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# EU Financial Integration: Is There a 'Core Europe'?
## - Evidence from a Cluster-Based Approach

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**THOMAS KIEHLBORN AND MARK MIETZNER†**

# EU FINANCIAL INTEGRATION: IS THERE A 'CORE EUROPE'? - EVIDENCE FROM A CLUSTER-BASED APPROACH*

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**Abstract**

Numerous recent studies, e.g. EU Commission (2004a), Baele et al. (2004), Adam et al. (2002), and the research pooled in ECB-CFS (2005), Gaspar, Hartmann, and Sleijpen (2003), have documented progress in EU financial integration from a micro-level view. This paper contributes to this research by identifying groups of financially integrated countries from a holistic, macro-level view. It calculates cross-sectional dispersions, and innovates by applying an inter-temporal cluster analysis to eight euro area countries for the period 1995-2002. The indicators employed represent the money, government bond and credit markets. Our results show that euro countries were divided into two stable groups of financially more closely integrated countries in the pre-EMU period. Back then, geographic proximity and country size might have played a role. This situation has changed remarkably with the euro's introduction. EMU has led to a shake-up both in the number and composition of groups. The evidence puts a question mark behind using Germany as a benchmark in the post-EMU period. The findings suggest as well that financial integration takes place in waves. Stable periods and periods of intense transition alternate. Based on the notion of 'maximum similarity', the results suggest that there exist 'maximum similarity barriers'. It takes extraordinary events, such as EMU, to push the degree of financial integration beyond these barriers. The research encourages policymakers to move forward courageously in the post-FSAP era, and provides comfort that the substantial differences between the current and potentially new euro states can be overcome. The analysis could be extended to the new EU member countries, to the global level, and to additional indicators.

*Keywords* : Financial integration process, country groups, core Europe, cluster analysis

*JEL Classification* : F3, F36, G15

*"(...) some countries could, and perhaps should take the initiative to go forwards. (...) They might be the EU founder members (...) or even a mixed group. (...) The union train cannot always move at the speed of the slowest wagon."*[a]

[a]Romano Prodi, in: La Repubblica (2004).

# 1 Introduction

## 1.1 Research motivation

It is important to measure the progress of financial integration from a variety of perspectives.[1] Direct, qualitative approaches identify and analyze economic and regulatory barriers, whereas indirect, quantitative approaches analyze the observable consequences of these barriers.[2] Micro-level analysis focuses on a separate assessment of, for example, individual financial market segments, value chain elements, and efficiency indicators, whereas macro-level analysis performs a simultaneous analysis of these areas. All approaches provide insights into the impact of integration initiatives, and provide guidance for the drivers of integration, namely market forces, collective action within the market community and public authorities,[3] in their targeting of future action.

From a quantitative micro-level view, the progress of EU financial integration are by now well-documented. A rich literature on EU financial integration has developed over time, and a broad set of sophisticated methods and indicators have been applied.[4] The numerous findings are reflected in a variety of recent studies, such as the taking stock of indicators in the EU Commission's first Financial Integration Monitor,[5] and in the manifold publications of the ECB-CFS research network on EU financial integration,[6] to name but a few. This research shows "that different market sectors have attained different levels of integration."[7] In fact, "(...) 'integrated wholesale markets, fragmented retail markets' is how most mainstream analyses would probably summarize the state of the euro area banking business."[8] Some of the remaining challenges and deficiencies are currently being tackled within the framework of the FSAP, but the debate on a post-FSAP agenda has already begun.[9] "Such a debate naturally has to start with a (...) review of the accomplishments to date."[10]

[1]"Conclusions on the progress of integration (...) cannot be based on the observation of one single indicator or trend." (EU Commission (2004a), p. 4)

[2]See Schüler and Heinemann (2002), p. 35ff.

[3]See ECB (2003a), p. 53ff.

[4]See, among other studies, EU Commission (2004a), Baele et al. (2004), EU Commission (2003), ECB (2003a), Hartmann et al. (2003), Cabral, Dierick, and Vesala (2002), and Adam et al. (2002) for a detailed discussion of methodologies, indicators and results. See also Section 2.

[5]See EU Commission (2004a), and its background documents EU Commission (2004b), EU Commission (2004c), EU Commission (2003), and EU Commission (2002).

[6]See ECB-CFS (2005), and Gaspar, Hartmann, and Sleijpen (2003).

[7]Baele et al. (2004), p. 81.

[8]Manna (2004), p. 7.

[9]FSAP = Financial Services Action Plan. See the FSAP progress reports, e.g. EU Commission (2004d), its predecessors, and Expert Group on Banking (2004), Securities Expert Group (2004), Expert Group on Insurance and Pensions (2004), Asset Management Expert Group (2004). See EU Commission (2005a) and EU Commission (2005b) for a detailed, frequently updated overview of the progress of the FSAP.

[10]Walter (2004), p. 3.

The aim of this paper is to contribute to the above research by shedding further light on the EU financial integration process from a holistic, macro-level perspective. Although the perspective is different, the underlying motivation, i.e. the assessment of the status quo, progress and trends in EU financial integration, corresponds to that of the micro-level research. However, our research questions differ slightly:

- 1) Are there stable groups of financially more closely integrated countries?
- 2) Does a Europe of two or more financial integration speeds exist?
- 3) Do some EU countries form a 'Core Europe'?
- 4) Is the choice of Germany as a benchmark justified?

In answering these research questions, we hypothesize that the barriers to financial integration - regulatory, legal, tax-related, geographical, cultural, and historic - will be visible in group building, if it exists. Strong 'mobility barriers' are likely to prevail in fragmented EU financial markets, leading to the formation of stable groups of financially more closely integrated countries. The well-documented reduction and removal of these barriers over time should have reduced the differences between these groups as well as between individual countries. In turn, this reduction in differences, i.e. this financial integration process, should translate into a change of the groups' composition. With increasing degrees of financial integration, it could be expected that countries leave their traditional group, join other groups, or form new groups.

The insights provided by our research are of value for future EU policy discussions and initiatives. Documenting whether and how 'old' EU member states have formed stable, financially more closely integrated groups in the past might be helpful in the current efforts to fully integrate the ten 'new' EU member states into the emerging EU financial system.[11] Our research results add to the discussion of whether the undisputable differences between 'old' and 'new' EU member states, and, more narrowly, between 'old' and potentially 'new' euro countries, might diminish as the future of EU financial integration unfolds. They may also serve as a 'success control': The effects of major integration initiatives, such as the European Monetary Union (EMU), should become visible in group building.

Additional observations underscore that answering our research questions is of academic, regulatory, and political relevance. The above statement from Romani Prodi, the Commission's President until 2004, mirrors the, in some political fields heated, debate on a Europe of two or more integration speeds.[12] The German Christian Democrats' Wolfgang Schäuble and Karl Lamers published a pamphlet as early as 1994 in which they called for a 'Kerneuropa' (= core Europe).[13] German Foreign Minister Joschka Fischer advocated strongly for an 'Avantgarde' of

[11] Eight CEE countries joined the EU alongside Malta and Cyprus on 01 May 2004.
[12] Prodi refers to the EU Constitution, which was signed in October 2004, but still needs ratification.
[13] See Schäuble and Lamers (1994).

countries to lead the EU in 2000,[14] and Grabbe and Guerot (2004) have asked "Could a hard core run the enlarged EU?"[15] in the title of a recent publication.[16]

Previous research has pointed to the existence of groups of financially more closely integrated countries. Gualandri (2000) claims that "in an integrated market, interest margins will tend to converge towards the lower levels found in (...) the Deutschmark area plus France (the so-called 'Core Europe') (...) in contrast to the other countries or 'Other Europe'."[17] Schüler and Heinemann (2002) conclude that their results point "to an integrated 'core' of countries, namely Spain, Germany, Italy, Ireland, and Belgium to which France and Finland have some link."[18] Kleimeier and Sander (2002) find differing results for countries "dubbed as 'non-core EMU' such as Ireland, Italy, Portugal and Spain (...) [and] for core-EMU countries such as Austria, Belgium, Germany and the Netherlands."[19]

Manna (2004) investigates the role of border sharing since "this offers an insight about the possibility that the euro market is in fact the sum of several regional markets."[20] Boreiko (2002) applies various economic criteria to assess the readiness of CEE countries to join EMU. He identifies "three groups of transition countries,"[21] and finds that "during the period 1998-2001, we observe (...) four groups"[22] with respect to Maastricht criteria adherence. Emiris (2002) examines equity markets and documents differences in integration speeds within the EU by concluding that "there appear to be differences in timing between countries."[23]

The research introduces a methodologically powerful, yet intuitive tool to the financial integration literature. Besides calculating cross-section dispersions statistics, it employs the Ward algorithm as a clustering technique to identify homogenous groups of financially more closely integrated countries. Cluster analysis best fits our research objectives as this methodology, among other advantages, aims to identify homogeneous groups, strives to maximize heterogeneity between groups and does not assume objects to be independent from each other. Transplanting this idea into the financial integration literature, it follows that countries that are assigned to the same group are more 'similar' and, thus, financially more closely integrated with each other than those countries which do not belong to this group. An increase in similarity over time, or a decrease in distances between countries, indicates that a financial integration process is taking place. This paper innovates in that an inter-temporal cluster analysis has, to our knowledge, not yet been found in the literature.

[14] See Fischer (2000). He later retreated from this idea. See Berliner Zeitung (2004).
[15] Grabbe and Guerot (2004).
[16] See also Schneider (2004).
[17] Gualandri (2000), p. 253.
[18] Schüler and Heinemann (2002), p. 54.
[19] Kleimeier and Sander (2002), p. 20f.
[20] Manna (2004), p. 24.
[21] Boreiko (2002), p. 3.
[22] Boreiko (2002), p. 7.
[23] Emiris (2002), p. 219.

