, i.e. $x_{[1]} \leq x_{[2]} \leq ... \leq x_{[T]}$, where $x_{[1]}$ represents the sample minimum and $x_{[T]}$ the sample maximum. Each original observation in the set $x = (x_1, x_2, ..., x_T)$ is now replaced by its corresponding value of the empirical CDF $\widetilde{x} = F(x) = (F(x_1), F(x_2), ..., F(x_T))$, which is computed as the rank r of observations not exceeding a particular value x, divided by the total number of observations T:

$$\widetilde{x} = F(x) := \begin{cases} \frac{r}{T} \text{ for } x_{[r]} \leq x < x_{[r+1]}, & r = 1, 2, ..., T-1 \\ 1 \text{ for } x \geq x_{[T]}. & \end{cases}$$

In case of tied observations, the ranking number assigned to each of the identical observations is set to the average of the covered ranks.

All thus transformed indicators of financial integration are unit-free and uniform distributed (since the transformation is based on the empirical CDF, only asymptotically so) over the range $(0, 1]$. Accordingly, the PIT has the distinct advantage that whatever is the original distribution of the raw indicators, the transformed indicators are homogenous not only in terms of scale but also in terms of (asymptotic) distribution. The transformation comes with the cost of losing that part of the indicator information which is only contained in the cardinal scale of the original data but not in the ordinal scale of the transformed series.

[2]See, e.g., Spanos (1999) or Cassela and Berger (2002). The term "probability integral transform" refers to the relationship between the continuous cumulative distribution function $F_X(.)$ and its corresponding density function $f_x(.)$, namely $F_X(x) = \int_{-\infty}^{x} f_x(u)du.$, where $F_X(x)$ equals the probability that the random variable X does not exceed the value x.

Second, we deal with the issue of how to relate the transformed input series to an ideal state of integration in a novel way. Why such a benchmarking is useful, or even necessary, can be illustrated by a simple example. Consider that each indicator can provide information only about the relative degree of financial integration as observed over its specific data sample. For instance, an indicator may display a trend increase over its sample period, signalling that financial integration has improved. In case the indicator reached a new historical maximum at the end of the sample, the most recent data point, ranked on position T, would receive a transformed value of $T/T = 1$. Reaching the upper limit of the possible range of values could be wrongly interpreted as if financial integration in the respective market segment has become perfect, whereas in reality the most recent state of financial integration may instead be rather low compared to other market segments, or to an ideal state of perfect integration. In order to address this issue, we construct sample-dependent scaling factors for the price- and quantity-based measures of financial integration, $\theta^p(x)$ and $\theta^q(x)$, which multiply the transformed indicators. Intuitively, the $\theta(x)$ relate the transformed series to a benchmark of full financial integration. We discuss the benchmarks in Section 4.3. This operation yields series z^p and z^q that are used as the final input variables in the computation of the composite indicators; the superscripts $k = p, q$ differentiate the price- from the quantity-based variables:

$$z^p = [1 - F(x)]\theta^p(x)$$

and

$$z^q = F(x)\theta^q(x).$$

In the case of price-based indicators, we exclusively rely on measures of price dispersion which indicate a lower degree of financial integration when they take higher values. Since we want higher values of the composite indicator to signal a higher level of financial integration, we transform each of the dispersion indicators by taking $1 - F(x)$. This is not required in the case of the quantity-based indicators which are calculated using cross-border security holdings, where higher values signal a higher level of financial integration.

3.2 Aggregation

The aggregation of the transformed indicators $z_{i,t}^k$ occurs at two levels. We first compute for each market segment j a subindex as the arithmetic mean of its N_j constituent integration indicators after transformation

$$s_{j,t}^k = \frac{1}{N_j} \sum_{n=1}^{N_j} z_{n,t}^k \text{ for } k = \{p, q\}.$$

Then, the resulting subindices $s_{j,t}^k$ are aggregated into the price-based and the quantity-based composite indicators c_t^k by computing weighted averages

$$c_t^k = \sum_j w_j^k s_{j,t}^k.$$

Both composite indicators cover all the market segments of interest (money, bond, equity and banking markets). However, while the price-based composite indicator consists of four market segment-specific subindices (i.e. $j = \{\text{money, bond, equity, banking}\}$), the quantity-based composite indicator comprises—due to data limitations—only three subindices with the banking and the money market segments replaced by an "interbank market segment" (i.e. $j = \{\text{bond, equity, interbank}\}$).

We apply two different weighting schemes to compute w_j^k. One assigns equal weights to each subindex. As an alternative, we use size weights reflecting the relative size of the underlying financial market segment. These are based on the aggregated euro area financial accounts, for which we take the average amounts outstanding over the period 1997-2013. This yields the following weights for the price-based subindices: money markets 17%, bond markets 36%, equity markets 15% and banking markets 32%.[3] The weights are recalculated for the three subindices of the quantity-based composite indicator such that they sum up to 100%. Taking into account that money markets represent the largest part of interbank transactions, only these are considered for the weighting, which yields the following weights: interbank markets 23%, bond markets 54% and equity markets 23%.

4 Raw indicators of financial integration

This section details the raw indicators of financial integration that are used in the construction of the composite indicator. These were selected according to a number of criteria. First, our aim to provide a comprehensive view of the state and development of financial integration requires at least one raw indicator for each market segment. Second, we are interested in a sufficiently representative geographical coverage of the monetary union. Third, the resulting

[3]Our results do not change materially if we use time-varying weights as the relative sizes of the different market segments are relatively constant.

time series should reach back in time to at least the inception of EMU in 1999. Fourth, to allow for intra-year monitoring of financial integration developments, the sampling frequency of the data should at least be quarterly with a relatively short publication lag. Fifth, the raw series should be sufficiently free of structural breaks caused by statistical re-definitions and other material methodological changes. And finally, it should be possible to compare the indicators to a theoretical benchmark of full integration. Trading off all the above criteria, our preferred selection of raw indicators comprises 10 price-based and 5 quantity-based ones.

4.1 Price-based indicators

This section describes the raw price-based indicators that we selected for the four financial market segments. The number of indicators is not equal across markets due to data availability. The theoretical foundation for the price-based indicators is the law of one price which, in the context of financial integration, requires that assets with identical risk and cash-flows should have the same price, regardless of the country where they are issued or traded. This raises the issue of finding truly comparable assets or finding slightly different assets where one can control for the difference in risk.

The most commonly used price-based measure for integration is the cross-country dispersion of returns, where a higher dispersion signals a weaker degree of financial integration. Applied to the markets of interest to us, it means looking at differences in interest rates across countries for the money, bond and banking markets, with a slightly different approach for equity markets. Some of the assets in these markets are more comparable, like for instance in the euro area money markets where yields strongly converged across countries due to the elimination of exchange rate risk and the common monetary policy. Also, sovereign bond markets are expected to show yield convergence once sovereign credit risk and liquidity risks are controlled for. Other markets like corporate bond or retail banking markets can be expected to be more heterogeneous across countries due to different risk characteristics of the underlying assets. The demand side can add further heterogeneity, for instance in retail banking where customers in different countries might have different preferences for certain risk characteristics, giving rise to partially segmented markets reflected in sustained cross-country price dispersions.