Our definition of financial integration innovates in two regards: It is based on the concept of distances, or similarities, and it lifts the definition of financial integration to the aggregate level of individual EU member states. Instead of 'full' integration, 'maximum similarity' forms the core of our definition. Our study employs price-based indicators that have been used in the financial integration literature before, i.e. national interest rates, for the money, government bond and credit markets. It covers eight euro area countries, and examines the period 1995 to 2002.[24]

Some words of caution seem warranted. First, we aim at incorporating as many indicators as possible to put the research on a broad footing. Little data is available that satisfies our requirements, i.e. all data points must be available for all countries, all periods and of 'good' quality. The data employed best fulfills these criteria. Second, we have run a separate analysis that includes additional indicators. Yet, data points of the additional indicators were missing. An application of data augmentation algorithms to complete the missing data points violates our data quality requirements. It puts noise to the analysis which is why we restrict the research to 'clean'data. Third, we use ECB data for the credit market. This is, to our knowledge, the most reliable data available, but it is not risk-adjusted. Adjusting for risk is complex with respect to credit market rates, and risk adjustments threaten to seriously distort our analysis. Fourth, to our knowledge, this is the first attempt to measure progress in EU financial integration from a macro-perspective by employing an inter-temporal cluster analysis. Econometricians could raise concerns about the statistical rigorousness of the clustering procedure. However, in our research setting, we consider it an advantage that cluster analysis leaves room for interpretation, and that the interpretation is not dominated by the method itself.[25] We take these limitations into account, and are confident that the results of our approach provide fruitful answers to the outlined research questions, and that our research serves as a starting point to stimulate subsequent methodological extensions.

## 1.2 Structure of paper

The paper is structured as follows. Section 2 reviews the literature on measuring EU financial integration. Section 3 introduces our definition of financial integration. We then discuss the set of indicators used, provide an overview of the cluster algorithm and its associated diagnostics, and outline the advantages and limitations of cluster analysis in identifying groups of financially more closely integrated countries. Section 4 applies cluster analysis to eight euro area countries, discusses the findings, and assesses their implications. Section 5 concludes and points to possible future research extensions.

[24] Greece, Ireland, Luxembourg and the Netherlands were excluded due to data unavailability.

[25] "Rudimentary, exploratory procedures are often quite useful in understanding the complex nature of multivariate relationships (...), for assessing dimensionality, identifying outliers, and suggesting interesting hypotheses concerning relationships." (Johnson and Wichern (1998), p. 726)

# 2 EU financial integration: Overview of literature

## 2.1 Indicators for measuring financial integration

The "effective interplay between market forces, collective action within the market community to overcome coordination problems, and action by public authorities,"[26] the latter via numerous harmonization, liberalization and deregulation initiatives,[27] is key for bringing about EU financial integration. As the introduction has already highlighted, a large body of research on EU financial integration has developed over time, and broad sets of sophisticated indicators have been applied to assess the degree and evolution of EU financial integration. Direct, qualitative approaches to measuring financial integration analyze economic and regulatory barriers, whereas indirect, quantitative approaches analyze the observable consequences of these barriers.[28] Our research follows the indirect, quantitative approach.

Table 1 provides an overview of the wide variety of statistical indicators that are employed in the literature to indirectly measure the degrees of integration in EU financial markets. This overview is based on the recommendations and findings of EU Commission (2004a), Baele et al. (2004), EU Commission (2003), and Adam et al. (2002) whose studies come closest to a comprehensive assessment of EU financial market integration. Following Baele et al. (2004), three categories of indicators can be distinguished: a) price-based indicators, b) news-based indicators, and c) quantity-based indicators.[29]

Price-based indicators, which can be further classified into the two categories a) yield-based measures and b) country effects, typically include the convergence of interest rates, which "measure the 'cost of money' in financial markets."[30] The rationale behind these indicators is that arbitrage should ensure that the law of one price holds in perfectly integrated financial markets, i.e. prices of identical assets that are traded in different country markets are equal.[31] Table 1 outlines that indicators based on quantities, either stock data or flow data, comprise data on international capital flows, portfolio compositions, cross-border lending and foreign shares in total issuing activity.[32]

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[26] ECB (2003a), p. 53.

[27] "The general model of financial integration in Europe is that of the 'single passport'. This concept combines minimum harmonization, mutual recognition and home country control." (Schmidt (2001), p. 435) See Dermine (2003), DB Research (2002), Kleimeier and Sander (2002), p. 2ff., for a review of the transformation of European banking from 1957 to the present.

[28] See Schüler and Heinemann (2002), p. 35ff. For example, the Annual Report on Exchange Arrangements and Exchange Restrictions of IMF (2003) provides an overview of barriers to international capital flows.

[29] See Baele et al. (2004), p. 12ff. Adam et al. (2002) identify additionally d) indicators based on economic decisions of households and firms, and e) indicators of institutional differences. See Adam et al. (2002). Furthermore, the EU Commission (2004a) provides indicators related to the efficiency of financial integration, looks at the re-organization of value chains at EU level, and examines changes in financial stability and competitive structures. See EU Commission (2004a).

[30] EU Commission (2004c), p. 2.

[31] See Schüler and Heinemann (2002), p. 37. The three interest parity conditions a) covered nominal interest parity, b) ex ante uncovered interest parity, and c) ex ante real interest parity are often employed to assess the degree of financial integration. As a result of the euro's introduction, "tests for interest parity in order to assess the degree of financial market integration within EMU make no sense." (Schüler and Heinemann (2002), p. 38)

[32] The arguably most known quantity-based indicator was introduced by Feldstein and Horioka (1980), who analyze correlations between investment and saving.

| Market segment | Indicators | |
|---|---|---|
| | (1) Price-based indicators | |
| | Yield-based measures | Country effects |
| a) Money | - Spread between interest rates<br>- Cross-sectional dispersion | - Dispersion of rates across countries vs. within countries |
| b) Corporate bond | - Size and significance of country effect for corporate bond spreads<br>- Cross-sectional dispersion in country effect<br>- Proportion of cross-sectional variance explained by country effect | - Country vs. rating effects within the country (rating) portfolio |
| c) Government bond | - Spread between yields using a reference asset<br>- ß-convergence<br>- Cross-sectional dispersion | |
| d) Equity | | - Sector vs. country effects |
| e) Credit | - Spread between interest rates using a reference country interest rate<br>- Margins using comparable market rates<br>- ß-convergence<br>- Cross-sectional dispersion | |
| | (2) News-based indicators | (3) Quantity-based indicators |
| a) Money | | - Cross-border lending activities<br>- Resort to standing facilities<br>- Repo market: number of trades |
| b) Corporate bond | | - Share of assets invested in bond funds with a European-wide investment strategy |
| c) Government bond | - Percentage of asset price change explained by common factors | - Share of assets invested in bond funds with a European-wide investment strategy |
| d) Equity | - Increase in common news components in equity returns | - Asset share of euro area investment funds with non-domestic and European horizon<br>- Share of non-euro area equity in total equity portfolio of pension fund and life insurance sectors |
| e) Credit | - Percentage of interest rate change explained by common factors | - Cross-border loans to non-banks and interbank loans<br>- Cross-border securities holdings issued by banks and non-banks |

Source: Adapted from Baele et al. (2004), p. 22. See also Table 4.1 in Adam et al. (2002), p. 61, and Table 1 in Schüler and Heinemann (2002), p. 36.

Table 1: Overview of integration indicators for different market segments

In comparison with quantity-based indicators, price-based indicators yield various methodological benefits. They are particularly useful for the analysis of long-term integration processes, since their application allows for the detection of trends. Another important advantage is that new integration measures are more rapidly visible in price-based than in quantity-based indicators. In addition, Adam et al. (2002) point out that "price indicators are more easily available and more accurate. (...) Price-based indicators also have a clear-cut interpretation, which is often lacking for quantity indicators when based on flow data."[33]

One of the main reasons for the inferiority of flow data is that "the presence of cross-border financial flows is neither a necessary nor a sufficient condition for financial market integration."[34] Quantity indicators that are instead based on stock data can be more straightforwardly interpreted.[35] The EU Commission (2004c) argues in favor of the use of quantity indicators, since they "can give us an indication of foreign presence in domestic markets, [and of] access of residents to other Member States markets."[36] Still, the Commission acknowledges that "the mere presence of cross-border activity in a certain market segment does not deliver absolute proof of market integration, (...) it is an indication that markets are contestable to some degree."[37]

Price-based indicators have limitations that are important in interpreting our research results.[38] The EU Commission (2004c) points out that a "convergence of interest rates may be observed independently of any significant increase in cross-border lending (...) [and] can be due to perceived contestability of markets".[39] In addition, price-based indicators refer to the law of one price, yet Padoa-Schioppa (2000) emphasizes that the "law of one price, which is the usual criterion for identifying the emergence of a unified market, provides only limited help in assessing the extent of integration in banking,"[40] since financial products are rarely perfect substitutes. "The law may fail to hold true because of factors such as transport or transaction costs, consumer switching costs or barriers to entry, maintaining market segmentation."[41] In addition, "in the context of retail banking the case for the law of one price is (..) not so straightforward. (...) Rather, credits are characterized by heterogeneity caused by risk differences, cultural influences in bank-client relationship, [and] country-specific strategic bank behavior in order to cope with informational imperfections (...)."[42]

[33] Adam et al. (2002), p. 1.

[34] Adam et al. (2002), p. 13. "It is not necessary because the law of one price may hold even in the absence of cross-border flows: according to the theory of contestable markets, potential competition arising from the threat of entry by foreign banks may be sufficient to enforce the same terms for borrowers in different countries. It is also not sufficient because credit markets may fail to be integrated despite high cross-border credit flows. Such flows might fail to equalize domestic and foreign interest rates, e.g. because banks' market power may vary across countries." (Adam et al. (2002), p. 13)

[35] See Adam et al. (2002), p. 13.

[36] EU Commission (2004c), p. 2.

[37] EU Commission (2004c), p. 2.

[38] We restrict the analysis to six price-based indicators. See Section 3.2.

[39] EU Commission (2004c), p. 7. A perceived contestability can result from the threat of entry by partner country institutions or high competition between local incumbents.

[40] Padoa-Schioppa (2000), p. 1.

[41] Cabral, Dierick, and Vesala (2002), p. 7.

[42] Kleimeier and Sander (2002), p. 8.

## 2.2 Degree of integration in EU financial market segments

We discuss the observed degrees of financial integration separately to bring order to the large body of available research. In a broad classification, EU wholesale financial markets can be distinguished from EU retail markets. Schüler and Heinemann (2002) even argue that "in the context of measuring integration, the distinction between wholesale capital markets and retail financial markets becomes crucial."[43] In a narrow view, the financial markets segments a) derivatives market, b) money market, c) bond market, d) equity market, and e) credit market can be identified.[44] This separation follows the literature, since many research studies, as Table 2 shows, either focus on a few market segments or on specific aspects of one single segment.

Various financial market segments are perfectly integrated within the euro area. The foreign exchange market, which forms an additional category, is one obvious example. All exchange rate risk has been eliminated with the euro's introduction on 01 January 1999.[45] The degree of financial integration in most derivatives market sub-segments is high as well. Trichet (2003) points out that the introduction of EONIA[46] in 1999 and "its adoption as a benchmark on the interest rate swap market has been an important factor for the integration of this particular market segment. Furthermore, (...) the market for interest rate swaps indexed on the EONIA is the most liquid and deepest of its kind in the world."[47] This assessment is supported by the ECB (2003a), which concludes that the "overnight interest rate swap market (...) [and] derivatives markets (...) can also be said to be perfectly integrated,"[48] and by the EU Commission (2004c), which argues that the past years "have been marked by the development of large pan-European organized markets for futures and derivatives (...), with its major functions fully integrated."[49]

The money market has, as Galati and Tsatsaronis (2001) put it, a "split personality (...), [since ] the impact of EMU has been considerable, but the progress towards integration (...) has been uneven across different market segments."[50] There was an "almost immediate integration of the money market - concerning both the interbank market and the derivatives market - at the beginning of 1999,"[51] but Baele et al. (2004) show that "not all segments of the market have yet reached the same level of what might be called 'near-perfect' integration."[52] It is important to distinguish between the unsecured and the secured parts of the money market. The EU Commission (2004c) underscores that the

[43] Schüler and Heinemann (2002), p. 34.
[44] These market segments can be further broken down according to, for example, transaction sizes, instruments and client groups.
[45] The commodities market may be identified as a seventh market segment. Most sub-segments of this market, i.e. gold, oil, soybeans, wheat, etc., are fully integrated not only on an EU level, but globally.
[46] EONIA = Euro OverNight Index Average.
[47] Trichet (2003), p. 1.
[48] ECB (2003a), p. 63.
[49] EU Commission (2004c), p. 23.
[50] Galati and Tsatsaronis (2001), p. 2.
[51] Trichet (2003), p. 1.
[52] Baele et al. (2004), p. 33.

| Study / Author | Investigated financial market segment |
|---|---|
| EU Commission (2004a, 2004b, 2004c)<br>EU Commission (2003) | Money, derivatives, fixed income,<br>equity, credit markets |
| Baele et al. (2004) | Money, government bond, corporate bond,<br>equity, banking / credit markets |
| Manna (2004) | Wholesale and retail markets |
| ECB (2003a) | Money, government bond, equity markets |
| Hartmann et al. (2003) | Money, bond, stock markets, banking |
| Adjaouté and Danthine (2003) | Government bond, equity markets |
| European Banking Federation (2003) | Money, bond, equity, retail credit markets |
| Schüler and Heinemann (2002) | Retail and wholesale financial markets |
| Cabral, Dierick, and Vesala (2002) | Wholesale-, capital market-, retail banking |
| Eppendorfer et al. (2002) | Market access strategies |
| Adam et al. (2002) | Bond, stock, credit markets, economic decisions<br>of households & firms, institutional differences |
| Emiris (2002) | Stock market |
| EU Commission (2002) | Wholesale and retail markets |
| Kleimeier and Sander (2002) | Retail credit market |
| Galati and Tsatsaronis (2001) | Money, bond, equity, foreign exchange markets |
| Ayuso and Blanco (2000) | Stock market |

Source: Own illustration, own compilation. See also Table 2 in Manna (2004), p. 12.

Table 2: Overview of selected recent studies on measuring EU financial integration

"euro-denominated interbank unsecured money market is an integrated market (...), [whereas] secured money markets are less integrated."[53] These results are reflected in a variety of other recent studies. To name but a few, the ECB (2003a) finds that the "unsecured euro overnight market has been highly integrated since the start of Stage Three of EMU,"[54] Hartmann et al. (2003) emphasize that "the euro area money market is characterized by a (...) highly integrated unsecured deposit market and by a (...) less integrated repo market,"[55] and the European Banking Federation (2003) even argues that "the market for unsecured interbank deposits (...) is highly integrated (...), the secured money markets (...) remain

[53] EU Commission (2004c), p. 20f.
[54] ECB (2003a), p. 62.
[55] Hartmann et al. (2003), p. 192.

largely fragmented."[56] However, integration in the secured part is advancing, and "evidence of this progress can be seen in the creation of the EUREPO benchmark index, or in the development of a standardized legal document known as the 'European Master Agreement'."[57]

The ECB (2003a) points out that the lower degree of financial integration in the secured money market is broadly comparable to the degree of financial integration in "the bond markets in general and the government bond market segment in particular."[58] This view is confirmed by Hartmann et al. (2003), who find, as well, that the "bond market has converged rapidly (...), although to a lesser extent than the money market."[59] In particular, the euro has played an important role for the integration in the bond market. Galati and Tsatsaronis (2001) speak in the context of the euro's impact on bond market integration of a "success story,"[60] and the European Banking Federation (2003) emphasizes that "EMU and the arrival of the euro resulted in a dramatic integration of the 12 national bond markets of the participating Member States."[61]

Adam et al. (2002) argue that "convergence is achieved in the (...) government bond market,"[62] but others emphasize that the euro government bond market is not perfectly integrated. For example, Adjaouté and Danthine (2003) show that the "evolution of government bond markets (...) has been spectacular. (...) Lower spreads (...), lower interest rate volatility (...), but (...) failure of financial integration."[63] The EU Commission (2004c) confirms the latter findings by showing that the "dispersion of sovereign bond yields between countries has decreased substantially (...), [but] there are still some barriers to overcome before full integration is reached."[64] Baele et al. (2004) incorporate yet another perspective and find that, since the euro's introduction, integration in the "government bond market has been very high (...) [and] yields became increasingly driven by common news, and less by purely local risk factors. However, (...) additional integration of the government bond market may be possible."[65] Thus, somewhat unsurprisingly, Adjaouté and Danthine (2003) point to the potential existence of "multiple equilibria"[66] in the government bond market.[67]

With respect to the corporate bond market, the analysis of Baele et al. (2004) "suggests that the level and evolution of corporate bond yield spreads in the euro area is to a large extent determined by credit rating, and to a lesser extent

[56] European Banking Federation (2003), p. 3.
[57] Trichet (2003), p. 1. See also ECB (2002b) and the regular ECB publications on the euro area money market, such as ECB (2004c), ECB (2003b), ECB (2002a).
[58] ECB (2003a), p. 64.
[59] Hartmann et al. (2003), p. 196.
[60] Galati and Tsatsaronis (2001), p. 5.
[61] European Banking Federation (2003), p. 4.
[62] Adam et al. (2002), p. 3.
[63] Adjaouté and Danthine (2003), p. 53f.
[64] EU Commission (2004c), p. 23.
[65] Baele et al. (2004), p. 44.
[66] Adjaouté and Danthine (2003), p. 17.
[67] For example, the remaining divergence arises from differences in liquidity, credit risk, issuance practices, trading platforms, economic fundamentals and the absence of a single bond yield curve. The heated debates on the future of the Stability and Growth Pact might also play a role. See Baele et al. (2004), p. 37ff., EU Commission (2004c), p. 22ff.

by the common, coupon, maturity, liquidity and sector factors. (...) Corporate bond markets (...) are reasonably integrated with each other."[68] Their results are confirmed by the EU Commission (2004c), which demonstrates that an "analysis of ECB data on corporate bond yields reveals country premia are low,"[69] and by the ECB (2003a), which argues that the "markets for high-yield debt securities and asset-backed securities (...) remain fragmented. (...) Another example of an imperfectly integrated market is the short-term securities market."[70]

The picture with respect to the degree of financial integration is less clear in the equity market. The work of Baele et al. (2004) indicates that the degree of financial integration is on the rise: "Equity returns in euro area countries have become increasingly more correlated (...), increasingly determined by common news factors and less by country-specific factors, (...) [and the] home bias (...) has decreased considerably."[71] Adam et al. (2002) similarly point out that their "indicators of European stock market integration generally suggest an increasing degree of stock market integration for the Euro area."[72] Adjaouté and Danthine (2003) add to these results by providing evidence of a lower cost of equity for European firms in an integrated euro area, and of a paradigm shift in asset allocation: from a country-based to a sector-based approach.[73] The European Banking Federation (2003) agrees and recognizes a "shift away from country-based investments towards sector-based investments, (...) [and a] much greater degree of correlation in equity price movements."[74]

The blurred picture with respect to the degree of integration in the equity market is underscored by the European Banking Federation (2003), which suggests that equity markets remain "essentially domestic in nature and greatly underdeveloped."[75] Emiris (2002) is skeptical, as well, and concludes that his "empirical application has shown that European equity markets are not perfectly integrated."[76] Hartmann et al. (2003) are only able to provide "weak evidence that some integration in equity markets took place over the past few years,"[77] and, similarly, Ayuso and Blanco (2000) argue that their results rather provide "mild support to the existence of an increase in stock market linkages."[78] Baele et al. (2004) even remark that "despite these advances in euro area equity market integration, it remains among the least integrated of those we have examined."[79] Galati and Tsatsaronis (2001) point to a potential explanation of the rather slow process in equity market integration by arguing that "the impact of the euro on

[68] Baele et al. (2004), p. 54.
[69] EU Commission (2004c), p. 23.
[70] ECB (2003a), p. 64.
[71] Baele et al. (2004), p. 81. See also EU Commission (2004c), p. 21f., ECB (2003a), p. 63.
[72] Adam et al. (2002), p. 50.
[73] See Adjaouté and Danthine (2003), p. 53f. "Taking account of average returns, and not only of correlations, (...) clearly strengthens the rationale for the paradigm change." (Adjaouté and Danthine (2003), p. 53)
[74] European Banking Federation (2003), p. 6f.
[75] European Banking Federation (2003), p. 6f.
[76] Emiris (2002), p. 219.
[77] Hartmann et al. (2003), p. 199.
[78] Ayuso and Blanco (2000), p. 182.
[79] Baele et al. (2004), p. 81.