It is beyond the scope of our paper to address all the possible differences on the demand or supply side of assets, but one needs to keep in mind that it could result in an overestimation of financial fragmentation. The main question is whether any price differences, which are due to other reasons than financial fragmentation, do affect the relative ranking in the time series of each indicator, which is what ultimately matters for the transformed indicators. A robustness check for the price-based composite indicator, in which we replace three indicators of pure bond yield dispersion by risk-adjusted dispersion measures[4], suggests that the risk-adjustment does hardly play a role for the composite indicator (see Section 5.2).

In addition to the relatively clear economic interpretation of price-based indicators, there are also practical advantages related to their use. First of all, price data is more accurate and more easily available, having in general longer histories and a higher frequency of observation than data on quantities. All the price-based indicators that we use are computed at the monthly frequency and cover the period July 1995 to December 2018, except for the corporate bond yield dispersion indicator which is included in the composite indicator only as of July 1998 due to data limitations.

For the **money market** segment we have only a single indicator: the cross-country standard deviation of average unsecured overnight interbank lending rates across euro area countries.[5] The indicator is computed as the unweighted standard deviation of average interest rates reported by each country in the sample:

$$D_t = \sqrt{\frac{1}{n_t}\sum_c (r_{c,t} - r_t)^2},$$

where n_t is the number of euro area countries that have adopted the euro in the reference period, $r_{c,t}$ is the unweighted average of the interest rate $r^c_{i,t}$ reported by each of the m_c panel banks at time t in country c,

$$r_{c,t} = \frac{1}{m_c}\sum_{i=1}^{m_c} r^c_{i,t},$$

and r_t is the euro area average calculated as the unweighted average of the national average interest rates $r_{c,t}$. The data are smoothed by calculating a 61 (business) day centered moving average of the standard deviation, transformed into monthly figures and taking the end-of-month observation of the smoothed series.[6]

We look at two large segments of the **bond markets**: sovereign and corporate bonds. For the government bonds segment, we compute the cross-country standard deviation of sovereign bond yields (yields to maturity) for the 2-year and the 10-year maturity segments.[7] The in-

[4]The yields of different sovereign bonds reflect country-specific credit risk (in turn driven by e.g. fiscal and macroeconomic risks) and liquidity risk. Battistini et al. (2013) make this argument and use in their analysis sovereign yields purged from country specific risks.

[5]The countries considered here are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

[6]The data is maintained at the ECB, based on a daily survey conducted by the EMMI. For more details see ECB (2014) and as well as the ECB (2006) Monthly Bulletin.

[7]The individual bond yields are for the country composition of the euro area as in 2011. The yields for Greece, Cyprus, Estonia, Luxembourg, Malta and Slovenia are excluded owing to infrequent or lack of observations. The data source is Bloomberg.

dicators for the corporate bond markets are based on the cross-country standard deviation in bond yields of uncovered corporate bonds issued by non-financial corporations. We use data aggregated at the country level.[8]

One of the indicators that we use for **equity markets** is the segmentation measure recently developed by Bekaert et al (2011b) which is based on the idea that integration should lead to a convergence in valuation of similar firms in different countries. Instead of looking at equity returns, they propose valuation ratios, measured using earnings yields. Following their methodology, we compute in a first step, at the individual country level, the absolute value of the difference between industry valuation ratios:

$$\left|EY_{i,j,t} - \overline{EY}_{j,t}\right|,$$

where $EY_{i,j,t}$ is the average earnings yield in sector j, measured as the inverse of the price-earnings ratio, based on analyst forecasts for industry sector j in country i, and $\overline{EY}_{j,t}$ is the corresponding euro area average. Each country is seen as a portfolio of N industries where the weight of sector j in the portfolio, $IW_{i,j,t}$, is computed as the share of sector j in the stock market capitalisation of country i .

In a second step, the segmentation measure for country i is computed as

$$SEG_{i,t} = \sum_{j=1}^{N} IW_{i,j,t}\left|EY_{i,j,t} - \overline{EY}_{j,t}\right|.$$

Finally, to compute equity market segmentation in the euro area, we take the median of the segmentation measures for all the countries in our sample.[9]

The second indicator for equity markets uses country and sector dispersions in equity returns as described in, e.g., European Central Bank (2015). The economic intuition has its origins in the paper by Adjaouté and Danthine(2003) and relies on the idea that in financially integrated markets there should be no boundaries to diversification and investors should be able to diversify their equity portfolios optimally, be it cross-country, sector or both. This means that country and sector dispersions in euro area equity returns should converge if markets are integrated. Based on this idea, the indicator is constructed as the absolute value of the difference between the cross-sectional dispersions in sector and country index returns. An indicator value closer to zero means higher financial integration. The index returns include dividends and are denominated in euro. Since stock returns display high volatility, the time series of cross-sectional return

[8]Due to data availability, we only include Barclay's country indices for Austria, France, Finland, Germany, Italy, the Netherlands and Spain. The data source is Datastream.

[9]The countries we consider are: Austria, Belgium, Germany, Greece, France, Finland, Ireland, Italy, Netherlands, Portugal and Spain. The data source is Thomson Reuters.

dispersion is quite erratic as well and is therefore filtered using the Hodrick-Prescott smoothing technique with the smoothing parameter λ set to $14,400$.

The indicators we use for the **banking markets** represent both the asset (loans) and the liability (deposits) side of bank balance sheets, and consider two counterparties of monetary financial institutions: households and non-financial corporations. We compute cross-country dispersion measures for bank lending rates and deposit rates on the following products: interest rates on new loans to households (for consumer credit and total loans) and non-financial corporations (up to 1 year, up to and including €1 million) on the one hand, and deposit rates for households and non-financial corporations on deposits with agreed maturity, on the other hand.[10]

4.2 Quantity-based indicators

The concept of financial integration can also be interpreted in the light of portfolio theory. A consequence of the definition given in Baele et al. (2004) is that economic agents with similar characteristics would also choose a similar portfolio allocation, regardless of their location. Following this idea we build quantity-based indicators using data on the international portfolio composition of two sectors of institutional investors where the assumption of similar characteristics across countries can be considered plausible: investment funds and banks (i.e. monetary financial institutions).

We compute the indicators as intra-euro area cross-border holdings expressed as a share of euro area total holdings

$$x_{EA,t} = \frac{\textit{intra-euro area cross-border holdings}_{EA,t}}{\textit{intra-euro area cross-border holdings}_{EA,t} + \textit{ domestic holdings}_{EA,t}},$$

where both intra-euro area cross-border holdings and domestic holdings are computed by using the cross-border and domestic quantities as euro area aggregates. The raw indicators are by definition already comparable, since they are all expressed as shares of total holdings. However, to ensure consistency between the quantity-based and the price-based composite indicators, we apply to the raw indicators the probability integral transform in the same way as we proceeded with the price-based indicators.

The main drawback of using quantity-based indicators is the lower data availability compared to data on prices. Our indicators have a quarterly frequency and start in the first quarter of 1999. Moreover, due to data availability, it is not possible for us to disentangle cross-border

[10]The countries in the sample are : Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain. Source: ECB Statistical Data Warehouse.

holdings in money and banking markets. To be able to differentiate the two markets, we would need to know the maturity of the loans. This is not possible with the available data, which does not contain a maturity distinction. We therefore consider three markets for the quantity-based indicators: the bond market, the equity market and the interbank market, the latter encompassing the money and banking markets.