European equity markets has been felt mostly on the economic factors that drive share prices and less on the structure of the trading of the same securities."[80] Although it is possible for investors to trade almost all financial instruments, it is well-documented that the costs of cross-border trades are still substantially higher than the costs of domestic trades.[81]

A consensus has emerged that the degree of integration in EU retail financial markets is rather low overall. The EU Commission (2004c) acknowledges that "some lending activity within the EU remains fragmented when considering the retail end of the spectrum."[82] Adam et al. (2002) provide evidence that "credit market integration (...) has so far been modest and is still far from being complete,"[83] Schüler and Heinemann (2002) conclude that "retail financial markets still reveal substantial fragmentation,"[84] and Cabral, Dierick, and Vesala (2002) claim that "market segmentation remains strongest in the retail area."[85]

A closer look at the credit market reveals important nuances in the overall low degree of integration in this financial market segment. In their comprehensive study, Baele et al. (2004) find differences in corporate lending "between short-term and medium- / long-term lending, with the former being more segmented (...), mortgage loan rates seem to be more uniform across countries than they were in the past, while the consumer credit segment remains relatively fragmented (...), [and] clear signs of persistent home biases."[86] These observations are reflected by the EU Commission (2002), which observes that the "market for consumer credit is still segmented. (...) [The] mortgage market is also still segmented. (...) There are some signs of a more unified market for corporate loans."[87] Kleimeier and Sander (2002) express the low degrees of financial integration in EU retail markets in an even more direct manner by asking "Do we then find evidence for a uniform European retail banking market? The brief answers are: No for mortgages, maybe no for consumer lending, and maybe yes for corporate lending."[88]

There seems to be no consensus on the outlook for the future degree of integration in retail banking. Kleimeier and Sander (2002) point out that their results "suggest that the introduction of the single currency already had and will most likely continue to have an important impact on the emergence of a single Eurozone retail banking market."[89] Padoa-Schioppa (2000) is less optimistic and argues that "in the case of retail activities (...), cross-border operations are largely lacking, but we should not expect the signs thereof to materialize very soon."[90]

[80] Galati and Tsatsaronis (2001), p. 16.
[81] See Giovannini Group (2001), Giovannini Group (2003), Serifsoy and Weiss (2003), and Tapking and Yang (2004). "In spite of the many consolidation efforts, there are still 20 or so national delivery-versus-payment systems in the European Union today. (...) This is not normal." (Trichet (2003), p. 1)
[82] EU Commission (2004c), p. 15. In a prior study, the Commission argued that "in the area of retail banking, (...) a large degree of fragmentation (...) remains." (EU Commission (2002), p. 17)
[83] Adam et al. (2002), p. 3.
[84] Schüler and Heinemann (2002), p. 56.
[85] Cabral, Dierick, and Vesala (2002), p. 47.
[86] Baele et al. (2004), p. 66.
[87] EU Commission (2002), p. 18.
[88] Kleimeier and Sander (2002), p. 19.
[89] Kleimeier and Sander (2002), p. 37.
[90] Padoa-Schioppa (2000), p. 1.

The European Banking Federation (2003) claims bluntly that "retail banking markets remain segmented and banks cannot market a single product on an EU-wide basis,"[91] whereas Schüler and Heinemann (2002) more calmly suggest that "considering the underlying obstacles to integration, (...) national retail financial markets will remain segmented to a certain degree."[92] "Responsible for this low degree of integration in retail markets are a number of natural barriers, such as language or culture, as well as politically induced market access barriers such as regulations or taxation."[93]

This overview of recent financial integration studies has shown that the concept of financial integration is discussed, and the degree of financial integration is measured from diverse angles in the literature. Figure 1 provides an indication of the degrees of integration in EU financial markets. The observation from Manna (2004), which was already quoted in the introduction, that "(...) 'integrated wholesale markets, fragmented retail markets' is how most mainstream analyses would probably summarize the state of the euro area banking business"[94] seems justified overall. Our research draws on and complements the plurality in approaches, indicators and results, beginning with our derivation of a definition of financial integration, which will come next.

| Financial market segment | Selected sub-segments | Degree of FMI |
|---|---|---|
| Wholesale markets: | | high + |
| Money market | Unsecured | |
| | Secured | |
| Derivatives | Interest rate swaps | |
| | Gov. bond futures | |
| Bond market | Gov. bonds | |
| | Corporate bonds | |
| Equity market | Equity | |
| Retail markets: | | |
| Credit market | Corporate loans | |
| | Mortgage loans | |
| | ST letter of credit | |
| | Consumer loans | - low |

Source: Own illustration. FMI = financial market integration, Gov. government, ST = short-term.

Figure 1: Indication of the degree of integration in EU financial markets

[91] European Banking Federation (2003), p. 10.
[92] Schüler and Heinemann (2002), p. 57.
[93] Eppendorfer et al. (2002), p. 1.
[94] Manna (2004), p. 7.

# 3 Methodology

## 3.1 Definition of financial integration: 'Maximum similarity'

Numerous definitions of financial integration are available in the rich literature. These definitions focus on different, yet related aspects of financial integration, as Table 3 reflects. This plurality is needed since a definition of financial integration must take into account the characteristics of the specific market segment for which progress in financial integration is being analyzed, and the methodology applied. For example, Emiris (2002) focuses on the equity market and declares that "financial integration is then defined as a process whereby stock markets become increasingly affected by the common, EU-wide risk factors, while the influence of country-specific risks is gradually reduced."[95]

| Focus | Research study | Definition of financial integration |
|---|---|---|
| Law of one price (theoretical perspective) | EU Commission (2004c) | "(...) perfectly integrated market is a market where the Law of One Price (...) holds and where supply and demand can react immediately to cross-border price differentials. (...) extent to which similar financial instruments (same risk / return profile) are traded at the same price." (p. 1) |
| | Adjaouté and Danthine (2003) | "Full financial integration implies that the law of one price applies to financial assets available across the euro-area. This means that the same discount factor is used to value uncertain but identical future cash flows (...)." (p. 8) |
| | Cabral, Dierick, and Vesala (2002) | "The concept of integration refers to a situation in which, out of previously segmented markets for a single product (or substitute products), one coherent market is created. Markets are considered integrated when the law-of-one-price holds, i.e. the prices for the products in question are the same irrespective of the geographical domicile of the seller or the buyer of the product." (p. 7) |
| Barriers to trade and investment (stakeholder perspective) | Hartmann et al. (2003), similarly ECB (2003a), p. 53 | "Financial integration is different from financial structure in that it refers to the ease with which financial instruments can be traded across regions, across national borders, or even globally. Formally, one can say that an economic area is financially integrated if there are no barriers that discriminate agents in their access to and investment of funds within that area, on the basis of their location." (p. 189) |
| | Schüler and Heinemann (2002) | "Perfect financial integration is given if national borders do not play any role for cross-border financial transactions." (p. 35) |
| Broad perspective | Baele et al. (2004) | "The market for a given set of financial instruments and/or services is fully integrated if all potential market participants with the same relevant characteristics (1) face a single set of rules when they decide to deal with those financial instruments and/or services; (2) have equal access to the above-mentioned set of financial instruments and/or services; (3) are treated equally when they are active in the market." (p. 6) |

Source: Own illustration, own compilation.

Table 3: Classification of selected financial integration definitions

[95] Emiris (2002), p. 218.

The classification of Table 3 demonstrates that a single definition of financial integration seems too rigid. There exist both broad and narrow definitions of financial integration, and research studies either analyze an individual financial market segment or investigate many segments, as we have discussed in the previous section. Since definitions of financial integration usually correspond to the research framework used, we also need to develop a definition of financial integration. Our definition is broad in scope, encompasses many segments and is based on those provided in Table 3. Yet, it innovates with respect to two dimensions: First, our definition of financial integration, displayed in Table 4, incorporates the concept of similarities, or distances. Second, it lifts the definition of financial integration to the aggregate level of individual EU member states.

| |
|---|
| - The concept of financial market integration refers to the creation of a single EU-wide financial market that results from an increase in similarities of previously segmented national markets. |
| - An increase in similarities, or a decrease in distances, is characteristic for a financial integration process. |
| - For a unification process between two or more financial markets to happen, it is important to remove differences between them. |
| - In fully integrated financial markets, distances will be minimized and maximum similarity will be achieved. |

Source: Own illustration.