We look at two segments of the **bond markets,** corporate and sovereign, and compute the monetary financial institutions' and the investment funds' shares of cross-border holdings of debt securities of all maturities issued by euro area governments and non-financial corporations. In a similar way, we use the monetary financial institutions' and the investment funds' cross-border holdings[11] of equity issued by euro area residents for the **equity markets.** Finally, the indicator for the **interbank markets** is based on the share of intra-euro area cross-border lending among monetary financial institutions.

4.3 Benchmarking

As discussed in Section 3.1, the transformation of the raw indicators requires the use of a benchmark in order to account for potentially different levels of financial integration across different market segments. As we shall see, this is of secondary importance for our particular sample of price-based data, but essential input for the quantity-based indicators.

All our indicators relying on cross-country price dispersions can be argued to have zero as a natural theoretical benchmark in a deterministic world ($BM^p = 0$).[12] We therefore use the following scaling factor for our price-based indicators of financial integration:

$$\theta^p(x) = \frac{\max(x) - \min(x)}{\max(x) - BM^p} = \frac{\max(x) - \min(x)}{\max(x) - 0}.$$

The factor scales down each transformed series by the percentage share of the realised range of dispersion (the historical maximum minus the minimum dispersion) to the ideal dispersion range (the historical maximum less the theoretical benchmark of zero). Because there is no theoretical upper bound on price dispersion, its highest observed value is set as the benchmark for the lowest degree of financial integration.[13]

[11] Adam et al (2002) also use a quantity-based indicator of stock market integration based on the international investment strategy of investment funds. Our indicator is strongly limited by the quality of the input data. There is a break in the time series and the different NCBs that report the IVF holdings had different reporting rules before 1999. This affects the reliability of the indicators based on IVF holdings.

[12] Ideally, we should have a stochastic benchmark, since zero dispersion is only attainable in a deterministic world, while in reality dispersion is partly caused by noise. However, it is not straightforward to develop a stochastic benchmark by way of simulation for our case.

[13] One could, for instance, also include the yields of other, non-euro area countries across the globe in the calculation of the "maximum possible" yield dispersion.

In order to derive a theoretical benchmark for the share of intra-euro area cross-border security holdings, we adopt a simple portfolio perspective. In a perfectly integrated market, all agents are expected to invest in the market portfolio. In the present case this implies that a euro area investor (say a Spanish bank) should hold a certain asset issued by a particular euro area country (say French corporate bonds) in proportion to the issuing country's share in the total euro area holdings as defined in Section 4.3. For each indicator we therefore first compute the share $\omega_{k,t}$ of country k at time t of the total euro area holdings. The case of perfect integration then implies that a share $1-\omega_{k,t}$ of that share $\omega_{k,t}$ should be held intra-euro area cross-border (i.e., should not be held domestically). The time-varying benchmark for a certain quantity-based indicator is then computed as the sum of this product of shares across all K euro area countries for which data is available:

$$BM_t^q = \sum_{k=1}^{K} \omega_{k,t} \times (1-\omega_{k,t}) \quad for \quad t = 1, ...T$$

which yields the sample-dependent, time-varying scaling factor

$$\theta_t^q(x) = \frac{\max(x)}{BM_t^q}.$$

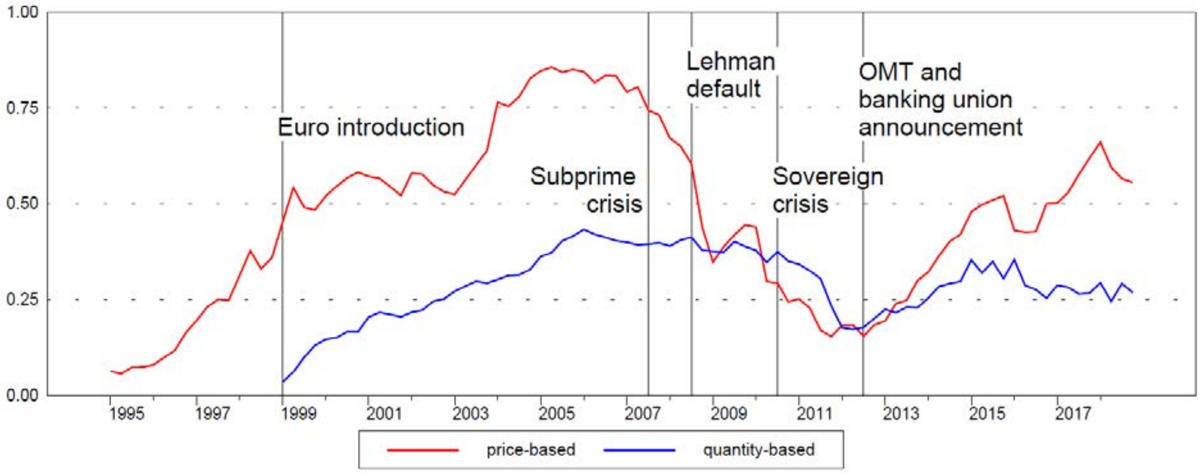
Intuitively, the maximum level of financial integration is reached when all investors hold a cross-border share that is consistent with the market portfolio based on the outstanding amount of a particular type of security.

5 Results on the composite indicators

5.1 Evolution of financial integration in the euro area

Figure 1 plots quarterly data of the price-based and the quantity-based composite indicators. It seems plausible to associate the long-term trends in financial integration with certain important events indicated in the figure by vertical bars. For instance, because the start of EMU was well anticipated in market participants' asset pricing and portfolio behaviour, a period of increasing integration started already well before the introduction of the euro. Steadily further increasing throughout the early 2000s, the level of financial integration reached its peak around the beginning of the subprime mortgage crisis in 2007, which marked a clear turning point. Subsequently, European financial markets fragmented considerably, further spurred by the turmoil caused by the Lehman debacle and the sovereign debt crisis in the euro area later on. It took until mid-2012 before this process of continued market fragmentation started to reverse. The reversal seems to be related to two main political events, namely the agreement between the Heads of State and Government to create the European banking union in June 2012 and the announcement of the ECB's Outright Monetary Transactions (OMT) programme. The partial recovery of financial integration since 2012 has been broad-based. For instance, the latest trend increase in the price-based composite indicator is supported, though to varying degrees, by all four subindices, i.e. by financial re-integration trends in money, bond, equity and banking markets (see Figure 2).