Table 4: Definition of EU financial integration of Kiehlborn and Mietzner

It is important to distinguish our definition of financial integration from some of the common definitions of economic integration. According to economic trade theories, trade integration and / or free trade will lead, among other things, to a specialization of countries, and to an international division of labor. In other words, similarities between countries are expected to decrease if economic integration progresses. This might hold, as well, in the case of financial integration, which we regard as a special variant of economic integration. One example is given by those areas in which consumer preferences, or the ways in which goods are supplied, remain different among the member countries of a financially integrating zone, regardless of the overall progress in financial integration. We acknowledge that it is in some cases beneficial for market participants, and for countries, to become more dissimilar, i.e. more specialized, in times of rising degrees of financial integration.

There are a number of reasons why our definition of financial integration seems appropriate, and this is important to stress, in our research setting. The above

review of the rich micro-level literature on EU financial integration has demonstrated that an increase in the degree of financial integration has translated, although to differing degrees, into an increase in similarities, or into a decrease of distances, of national financial market segments - regardless of the employed methodologies, and regardless of the employed indicators. To repeat but a few examples from the above discussion, recent research has shown that the correlation of national equity market returns has increased, that the characteristics of capital market products have become considerably more similar, and that the standard deviations, or other measures of dispersion, of bond yields have greatly decreased.

The concept of 'minimum distances', or 'maximum similarity', innovates, yet it is implicitly in line with previous findings. There seems to have emerged a consensus that, as Schüler and Heinemann (2002) point out, an investigation of "the extreme cases of perfect integration and no integration are only of theoretical interest."[96] This view is also taken by the ECB (2003a), which speaks of an "optimal level of integration (...)."[97] Kleimeier and Sander (2002), who focus on retail credit markets, argue, as well, that "full equalization cannot be expected, the concept of market integration requires that interest rates should exhibit a certain long-run equilibrium relationship."[98]

Our adopted macro-level definition of financial integration acknowledges that financial integration is an ongoing process. It also reflects our research objectives, namely the identification of groups of financially more closely integrated countries, and the assessment of the status quo, progress and trends of EU financial integration. As we have outlined in our introductory comments, we hypothesize that the barriers to financial integration - regulatory, legal, geographical, tax-related, cultural and historic - will be visible in group building, if it exists. Strong 'mobility barriers' in fragmented EU financial markets should have created stable sets of financially more closely integrated countries. The well-documented reduction and removal of these barriers over time within the EU should have led to a reduction of the differences between a) these groups, and between b) individual countries. In turn, this increase in similarities, i.e. this financial integration process, should have translated into a change of the groups' composition, and into a change of the groups' number. With increasing degrees of financial integration, countries should leave their traditional group, join other groups, or form new groups. To reach our research objectives, we require indicators. This will be discussed next.

[96] Schüler and Heinemann (2002), p. 35.

[97] ECB (2003a), p. 54. An "optimal level of integration is achieved when further consolidation or concentration of markets would mean that the benefits of integration are outweighed by the loss of opportunities (...) or that markets are no longer contestable."

[98] Kleimeier and Sander (2002), p. 10.

### 3.2 Choice of sample indicators, period and countries

This paper quantifies distances and similarities between financial markets indirectly by combining sets of financial integration indicators. Our macro-level approach reflects that 'the' EU financial market is often separated into the above discussed segments wholesale / retail markets or, more narrowly, money, derivatives, bond, equity and credit markets to derive judgments about the evolution of financial integration. Our identification of groups of financially more closely integrated countries aims to incorporate as many variables of as many financial market segments as possible in order to put the research on a broad footing.

Following the recommendations of Adam et al. (2002), our choice of variables is based on the criteria "data availability, data reliability, and economic content."[99] Although cluster analysis, as we will further outline in the next section, is an appropriate methodology for identifying groups of financially more closely integrated countries, data availability and data reliability are major obstacles. First, in order to avoid distortions and noise in our results, a precondition for data to be included is that it is simultaneously available for all investigated countries and for all investigated time periods. Unfortunately, the availability of such data poses serious challenges. The EU Commission (2004c) points out that this problem is faced by many researchers who measure progress in EU financial integration quantitatively: "Price indicators are not always available because the underlying data series are lacking or incomplete."[100] Even if complete data series are available, the time period of their availability is often limited. In light of these severe data and time period constraints, our analysis needs to be restricted to the period 1995 to 2002 and cannot be conducted for a broad set of indicators.

The pool of indicators than can be used as an input for our research is narrowed by a second obstacle. Of the few data series available for our investigated time period, most are not sufficiently harmonized from a statistical point of view.[101] Yet, harmonization is especially needed for price-based indicators to serve as appropriate integration indicators. Relatively homogenous assets are available for the money and the government bond markets, whereas this is "not necessarily the case for credit market rates, as there may be very significant differences with respect to credit risk."[102] These limitations have only recently been addressed by public and private research institutions, which is unfortunately too late for our backward-looking analysis.[103]

We base our research on price-based indicators that best fulfill the above outlined requirements. As was discussed above, price-based indicators have various advantages in comparison with quantity-based indicators, and they are often employed in financial integration studies. One major benefit, compared to quantity-based indicators is that the impact of new integration measures become visible

[99] Adam et al. (2002), p. 4.
[100] EU Commission (2004c), p. 2.
[101] See Baele et al. (2004), p. 14, Kleimeier and Sander (2002), p. 17f.
[102] Baele et al. (2004), p. 14.
[103] For example, the ECB has started to publish harmonized interest rates for the euro area in 2003.

more quickly in price-based indicators.[104] In addition, price-based indicators are closely related to the law of one price, and, despite the above discussed limitations of this law, "checking the validity of the law of one price remains the natural basis for (...) measures of financial integration."[105] We agree with Baele et al. (2004) that the results for the pre-1999 period are influenced by exchange rate considerations,[106] yet do not regard this as a problem, since our analysis is concerned with assessing the degree and evolution of financial integration: Exchange rate convergence in the pre-1999 period and the subsequent elimination of exchange rate risk in 1999 is part of this process.

The choice of indicators follows the recommendations of the EU Commission (2003).[107] Our indicators represent the euro area money, credit and government bond markets. The results are partly derived from the ECB national interest rates series,[108] which were also employed by Baele et al. (2004), Schüler and Heinemann (2002), and Kleimeier and Sander (2002).[109] Since not all data series are available for all countries and for all periods, we restrict the analysis to three retail lending markets and to one retail deposit market: (1) Mortgage loans to households (N2 series), (2) consumer loans to households (N3 series), (3) short-term loans to enterprises (N4 series), and (4) time deposits (N8 series). In addition, we use monthly data, provided by Deutsche Bank (DB) Research, for (5) the 3-months money market rate (M3IR), and (6) the 10-year government bond rate (Y10IR). We follow the reasoning of Baele et al. (2004) and Schüler and Heinemann (2002) in our holistic research setting and use nominal interest rates.[110] We agree, in particular, that "(...) consumers and firms look at nominal rates when borrowing or investing money. Inflation in the foreign country, and thus, real interest rates do not matter to them."[111]

These price-based indicators are an obvious starting point for our analysis. We have run a separate analysis that incorporates various efficiency and quantity-based indicators in addition to our selected price-based indicators in order to a) put the research on a broader footing, and b) control for the robustness of our results. However, the available data series for the efficiency and quantity-based indicators are in most cases, as we have already pointed out above, either incomplete or their cross-border comparability appears questionable. We have applied data augmentation algorithms to fill in the missing data points to solve the former problem. Yet, this approach violates the above outlined data quality requirements, and puts noise to the analysis. The same holds true with respect to attempts to improve the cross-border comparability of the additional indicators, and to adjusting the rates for risk. Risk adjustment in the case of government

[104] For example, it takes a relatively long time period to change the composition of equity portfolios.
[105] Baele et al. (2004), p. 7.
[106] See Baele et al. (2004), p. 12.
[107] See EU Commission (2003), p. 22.
[108] See ECB (2004b), ECB (2002c). "These are the only available interest rate series that go back to the beginning of the nineties for the time being." (Baele et al. (2004), p. 58)
[109] See Baele et al. (2004), p. 57ff., Schüler and Heinemann (2002), p. 42ff., Kleimeier and Sander (2002), p. 39ff.
[110] See Baele et al. (2004), p. 13, Schüler and Heinemann (2002), p. 42.
[111] Schüler and Heinemann (2002), p. 42.

bond rates is obvious, as one could apply country credit ratings to eliminate country risk. However, in the case of credit rates, it is not straightforward.

For these reasons, we restrict the analysis to the outlined 'clean' price-based indicators: The data series of these indicators are complete, the indicators have been employed in previous studies, and they are to our knowledge the most reliable ones available. We use data from the ECB and DB Research, since we assume that this data has been carefully put together so as to make the underlying assets as comparable across countries as possible.[112] Thus, we have reason to believe that it is not distortions in data that drive our results. In the interpretation of our results, it still has to be taken into account that the reduced database from which we are able to derive judgments, and the fact that these interest rates are not risk-adjusted limits the representativeness of the clustering procedure.

The analysis focuses on euro area countries, yet excludes Greece, Ireland, Luxembourg and the Netherlands for data limitations. Our study comprises the eight euro area countries Austria, Belgium, Finland, France, Germany, Italy, Portugal and Spain, and is conducted for the period 1995 to 2002. Table 5 provides an overview of the sample indicators, period and countries.

| | | |
|---|---|---|
| Indicators: | A) Money market: | (1) 3-months money market rate (M3IR) |
| | B) Credit market: | (2) Mortgage loans to households (N2 series) |
| | | (3) Consumer loans to households (N3 series) |
| | | (4) Short-term loans to enterprises (N4 series) |
| | | (5) Time deposits (N8 series) |
| | C) Bond market: | (6) 10-year government bond rate (Y10IR) |
| Time period: | | 1995 to 2002 |
| Countries: | | Austria, Belgium, Finland, France, Germany, Italy, Portugal, Spain |

Source: Own illustration.

Table 5: Overview of sample indicators, period and countries

[112] See Baele et al. (2004), p. 14.

### 3.3 Indicators employed: Stylized facts

This section provides insights for the expected increases in similarities between the investigated countries, and complements the above review of the literature, by discussing the indicators employed from the following perspectives. In a first step, we analyze whether a convergence in absolute interest rate terms has occurred. To this end, we calculate the annual average of each indicator for each year and each country. In a second step, we analyze the extent to which the financial market sub-segments represented by each indicator are integrated. Integration can be measured by calculating the cross-sectional dispersions in interest rates across countries. We follow both the EU Commission (2004a) and Baele et al. (2004) and express the cross-sectional dispersions as a) the standard deviation, and b) the coefficient of variation.[113] Both measures yield the same conclusions overall, i.e. a convergence towards zero signals integration, a value of zero indicates full integration. However, the standard deviation is expressed in %-terms and might be influenced by the absolute mean value of the interest rates considered. This potential distortion is eliminated by calculating relative statistics such as the coefficient of variation. The latter is standardized, since it is obtained by dividing the standard deviation of rates by the corresponding series' mean value. In addition, we calculate the year-to-year percentage changes of the standard deviations and coefficients of variation.

Although they do not allow us to distinguish between countries, cross-sectional dispersions are particularly useful in our research context. First, an increase in financial integration, or an increase in similarities, should go hand in hand with a reduction in price differentials. In other words, an increase in similarities is equal to a reduction of the cross-sectional variance of the investigated time series, or its square root 'standard deviation'. Second, a key advantage of calculating cross-sectional dispersions is that "correlations and cross-sectional dispersions are inversely correlated."[114] The instantaneous cross-sectional dispersion tends to be low in those cases in which series are strongly correlated, which they should be in integrated financial markets. Third, correlations between annual data points for a short time period, such as in our case, have a rather dubious economic content, whereas the cross-sectional dispersion can be meaningfully calculated at any point in time.[115] Fourth, the calculation of the percentage by which the cross-sectional dispersion statistics have changed year-to-year provides an indication of the speed of financial integration.[116]

[113] See EU Commission (2004a), p. 5, Baele et al. (2004), p. 15, EU Commission (2003), p. 24f., Adam et al. (2002), p. 15, Adjaouté and Danthine (2003), p 196. Baele et al. (2004) calculate the cross-sectional dispersion as standard deviations, EU Commission (2004a) uses coefficients of variation, Adam et al. (2002) calculate the standard deviation of the log values.

[114] Baele et al. (2004), p. 15.

[115] See Baele et al. (2004), p. 15.

[116] Adam et al. (2002) propose to use ß-convergence to measure the speed of convergence. They apply it to the investigated interest rates in terms of deviations from the German benchmark. See Adam et al. (2002), p. 21ff. Baele et al. (2004) also use the German bank interest rates as a benchmark. See Baele et al. (2004), p. 38ff., p. 59. Our cluster analysis aims at identifying groups of financially more closely integrated countries. There is no reason in this research framework why Germany, or any other country, should be taken as a benchmark.

Figures 10 to 12, provided in the appendix, plot the development of the indicators in terms of aggregate levels and cross-sectional dispersions.[117] The cross-sectional standard deviation was for all rates on the order of several hundred basis points in 1995, implying a relatively strong degree of fragmentation. A convergence of rates has taken place in all investigated market segments from 1995 to 2002, yet to varying degrees. Convergence was strongest in the unsecured money market, represented by the M3IR indicator. In this segment, convergence was rapid in the pre-EMU period, and it was particularly pronounced for the southern euro area countries Italy, Portugal and Spain. This market segment became fully integrated with the introduction of the euro and EURIBOR[118] in 1999.

A similar pattern is observable for the government bond market, as the statistics and graphs for the Y10IR rate indicate. Again, most of the convergence has occurred in the run-up to the start of EMU, with the yields in Finland, Italy, Portugal and Spain showing an almost dramatic decrease. Yet, the developments of the absolute values of the two cross-sectional dispersion statistics, and in particular their year-to-year percentage changes, illustrate that a slight divergence in government bond yields is observable between 1999 and 2001. The remaining dispersion in the Y10IR rate has recently been relatively stable, which provides evidence that integration in the euro area government bond market is not perfect. Stable barriers to full integration remain and need to be overcome.[119]

Financial integration in each of the investigated credit market segments has taken place, as well, but the degree of integration is lower. All rates tended to converge, but the speed and intensity of convergence in the credit market segments are below those observed in the money and government bond markets. The analysis of the two cross-sectional dispersion statistics reveals that there exists no straightforward integration pattern in the mortgage, consumer, and corporate loan markets nor in the time deposit market. In the mortgage loan to households market, progress in financial integration was most pronounced, since rates have converged relatively strongly and both cross-sectional dispersion statistics have steadily decreased. Yet, the financial integration process in the mortgage loan market has slowed down in recent years, and rates have even weakly drifted apart in 2001 and 2002.

The evidence with respect to the time deposit market points to a comparably advanced, yet incomplete degree of financial integration in this market segment. The integration process was fastest in the pre-EMU period. Yet, in contrast to the mortgage market, the degree of financial integration has continued to increase in the post-EMU era, and the cross-sectional dispersion statistics are now almost

Baele et al. (2004) suggest to perform a regression of the cross-sectional dispersion on a time trend. See Baele et al. (2004), p. 15. We use annual data, i.e. the average of a twelve-months period, for a short time period, which is why a regression on a time trend is not warranted. Schüler and Heinemann (2002) use interest rate spreads. See Schüler and Heinemann (2002), p. 42ff.

[117] The underlying data tables, the graphs of the development of the indicators employed at the country level as well as the year-to-year percentage changes are available upon request.

[118] EURIBOR = Euro Interbank Offered Rate.

[119] See FN 67.

at the low level of the government bond market. The rates of Finland, France, Italy, Portugal and Spain have experienced the strongest convergence over the investigated time period.

Both the consumer and the enterprise loan markets show rather erratic patterns, and progress in financial integration is less evident. In both markets, convergence of rates is visible in absolute terms, but less than in the above discussed financial market segments. The standard deviations and coefficients of variation are high and integration has taken place only weakly in the time period 1995 to 1998. The financial integration process in these two market segments seems to have followed an, in our view, unexpected development after the introduction of the euro: In 2002, a) the two corresponding standard deviations have returned close to their 1997 levels, and b) the two corresponding coefficients of variation are even above their 1995 level. However, in these two market segments, remarkable patterns can be detected in the development of the German, Italian, Portuguese, and Spanish rates. Since 1998, the German rates have been higher than the rates of all other countries. The rates of the latter three countries have strongly converged with the rates of the rest of the investigated countries before the start of EMU. The Italian rates have even declined so much that they have been among the lowest since 1999.

In sum, the analysis of the interest rate series has applied various indicators of financial integration. Most of the investigated interest rates have tended to converge in absolute levels between 1995 and 2002, with most of the convergence happening in the run-up to the start of EMU. Yet, financial integration, as measured by the cross-sectional dispersion of rates is progressing at varying degrees and varying speeds across different financial market segments. In fact, there are even increases in the cross-sectional dispersion statistics observable for some rates in the years following the start of EMU, which suggests that financial integration is not one-way. In addition, no interest rate has lain consistently above or below another country's one. Overall, with the exception of the unsecured money market segment, full integration has not occurred for any of the financial market segments under investigation: The government bond market is highly integrated, the mortgage and time deposit markets have experienced some integration, but to a lesser extent, and the consumer and enterprise market segments still show signs of fragmentation.

These results confirm the above discussed findings of the literature and suggest, as well, that a combination of our indicators via cluster analysis can be expected to detect interesting patterns re the grouping of countries. An increase in financial integration should translate into an increase in similarities between countries, and, in more technical terms, should result in a reduction of our proposed distances measure. Before this combination will be performed, the next section will discuss the merits of a cluster-based approach for achieving our research objectives.

### 3.4 Concept and advantages of cluster analysis

There is a strong case for using cluster analysis to identify groups of financially more closely integrated countries. According to our definition, a financial integration process corresponds to an increase in similarities, or a decrease in distances. Cluster analysis performs a grouping of variables explicitly "on the basis of similarities or distances."[120] In addition, we aim at identifying homogenous groups of financially more closely integrated countries. Cluster analysis is designed to identify groups within an underlying population, maximizes homogeneity within groups and heterogeneity between those groups, and does not assume financial market segments to be independent from each other. Cluster analysis also allows for a flexible, simultaneous analysis of multiple market segments and multiple indicators. It does not depend on rigid assumptions, and "no assumptions are made concerning the number of groups or the group structure."[121] Normality assumptions and homoscedasticity are of minor relevance. Finally, cluster analysis copes with the limited data availability, since it only requires annual data.[122]

The algorithm underlying this paper is programmed in SAS and uses the Ward algorithm.[123] The Ward algorithm is particularly suited for our research setting since this algorithm aims at minimizing the loss of information, or the loss of homogeneity, that occurs by merging clusters.[124] Initially, the number of groups equals the number of countries in the sample with each individual country forming one group. In a next step, the Ward algorithm combines those two countries which are most similar to each other. At the end, after a series of successive mergers and a loss in homogeneity, all groups are fused and all countries belong to one single group. Although our data set only contains metric variables, i.e. all indicators are interest rates that are expressed in percentage terms, a standardization needs to be performed to treat all indicators equally in determining group composition.[125] All values are standardized with mean $\mu$=0 and standard deviation $\sigma$=1.