Figure 1: The price- and the quantity-based Financial Integration Composite Indicators



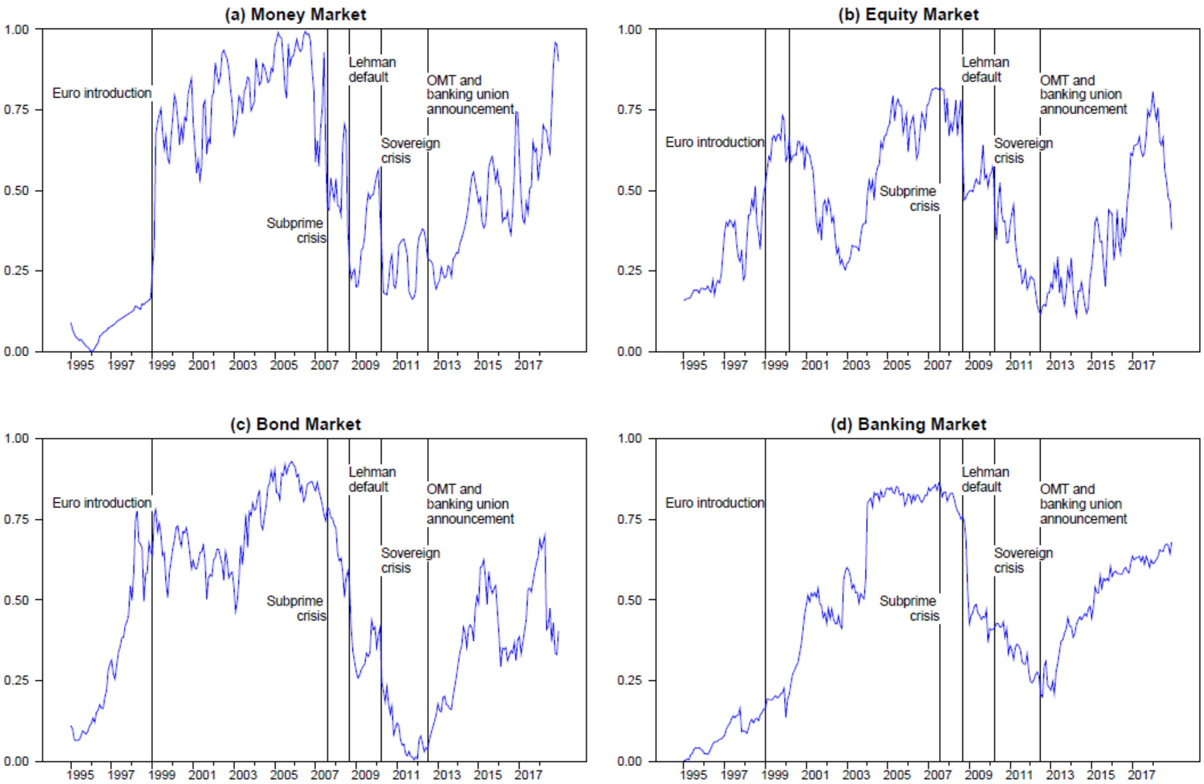
Notes: Quarterly data: Q1 1995 - Q4 2018.

The critical role played by varying financial stability conditions for trend developments in European financial integration can be further illustrated when comparing the price-based composite financial integration indicator with the ECB's composite indicator of systemic stress (CISS).[14] Figure 3 shows that over the first part of the sample, until the start of the subprime crisis, both series do not seem to share a common trend. While financial integration steadily improved over this time period, financial stress hovered around a more or less flat path.[15] This pattern changed abruptly with the start of the financial crisis. The rapid surges in financial stress around the Lehman default in September 2008 and at the height of the sovereign debt crisis in the summer of 2011 were accompanied by a strong trend towards financial fragmentation. It is striking that this process of decreasing financial integration also continued in periods when financial stress partially recovered from its worst states. It took until the two policy announcements mentioned above for financial integration to assume a path of solid but still partial recovery.

[14]See Holló et al. (2012).

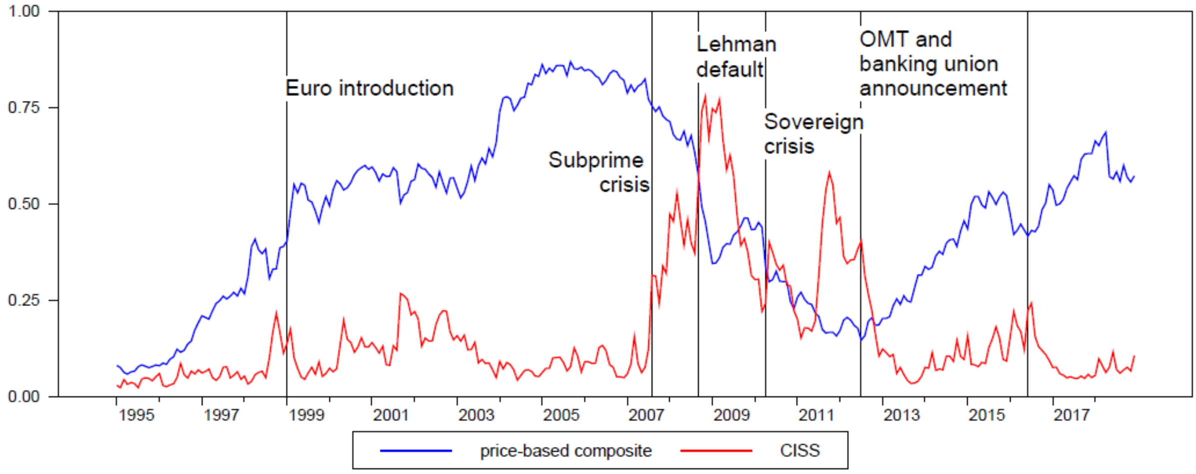
[15]In this regard it is important to note that the CISS is a coincident indicator of systemic financial stress (i.e. systemic risk which has materialised), not a leading or early warning indicator.

Figure 2: Subindices of the price-based Financial Integration Composite Indicator



Notes: Monthly data: January 1995 - December 2018.

Figure 3: Financial integration and systemic stress



Notes: Monthly data: January 1995 - December 2018. The two series plotted are the price-based composite indicator of financial integration (in blue) and the Composite Indicator of Systemic Stress (CISS, in red) developed by Holló, Kremer, Lo Duca (2012).

A statistical comparison reveals that the price-based composite indicator of financial integration tends to fluctuate more strongly than the quantity-based indicator. The standard deviation of first differences is about twice as high for the former compared with the latter indicator. This fact is likely due to the fact that financial asset prices tend to reflect new information rather quickly, while asset portfolios tend to adjust more gradually as they are also influenced by institutional factors. This differential behaviour is best observed in the period after 2007, when the sharp drop in the price-based indicator coincides with a more stable level of financial integration from a quantity perspective. Against this background, both indicators should be seen as providing complementary information about the state of financial integration within the euro area.

Finally, a few reservations have to be expressed concerning the interpretation of the two variants of the composite indicator. The price-based indicator relies on indicators which measure the degree of price dispersion across euro area countries. The law of one price claims that if two assets constitute perfect substitutes, they should bear the same price irrespective of the residency of the issuer. However, in reality it is difficult to control for all other factors—apart from those which can be attributed to a lack of financial integration—which may affect the prices of two similar assets issued in different jurisdictions. That said, the price-based composite indicator measures financial integration in a broader sense, also taking into account the degree of convergence in the domestic risk factors impacting on asset prices. In a similar vein, developments in the quantity-based composite indicator can also be driven by factors unrelated to financial integration in a pure sense.

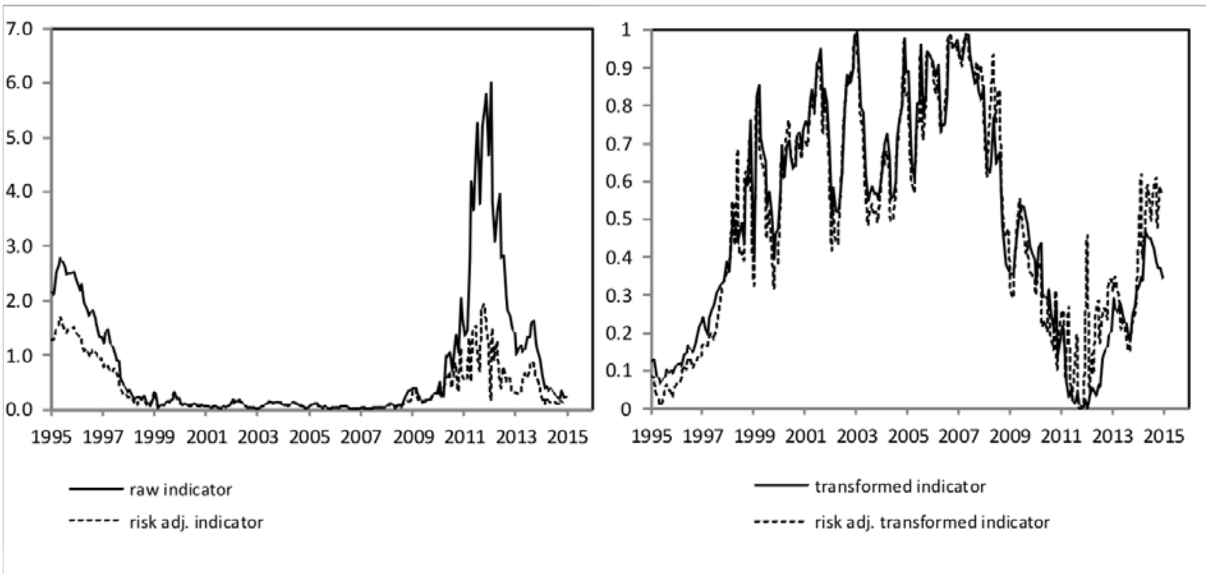
5.2 Robustness - accounting for differences in risk

The difference in credit risk across different jurisdictions constitutes one potential issue when measuring financial integration via raw dispersion indicators. For example, sovereign bond yields may differ considerably across countries in a well integrated market if they are a mere reflection of different levels of risk. In order to account for this, we adjust our measures of dispersion for credit risk as a robustness test. In order to filter out the sovereign risk component from the dispersion of bond yields, we regress the latter on a measure of sovereign credit risk based on ratings of government debt, and the resulting root mean squared error represents the residual cross-country dispersion.[16]

We apply this risk adjustment to the three price-based indicators pertaining to the bond market (sovereign bond yields with 2-year and 10-year maturity and corporate bond yields).

[16]We convert the sovereign ratings to a linear numerical scale following Michaelides et al. (2015) and use the average rating for each country across the three major agencies.

Figure 4: Raw versus risk-adjusted indicator before and after the transformation: 2-years sovereign bond yield dispersion



Notes: Monthly data: January 1995 - December 2014.

For illustration, Figure 4 depicts the raw and the adjusted time series of the 2-year sovereign bond dispersion as well as the transformed series resulting from the PIT. It can be seen that the large discrepancy between the raw series gets almost completely eliminated by the application of the PIT due to its pure reliance on a ranking of observations. Hence, our methodology is largely robust against a lack of risk adjustment.

6 Financial integration and the real economy

In general, countries promote financial integration not as an end in itself but for its expected welfare-increasing effects. Financial integration should therefore be evaluated on the basis of the costs and benefits, in terms of social welfare, which it may create or may have created. A broad theoretical and empirical literature highlights the potential benefits of international financial integration and liberalisation in terms of higher economic growth as well as improved intra- and intertemporal risk sharing, resulting from an enhanced cross-border capital allocation and asset diversification.[17] However, other papers stress certain risks of international financial integration. For instance, it is argued that financial integration raises the odds of experiencing capital market crises in a world of imperfect financial markets. In addition, enhanced financial integration can facilitate contagion in crisis times.[18] Whether the positive or negative effects

[17]A few examples are Agénor (2003), Bekaert and Harvey (1995) and Bekaert et al. (2005 and 2006). See Chapter 1 in Obstfeld and Taylor (2004) for a short overview of the theoretical benefits and practical problems of international financial integration.

[18]See, for instance, Stiglitz (2010), Fecht and Grüner (2005) and Fecht et al. (2012).

exist, and which effect outweighs, still remains an open question.

In what follows we provide empirical evidence on the potential real effects of within-euro area changes in the degree of financial integration —measured in terms of the price-based composite indicator—between 1995 and 2017.[19] For this purpose, we investigate whether the observed process of financial integration—which first increased steadily before collapsing during the recent crisis episodes—has been systematically associated with certain patterns of economic growth in 19 euro area countries.

6.1 Empirical specification

The setup of our analysis is similar to Bekaert et al. (2005) who study the effect of equity market liberalisation on economic growth in a sample of more than 70 countries. The empirical specification has its origin in the growth literature. We start with a basic growth regression to which we add our main variable of interest, the price-based composite indicator of financial integration ($FinInt_t$).

We also include the $CISS_t$ in the set of explanatory variables in order to obtain a cleaner estimate of the "pure"financial integration effects on economic growth since our measure of financial integration may tend to decrease (increase) with rising (declining) levels of systemwide financial stress as illustrated in Figure 3. The $CISS$ measures systemic stress (i.e., the level of financial instability) on a continuous scale over the range $(0, 1]$, thereby allowing us to identify and control for crisis effects of different intensity over time.[20]

All these considerations give rise to the following baseline regression equation:

$$y_{i,t+1} = \beta_1 FinInt_t + \beta_2 CISS_t + \beta_3 GO\_MA_{i,t} + \beta_4 \, y_{US,t+1} + \gamma' \mathbf{X}_{i,t} + \Psi_i + \varepsilon_{i,t,t+1}. \quad (1)$$

Economic growth is defined as the annual logarithmic growth rate in real GDP per capita for country i between t and $t+1$, i.e.

$$y_{i,t+1} = 100 \cdot \ln \left(\frac{GDP_{i,t+1}}{POP_{i,t+1}} \bigg/ \frac{GDP_{i,t}}{POP_{i,t}} \right),$$

where GDP and POP denote the level of real GDP and total population, respectively.

It might be argued that the (price-based) composite indicator of financial integration $FinInt$

[19] The analysis is based on price-based indicator since the quantity-based composite indicator is only available as of the first quarter of 1999.

[20] The literature clearly documents that financial crises—typically identified based on qualitative variables (e.g., a dichotomous crisis dummy) or quantitative "financial stress indices" like the CISS—are associated with large drops in real economic activity (see, e.g., Laeven and Valencia (2018), Cardarelli et al. (2011), Giglio et al. (2016), Hartmann et al. (2015), Hubrich and Tetlow (2014) and Kremer (2016)).

could contain indicators that are endogenous to current real GDP growth. In order to mitigate such endogeneity concerns, all our explanatory variables enter the regressions with a one-year lag (except US economic growth). We furthermore directly control for exogenous growth opportunities $GO_{i,t}$; this variable is a time-varying country-specific measure of global growth opportunities developed by Bekaert et al. (2007) on the basis of global sectoral price to earnings ratios combined with country-specific sector weights. As suggested in Bekaert et al. (2007), the variable enters the regression in deviations from a 4-year moving average, i.e. $GO\_MA_{i,t} = GO_{i,t} - 1/4\sum_{j=1}^{4} GO_{i,t-j}$. All this certainly does not fully resolve potential biases resulting from the possible endogeneity and simultaneity of the $FinInt$ series vis-à-vis economic growth. However, we overcome the potential issue that the effect of financial integration on growth might actually be driven by growth opportunities in the euro area, and not by financial integration per se.