A year-to-year comparison of the y-values in the two-dimensional, tree-like dendrogram allows for a dynamic analysis of a financial integration process. The dendrogram displays the results of the clustering procedure for each year. In other words, it is a graphical illustration of the mergers that were made at successive levels of the clustering process. The x-axis displays the names of the entities observed, namely the investigated euro area countries, the y-axis serves as a distance measure: The y-axis displays the standardized similarity coeffi-

[120] Johnson and Wichern (1998), p. 726.
[121] Johnson and Wichern (1998), p. 726.
[122] In the absence of this feature, for example, we would have had to exclude France, for which N2 and N3 are only available quarterly.
[123] The programming code is available upon request. See Johnson and Wichern (1998) for the following.
[124] See Johnson and Wichern (1998), p. 739ff., for an overview of linkage methods, i.e. single linkage (minimum distance, nearest neighbor), complete linkage (maximum distance, farthest neighbor) and average linkage (average distance). See Johnson and Wichern (1998), p. 754ff., for an overview of non-hierarchical procedures. A drawback of the latter is that they require a prior specification of the number of clusters.
[125] Among other things, standardization is required to avoid a variable with a high variance dominating the clustering procedure. It must also be performed if the underlying variables are of different magnitude and are not directly comparable. In our study, for example, this is the case for the money market rate and the consumer loan rate, the latter always being higher.

cients, i.e. the semi-partial R-squared values, which result from the division of the between-cluster sums of squares by the total variance of variables.[126] Each branch in the dendrogram tree represents a cluster, and the branches merge at nodes. The position of the nodes on the y-axis indicates at which distance level the mergers occur. If mergers take place at lower y-axis coefficients in each subsequent year in the investigated time period 1995 to 2002, then countries will have become more similar, or financially more integrated, with respect to the investigated variables. The intensity and speed of this integration process can be measured by comparing the percentage changes in the reduction of the y-axis values.

The identification of the 'correct' number of country groups requires judgment. Cluster analysis does not prescribe any number of groups since no information about the true belonging of a country to group is available, nor is it required. One cannot distinguish 'true' from 'false' classifications, only 'useful' or 'good' ones from 'not so useful' or 'bad' ones.[127] A useful approach to determining an appropriate number of groups is to examine the changes in the fusion curve during the clustering process. The fusion curve displays on the x-axis the number of clusters, and on the y-axis the corresponding semi-partial R-squared values. The fusion curve steadily increases as clusters, i.e. countries in our study, are combined. The appropriate number of clusters, or country groups, to be considered is the one that the x-axis indicates just before a sudden upward jump occurs in this curve, reflecting a relatively high loss in homogeneity.

Variances, means, F- and t-values are employed to assess the characteristics of the identified country groups and to identify those discriminatory variables that drive group building. To this end, clusters are compared pair wise with each other on the level of individual variables with the help of means and variances. The F-values indicate whether the level of dispersion of a specific variable within one group is greater or smaller than in the underlying data sample.[128] Since we aim at identifying homogenous groups, our goal is to find groupings in which a maximum of variables have F-values $< 1$. Finally, a positive (negative) sign of the t-value indicates that a variable in one specific group is over- (under-) represented vis-à-vis the entire sample.[129] The absolute degree that a t-value deviates from 0 can be interpreted as the extent to which a variable is either over- or under-represented.

[126] At the start of the clustering process, the value of this coefficient is zero, and it increases with the merger of clusters. The between-cluster sums of squares are easier to interpret when they are divided by the total sum of squares, i.e. the total variance of variables, to give proportions of variance (squared semi-partial correlations).

[127] Cluster algorithms search for good, but not in any case the best groupings. See Johnson and Wichern (1998), p. 726f., Fahrmeier, Hamerle, and Tutz (1996), p. 438.

[128] F-value $= \frac{\sigma^2_{i,k}}{\sigma^2_i}$. The variance $\sigma^2_{i,k}$ of variable $i$ within group $k$ is divided by the variance $\sigma^2_i$ of variable $i$ within the whole dataset. If F$>$ 1 (F$<$ 1), then the group variance of variable $i$ is greater (smaller) than in the underlying entire data sample. See Backhaus et al. (2000), p. 378.

[129] $t = \frac{\overline{x}_{i,k} - \overline{x}_i}{\sigma_i}$. $\overline{x}_{i,k}$ is the mean of variable $i$ in the group $k$, $\overline{x}_i$ is the mean of variable $i$ in the sample, and $\sigma_i$ is the accompanying sample standard deviation. If the difference in the ratio is positive (negative), then the small (large) values of the variable within a specific group have to overcompensate the large (small) values. The division by the standard deviation is required for standardization, i.e. to make the t-values comparable. See Backhaus et al. (2000), p. 379.

Besides using cluster analysis to identify groups of financially more closely integrated countries, the inter-temporal nature of our approach, i.e. to measure the speed of financial integration, is, to our knowledge, an innovation. Of particular advantage is the fact that cluster analysis is able, vis-à-vis those methods that are time series-based, to separately analyze the degree of financial integration in each year. It follows that it does not matter in our research setting whether a time series is long or short, whereas it does in regression-based approaches. Another comforting feature is that time series do not need to be examined for structural breaks since each year is separately assessed. This is not a circumvention of a problem that lies at the heart of other methodologies:[130] Cluster analysis allows one to accurately investigate the effects of structural breaks. For example, the effects of the introduction of the euro, clearly promoting EU financial integration and a structural break, should become visible in cluster analysis via a smaller agglomeration coefficient on the y-axis of the dendrogram.

The cluster-based approach, as it is used in this paper, has drawbacks that have to be borne in mind in the interpretation of the clustering results. First, some commonly applied econometric concepts, such as the calculation of significance values via a test of equality of means, simply cannot be applied to small samples, such as our eight-country study. Second, cluster analysis is a tool that leaves room for interpretation, a drawback which we actually consider an advantage in our research setting, as we have argued above. Third, it is important to note that this method may be sensitive to the presence of outliers. Thus, the resulting configuration of groupings must always be carefully examined.

In sum, there is a strong case for using cluster analysis to identify groups of financially more closely integrated countries, and to derive indications of the speed of financial integration.[131] Countries that are assigned to the same group are more similar and, thus, financially more closely integrated with each other with respect to the underlying indicators than those countries that do not belong to this group.

[130] For example, Baele et al. (2004) employ the same indicators that we use in our study. Yet, they distinguish between 3 sub-periods, i.e. 1990-94, 1995-98, and 1999-onwards. See Baele et al. (2004), p. 58ff. Adam et al. (2002) measure convergence for these indicators for the two periods pre-EMU and post-EMU. See Adam et al. (2002), p. 22f. Kleimeier and Sander (2002) find "evidence in favor of a structural break around the time of the introduction of the single currency." (Kleimeier and Sander (2002), p. 16) Consequently, they divide their sample into a pre-EMU period 1995-98 and a EMU period 1999-onwards. See Kleimeier and Sander (2002), p. 9ff.

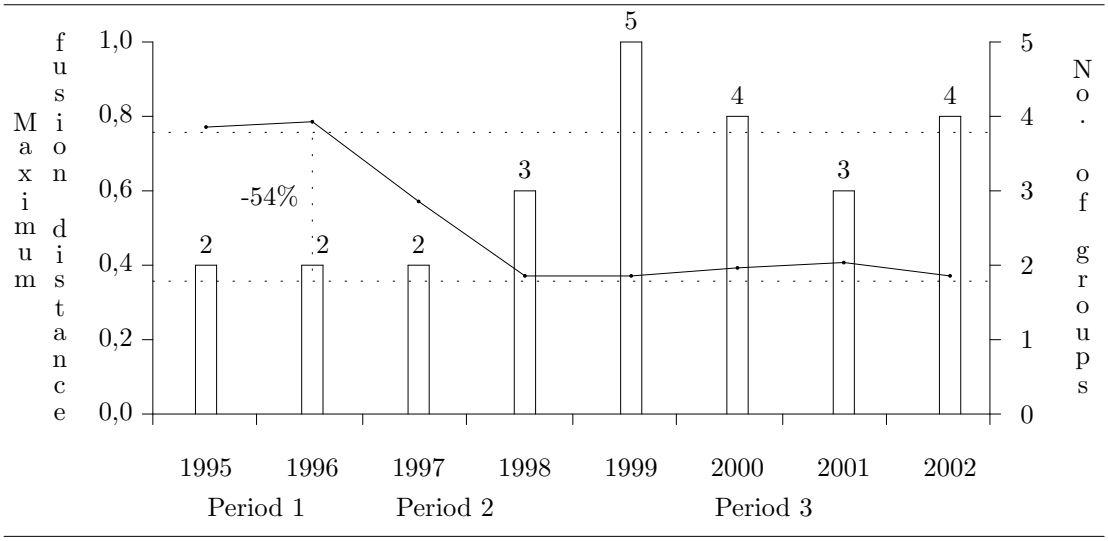
[131] Discriminant analysis and logit-/probit models may be used to investigate the discriminatory power of variables. Various restrictive assumptions do not hold in our research setting.

# 4 Evidence: Application of cluster analysis

## 4.1 General findings: Integration waves, similarity barriers

The groupings of the investigated countries are obtained from separately running the Ward algorithm in SAS for each year of the time period 1995-2002. We then calculated the fusion curves to determine the appropriate number of country groups.[132] As outlined in the previous section, we choose the number of groups just before a sudden upward jump in the respective fusion curve occurs, reflecting a relatively high loss in homogeneity.

An aggregate view of results reveals interesting patterns with respect to the speed and progress of euro area financial integration. Figure 2 displays on the left hand scale the maximum fusion distances, their development over time is shown by the solid line. The maximum fusion distance represents the distance measure by which all investigated countries form one single group. This measure is zero in a fully integrated market. A decline in this statistic towards zero indicates that an integration process is taking place. The year-to-year percentage change of this statistic provides an indication of the speed of financial integration.




Source: Own illustration.

Figure 2: Maximum fusion distances and number of groups in each year

The development of the maximum fusion distance curve over time suggests that financial integration does not take place smoothly in the euro area. Instead, it may happen in waves. The high values of the maximum fusion distances at which all countries form one single group in Period 1, i.e in 1995 and 1996, underscore that a relatively strong degree of fragmentation prevailed among the eight countries at the beginning of our examined time period. The observation that there was not much change in the maximum fusion distances suggests that financial integration was initially taking place rather weakly.