To account for variations in the world business cycle[21] and to capture the effect of financial integration on economic growth in the euro area beyond the general growth trend in developed countries, we control for simultaneous annual percentage growth in US real GDP per capita, $y_{US,t+1}$.

$\mathbf{X}_{i,t}$ is a vector of control variables typically used in the growth literature: the ratio of government consumption to GDP, secondary school enrollment, population growth, and life expectancy.[22] All regressions also control for country fixed effects Ψ_i to take into account country-specific characteristics that do not change over time and affect a country's economic growth.[23]

Since it has been argued that financial integration might be detrimental to the economy during times of crises, we investigate in the next step whether the correlation between financial integration and output growth varies for different degrees of systemic stress. To this end, we introduce an interaction term between $FinInt_t$ and $CISS_t$, and equation (1) becomes

$$\begin{aligned} y_{i,t+1} &= \beta_1 FinInt_t + \beta_2 FinInt_t \cdot CISS_t + \beta_3 CISS_t \\ &+\beta_4 GO\_MA_{i,t} + \beta_5\, y_{US,t+1} + \gamma' \mathbf{X}_{i,t} + \Psi_i + \varepsilon_{i,t,t+1}. \end{aligned} \tag{2}$$

We do a similar exercise in order to assess how financial integration and growth are correlated conditional on a country's exogenous growth opportunities. Introducing an interaction term between $FinInt_t$ and $GO\_MA_{i,t}$ we obtain

[21] Bekaert et al. (2005) compute average growth over five- or three-year intervals in order to capture an entire business cycle, which we can not do since our sample is much shorter.

[22] See Table 2 for the variable definitions.

[23] Thus we do not need to include the level of initial real GDP of each country that would usually be a control variable in a basic growth regression.

$$y_{i,t+1} = \beta_1 FinInt_t + \beta_2 FinInt_t \cdot GO\_MA_{i,t} + \beta_3 CISS_t + \beta_4 GO\_MA_{i,t} + \beta_5\, y_{US,t+1} + \gamma' \mathbf{X}_{i,t} + \Psi_i + \varepsilon_{i,t,t+1}. \quad (3)$$

While the interaction term between $FinInt$ and $CISS$ is solely time-varying and therefore captures a factor common to all countries in the sample, the interaction of $FinInt$ and GO_MA results in a time-varying country-specific variable. Hence, the coefficient on the interaction term reflects how the correlation between financial integration and economic growth in a particular country in the euro area is affected by its exogenous growth opportunities.

6.2 Empirical Results

We run OLS regressions with country fixed effects of equations 1 to 3 for a sample of 19 euro area countries with yearly observations from 1995 to 2017. The estimation results for each equation are reported in columns 1 to 3, respectively, of Table 1. The variable of interest, our price-based financial integration indicator, has a positive and statistically significant coefficient in all three equations, suggesting that intra-euro area financial integration is on average positively associated with economic growth in the euro area countries.

The coefficient on the systemic stress measure in equation 1 has a statistically significant negative coefficient, confirming the general finding in the literature that financial instability depresses economic activity. The coefficient on the growth opportunities variable is positive and statistically significant as well. As expected, economic activity in the euro area and the United States are strongly synchronised; this is reflected in the positive coefficient on US output growth which is close to one and significant at the statistical level of 1% in all three equations. The estimates for the typical growth control variables are broadly in line with the literature but do not turn out to be statistically significant at conventional confidence levels in our case. The goodness of fit of the rather parsimoniously specified equation 1 is relatively high with an R^2 statistic of 0.55. Actually, our main explanatory variables capture all common time-variation in cross-country output growth rather well: when replacing $FinInt$, $CISS$, and US output growth by a time fixed effect, the R^2 only increases by an equivalent of 6 percentage points to 0.61 (see column 4 in Table 1). The fact that the coefficient on the growth opportunities variable GO_MA turns insignificant when adding time fixed effects indicates that this variable does not seem to add much country-specific information in our data sample.

The second regression tests whether the correlation between financial integration and growth varies for different degrees of systemic stress. However, the interaction term $FinInt \times CISS$ turns out to be statistically insignificant. While the composite financial integration variable

Table 1: Real GDP growth and financial integration controlling for systemic stress and exogeneous growth opportunities

	(1)	(2)	(3)	(4)
$FinInt$	3.484***	3.354**	3.965***	
	(0.829)	(1.684)	(1.087)	
$FinInt \times CISS$		1.372		
		(11.323)		
$FinInt \times GO\_MA$			5.417	
			(4.125)	
$CISS$	–3.688**	–4.212	–3.726**	
	(1.475)	(4.732)	(1.495)	
GO_MA	3.350***	3.377***	0.530	–0.365
	(0.795)	(0.698)	(2.226)	(0.948)
US output growth	1.083***	1.098***	1.099***	
	(0.137)	(0.113)	(0.138)	
Additional controls	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes
R^2	0.551	0.551	0.552	0.609
N	331	331	331	331

Notes: The dependent variable is economic growth, defined as the annual logarithmic growth rate in real GDP per capita of a country in year $t+1$. $FinInt$ is the price-based composite indicator of financial integration. $CISS$ is the Composite Indicator of Systemic Stress of Holló et al. (2012). GO_MA is an exogenous measure of a country's global growth opportunities as defined in Bekaert et al. (2007). US output growth is the annual logarithmic growth rate in real GDP per capital in the US in year $t+1$. The additional control variables are defined in Table 2 in the Appendix. Except US growth, all explanatory variables enter the regression with time index t. The sample covers 19 euro area countries during the period 1995 to 2017. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent level, respectively. All standard errors (in parenthesis) are clustered at the country level.

remains individually statistically significant in this equation, the coefficient on the $CISS$ becomes insignificant.[24] We therefore do not find that the correlation between growth and financial integration depends on current financial stability conditions.

Next, we investigate how financial integration is correlated with a country's economic growth conditional on the country's exogenous growth opportunities. Column 3 of Table 1 reports the estimation results from the regression that includes the interaction term $FinInt \times GO\_MA$. Similar to the previous case, the interaction term is not statistically significant at conventional levels (with a p-value of 0.19). The fact that the coefficient on GO_MA becomes insignificant, too, again relates to the strong correlation (0.94) between growth opportunities and the interaction term. This notwithstanding, the combined coefficient on $FinInt$ as a function of growth opportunities GO_MA—i.e., $\partial y_{i,t+1}/\partial FinInt_t = \beta_1 + \beta_2 \cdot GO\_MA_{i,t}$—is mostly statistically significant. This can be inferred from Figure 5, panel (a), which plots the combined coefficients on the $FinInt$ variable for different percentiles of GO_MA along with their 95% confidence intervals.[25]

The figure shows that the estimated correlation between financial integration and growth is a monotonically increasing function of exogenous growth opportunities; the combined coefficient is low with weak statistical significance only for countries and in times with very low growth opportunities. An interpretation of this result is that countries that potentially reap the highest benefits in terms of growth from financial integration in the euro area are those with high growth opportunities. Also, for a given country, financial integration and growth are more positively correlated in periods in which growth opportunities are generally larger.

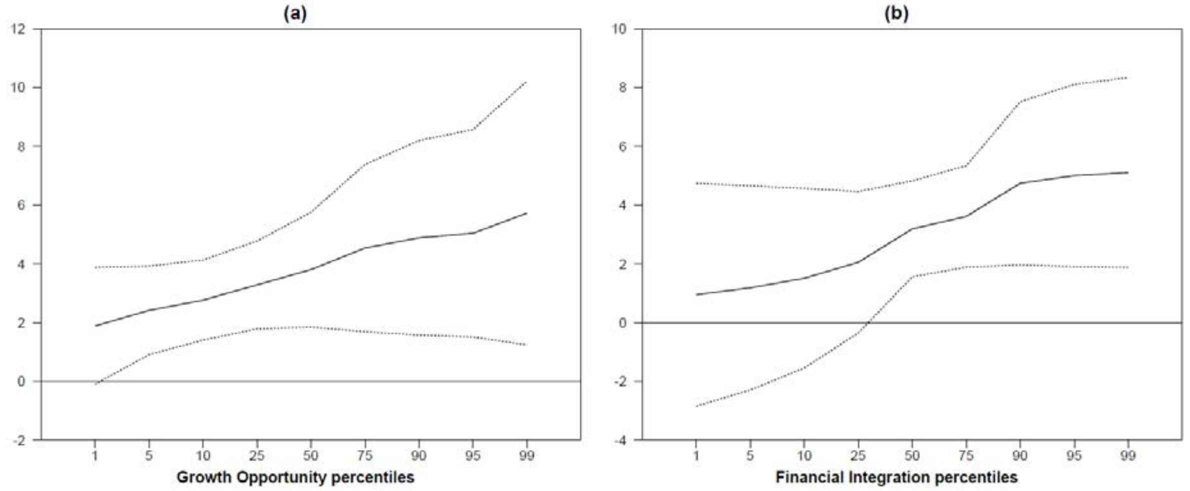
We can use the results of equation 3 also to demonstrate the conditional nature of the growth-enhancing effects of growth opportunities. Panel (b) of Figure 6 shows the combined coefficient on growth opportunities including its interaction with financial integration, i.e. $\beta_4 + \beta_2 \cdot FinInt$, which is an increasing function of the measured degree of financial integration because $\beta_2 > 0$. This pattern implies that at levels of the composite financial integration indicator below its median the correlation between growth opportunities and actual growth in real GDP becomes weak and insignificant, perhaps suggesting that intra-euro area financial market fragmentation as it occurred during the recent financial crises hampered member countries from reaping the growth potential offered in global markets.

To sum up, we find that, in our sample, financial integration is generally associated with

[24] The fact that the $CISS$ becomes statistically insignificant in this model specification reflects the relatively strong collinearity between the interaction term and the $CISS$ with a sample correlation coefficient of 0.85.

[25] Analytical standard errors for the combined coefficient are computed as $\sigma_{\frac{\partial y_{i,t+1}}{\partial FinInt_t}} = \sqrt{var(\beta_1) + GO\_MA_{i,t}^2 \cdot var(\beta_2) + 2 \cdot GO\_MA_{i,t} \cdot cov(\beta_1, \beta_2)}$.

Figure 5: The combined effects of financial integration and exogenous growth opportunities on economic growth



Notes: Based on the estimates of equation 3 in Table 1, panel (a) shows the combined coefficient on financial integration ($FinInt_t$) for different percentiles of growth opportunities, i.e. $\beta_1 + \beta_2 \cdot GO\_MA_{i,t}\, percentiles$. Panel (b) plots the combined coefficient on growth opportunities $GO\_MA_{i,t}$ for different percentiles of financial integration, i.e. $\beta_4 + \beta_2 \cdot FinInt_t\, percentiles$. Confidence bands are computed analytically according to footnote 25.

higher output growth. This empirical association does not reflect the joint dependence of growth and financial integration on the impacts of the recent financial crises in the euro area as a potential omitted variable since we explicitly control for crisis effects by including a measure of systemwide financial stress into the regression.[26] We also find that the positive correlation between financial integration and growth is stronger for countries with higher exogenous growth opportunities. Since we use lagged explanatory variables and control for exogenous growth opportunities and contemporaneous US output growth, we cautiously interpret our main results in terms of causality running from financial integration to growth.

7 Concluding remarks

This paper develops a price-based and a quantity-based composite indicator of financial integration within the euro area. Our purpose is to offer a comprehensive overview of developments in the state of financial integration across different major market segments. As an application of our composite indicator concept, we investigate whether and to which extent financial integration has influenced economic growth across euro area countries. We indeed find that higher financial integration is associated with higher growth.

A few caveats to the analysis are in order. First, the price-based composite indicator may be

[26]We also experiment with different binary crisis dummies instead of or along with the $CISS$, but none of our main results change in any material way.

distorted by the existence of risk factors that generate cross-country price dispersion. However, a robustness test suggests that this problem is less severe than one may think due to the transformation of the raw dispersion measures. Second, in the growth regressions reported in Section 6, our list of control variables is likely not to be exhaustive. In particular, it could be worthwhile investigating whether instruments, which capture the main policy measures which were adopted to foster financial integration in Europe, may help identify causality of financial integration for economic outcomes. The pervasive problem of endogeneity may be further mitigated by assessing the link between financial integration and output at the industry sector level similar to Schnabel and Seckinger (2015). However, it should be understood that these growth regressions can only provide stylised facts. A proper understanding of the potential welfare effects arising from financial integration rather requires a structural model analysis of the underlying mechanisms.

All this notwithstanding, the proposed composite indicators of intra-euro area financial integration are, in our view, an improvement relative to the use of standard indicators which typically focus on one particular market segment. Aggregating information across markets can provide policymakers and researchers with a broader view of the state of financial integration.[27]

[27] See, e.g., the use of our price-based composite indicator in Lamas and Mencia (2018) as a measure of the degree of financial market fragmentation in panel regressions of Spanish banks' sovereign bond holdings.

Appendix

Table 2: Variables Description

Government consumption/GDP	Government consumption divided by gross domestic product. General government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.
Secondary school enrollment	Secondary school enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the secondary level of education. Accordingly, the reported value can exceed (or average) more than 100%.
Population growth	Growth rate of total population which counts all residents regardless of legal status or citizenship.
Life expectancy	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Source: World Bank Development Indicators, OECD.

References

[1] Abascal, M., T. Alonso, and S. Mayordomo (2013), "Fragmentation in European Financial Markets: Measures, Determinants and Policy Solutions", BBVA Working Paper, Madrid.

[2] Adam, K., T. Jappelli, A. Menichini, M. Padula and M. Pagano (2002), "Analyze, Compare, and Apply Alternative Indicators and Monitoring Methodologies to Measure the Evolution of Capital Market Integration in the European Union", EC Report, January.

[3] Adjaouté, K. and J.-P. Danthine (2003), "European Financial Integration and Equity Returns: A Theory-Based Assessment", FAME Research Paper Series rp84, International Center for Financial Asset Management and Engineering.

[4] Agénor, P. R. (2003), "Benefits and Costs of International Financial Integration: Theory and Facts", The World Economy, Vol. 26, No. 8, pp. 1089-1118.

[5] Babecký, J., Komárek, L., and Komárková, Z. (2010), "Financial Integration at Times of Financial Instability", Czech Journal of Economics and Finance (Finance a uver), Charles University Prague, Faculty of Social Sciences, Vol. 63, No. 1, pp. 25-45.

[6] Backus, D.K., P.J. Kehoe and F.E. Kydland (1995), "International Business Cycles: Theory and Evidence", in T.F. Cooley (ed.), Frontiers of Business Cycle Research, Princeton University Press, Princeton, 331-356.

[7] Baele, L., A. Ferrando, P. Hördahl, E. Krylova and C. Monnet (2004), "Measuring Financial Integration in the Euro Area", ECB Occasional Paper Series, No. 14, April.

[8] Baltzer, M., L. Capiello, R.A. De Santis and S. Manganelli (2008), "Measuring Financial Integration in New EU Member States", ECB Occasional Paper Series, No. 81, March.

[9] Battistini, N., M. Pagano and S. Simonelli (2014), "Systemic Risk, Sovereign Yields and Bank Exposures in the Euro Crisis", Economic Policy, Vol. 29, No. 78, pp. 203-251.

[10] Bekaert, G. and C.R. Harvey (1995), "Time-Varying World Market Integration", Journal of Finance, Vol. 50, No. 2, pp. 403-444.

[11] Bekaert, G., C.R. Harvey and C. T. Lundblad (2001), "Emerging Equity Markets and Economic Development", Journal of Development Economics, Vol. 66, pp. 465-504.

[12] Bekaert, G., C.R. Harvey and C. T. Lundblad (2005), "Does Financial Liberalization Spur Growth?", Journal of Financial Economics, Vol. 77, pp. 3-55.

[13] Bekaert, G., C.R. Harvey and C. T. Lundblad (2006), "Growth Volatility and Financial Liberalization", Journal of International Money and Finance, Vol. 25, pp. 370-403.

[14] Bekaert, G., C.R. Harvey, C. T. Lundblad and S. Siegel (2007), "Global Growth Opportunities and Market Integration", Journal of Finance, No. 3, pp. 1081-1137.

[15] Bekaert, G., C.R. Harvey, C. T. Lundblad (2011a), "Financial Openness and Productivity", World Development, Vol. 39, No. 1, pp. 1-19.

[16] Bekaert, G., C.R. Harvey, C. T. Lundblad and S. Siegel (2011b), "What Segments Equity Markets?", Review of Financial Studies, Vol. 24, No. 12, pp. 3841-3890.

[17] Cardarelli, R., S. Elekdagb and S. Lall (2011), "Financial Stress and Economic Contractions", Journal of Financial Stability, Vol. 7, pp. 78-97.

[18] Cassela, G. and R.L. Berger (2002), "Statistical Inference", 2nd edition, Brooks/Cole Cengage Learning.

[19] Diebold, F.X. and Yilmaz, K. (2012), "Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers", International Journal of Forecasting, Vol. 28, pp. 57-66.

[20] European Central Bank (2006), "The Contribution of the ECB and the Eurosystem to European Financial Integration", Monthly Bulletin, May.

[21] European Central Bank (2014), "Financial Integration in Europe", Frankfurt, April.

[22] European Central Bank (2015), "Financial Integration in Europe", Frankfurt, April.

[23] Fecht, F. and H.P. Grüner (2005), "Financial Integration and Systemic Risk", Deutsche Bundesbank Discussion Paper, Series 2: Banking and Financial Studies, No. 11.

[24] Fecht, F., H.P. Grüner and P. Hartmann (2012), "Financial Integration, Specialization, and Systemic Risk", Journal of International Economics, Vol. 88, No. 1, pp. 150-161.

[25] Giglio, S., Kelly, B. and S. Pruitt (2016), "Systemic risk and the macroeconomy: An empirical evaluation", Journal of Financial Economics, Vol. 119, pp. 457–471.

[26] Gropp, R. and A. K. Kashyap (2010), "A New Metric for Banking Integration in Europe", NBER Working Paper No. 14735.

[27] Gupta, N. and K. Yuan (2009), "On the Growth Effect of Stock Market Liberalizations", Review of Financial Studies, Vol. 22, No. 11, pp. 4715-4752.

[28] Hartmann, P., A. Maddaloni and S. Manganelli (2003), "The Euro Area Financial System: Structure, Integration and Policy Initiatives", ECB Working Paper No. 230, May.

[29] Hartmann, P., K. Hubrich, M. Kremer and R.J. Tetlow (2015), "Melting Down: Systemic Financial Instability and the Macroeconomy", Mimeo.

[30] Holló, D., M. Kremer and M. Lo Duca (2012), "CISS - A Composite Indicator of Systemic Stress in the Financial System", ECB Working Paper No. 1426, March.

[31] Hubrich, K. and R. J. Tetlow (2014), "Financial Stress and Economic Dynamics: the Transmission of Crises", Journal of Monetary Economics, Vol. 70, pp. 100-115.

[32] Imbs, J. (2006), "The Real Effects of Financial Integration", Journal of International Economics, Vol. 68, pp. 296-324.

[33] Kremer, M. (2016), "Macroeconomic Effects of Financial Stress and the Role of Monetary Policy: a VAR Analysis for the Euro Area", International Economics and Economic Policy, Vol. 13, pp. 105-138.

[34] Laeven, L. and F. Valencia (2018), "Systemic Banking Crises Revisited", IMF Working Paper WP/18/206.

[35] Lamas, M. and J. Mencia (2018), "What Drives Sovereign Debt Portfolios of Banks in a Crisis Context?", Banco de España, Documentos de Trabajo No. 1843.

[36] Michaelides, A., Milidonis, A., Nishiotis, G. and P. Papakyriakou (2015), "The Adverse Effects of Systematic Leakage Ahead of Official Sovereign Debt Rating Announcements", Journal of Financial Economics, Vol. 116, Issue 3, pp. 526-547.

[37] Mitton, T. (2006), "Stock Market Liberalization and Operating Performance at the Firm Level", Journal of Financial Economics, Vol. 81, pp. 625-647.

[38] Obstfeld, M. and A.M. Taylor (2004), "Global Capital Markets: Integration, Crisis, and Growth", Cambridge University Press.

[39] Schnabel, I. and C. Seckinger (2015), "Financial Fragmentation and Economic Growth in Europe", Annual Conference 2015 (Muenster): Economic Development - Theory and Policy 112864, Verein für Socialpolitik / German Economic Association.

[40] Spanos, A. (1999), "Probability Theory and Statistical Inference. Econometric Modeling with Observational Data", Cambridge: Cambridge University Press.

[41] Stiglitz, J. E. (2010), "Risk and Global Economic Architecture: Why Full Financial Integration May be Undesirable", American Economic Review, Vol. 100, No. 2, pp. 388-392.

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