[132] Figures 13 and 14 in the appendix display the fusion curves.

Both the speed and the intensity, by which financial integration has progressed, increased remarkably in the period that predated the introduction of the euro in 1999 (Period 2). From 1996 to 1998, the maximum fusion distances decreased from 0.78 to 0.36, which equals a reduction of -54%. The integration of the short-term unsecured money market and the strong integration process in the long-term government bond market, i.e. in the two investigated wholesale market segments, account for most of this reduction. The observations for the period 1999-onwards (Period 3) suggest that financial integration has lost momentum considerably with the start of EMU, since the distance measure has remained at comparable levels since 1999. In fact, the results even point to an, admittedly weak, disintegration process in the period 1999 to 2001. It takes until 2002 before the distance measure falls back to, and even slightly below, the 1998 level.

These observations suggest that there may exist a level of financial integration that one could characterize as 'maximum similarity' between countries. This finding underscores the appropriateness of our financial integration definition. More importantly, it implies that extraordinary efforts or events may be required to push the degree of financial integration beyond 'maximum similarity barriers'. In particular, the asymptotic development of the maximum fusion curve both in the early and later years provides strong support for this notion. A barrier seems to have existed in Period 1, with maximum fusion distance values fluctuating around 0.78. In Period 2, the certainty that EMU will start in 1999 seems to have triggered an acceleration in the financial integration process, a sharp increase in the degree of financial integration, and a lowering of the 'maximum similarity barrier' towards values around 0.35. Despite all efforts to promote financial integration since 1999, the degree of financial integration has remained stable at this lower distance measure in Period 3. Integration is far from being completed, but, against the background of our findings, it remains to be seen whether the FSAP measures, once they have been fully implemented in the euro area member states, and once they have started to affect the day-to-day operations of market participants, are sufficient to infuse new life into the recently weakly progressing financial integration process.

The right hand scale in Figure 2 displays the number of groups that the calculated fusion curves have indicated as being the most appropriate ones for each investigated year. Initially, from 1995 to 1997, a pre-EMU zone of two financial integration levels can be identified. Two groups of financially more closely integrated countries coexisted in this period, and group composition was stable, as the next section will show in more detail. The acceleration in the financial integration process that took place in Period 2, and which we detected in the above analysis of the maximum fusion distances, translated into a break-up of this original divide. In fact, the introduction of the euro in 1999 seems to have shaken up the number of groups entirely: The clustering procedure has identified five groups of financially more closely integrated countries in 1999. In light of

the fact that we only consider eight countries in this study, an explanation of these findings could be that the year 1999 may have served as the beginning of a 'transition phase' towards the creation of new sets of financially more closely integrated countries. This view is supported by the observation that the number of country groups has increased from two in the period 1995-1997 to four between 1999-2002, on average. Thus, we agree with Adjaouté and Danthine (2003) that "the euro together with the accompanying structural changes (...) has not been the minor event that some had predicted."[133]

In sum, our results suggest that EU financial integration could take place in waves, that substantial 'maximum similarity barriers' may need to be overcome to boost EU financial integration in the future, and that there existed distinct groups of financially more closely integrated countries in the past. EMU seems to have played a strong role in changing the number and composition of groups over time. The next section will provide detailed evidence on how remarkable this change was.

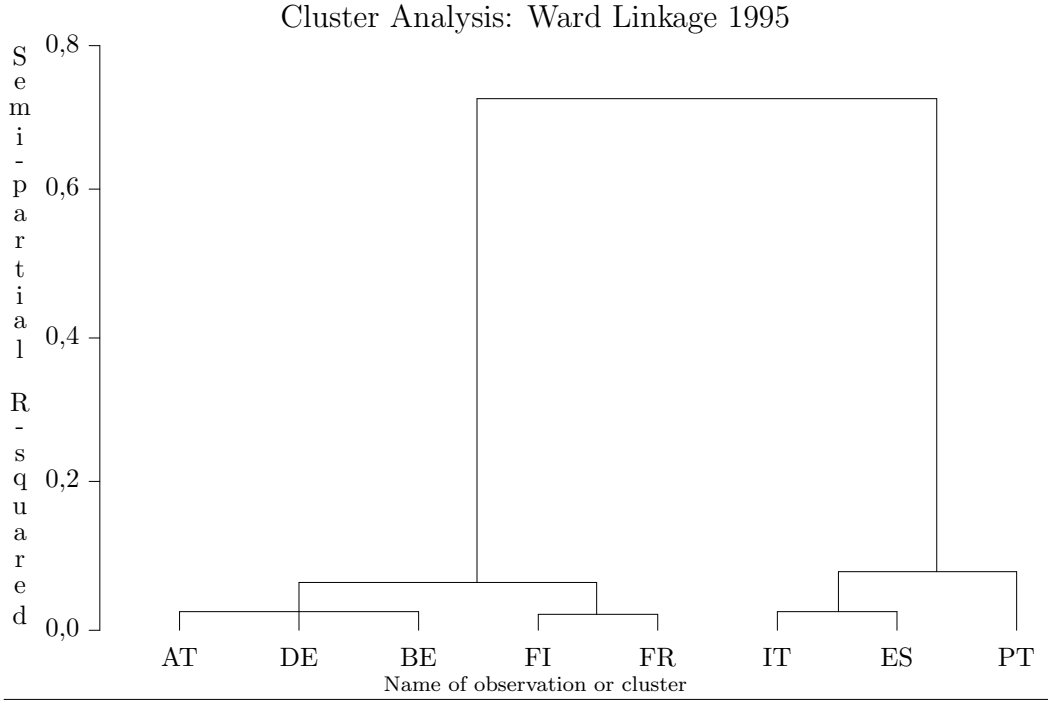
### 4.2 Detailed evidence: Existing, but greatly changing groups

This section discusses the results of the clustering procedure for each year. The dendrograms graphically illustrate the mergers of countries that were made at successive levels of the agglomeration process. The x-axis displays the names of the countries, the y-axis represents the fusion distance measure. The above discussed F-value, i.e. the ratio of inner-group variance over total sample variance, is for most variables and most groups below one.[134] This implies a high degree of homogeneity of countries belonging to one assigned group, signaling validity of our clustering results.

Figure 3 displays the results of the clustering procedure for the year 1995. According to the fusion curve, displayed in Figure 13 in the appendix, two groups of financially more closely integrated countries should be chosen. The first partition G1 contains Austria, Belgium, Finland, France and Germany. The second group G2 is made up of Italy, Portugal and Spain. G1 can be classified as a 'low interest rate zone', and G2 as a 'high interest rate zone'. The t-values of G1 are without exception below zero, which implies that the group mean of all interest rates is below the corresponding sample mean. In contrast, all t-values lie above zero in G2, implying that the group mean of all interest rates is higher than the corresponding sample mean. In addition, the absolute deviation of the t-values from zero is greater for G2 than for G1. This finding indicates that the G2 countries are further away from the sample mean than the countries that belong to G1. In sum, the cluster procedure is able to identify two groups of financially more closely integrated countries in 1995, with mean interest rates being substantially higher among G2 countries than among G1 countries.

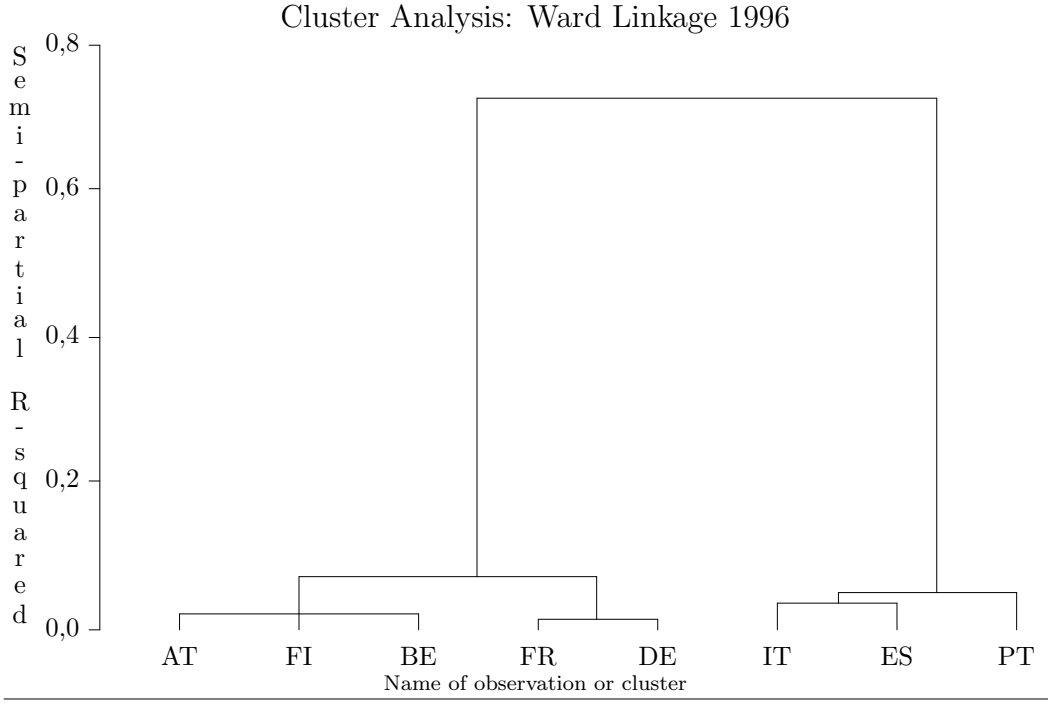
[133] Adjaouté and Danthine (2003), p. 230. See also, among other studies, Geis, Mehl, and Wredenborg (2004), ECB (2003c), ECB (2002d) on the international role of the euro.

[134] The descriptive statistics that characterize a group are provided in Tables 6 to 13 in the appendix.



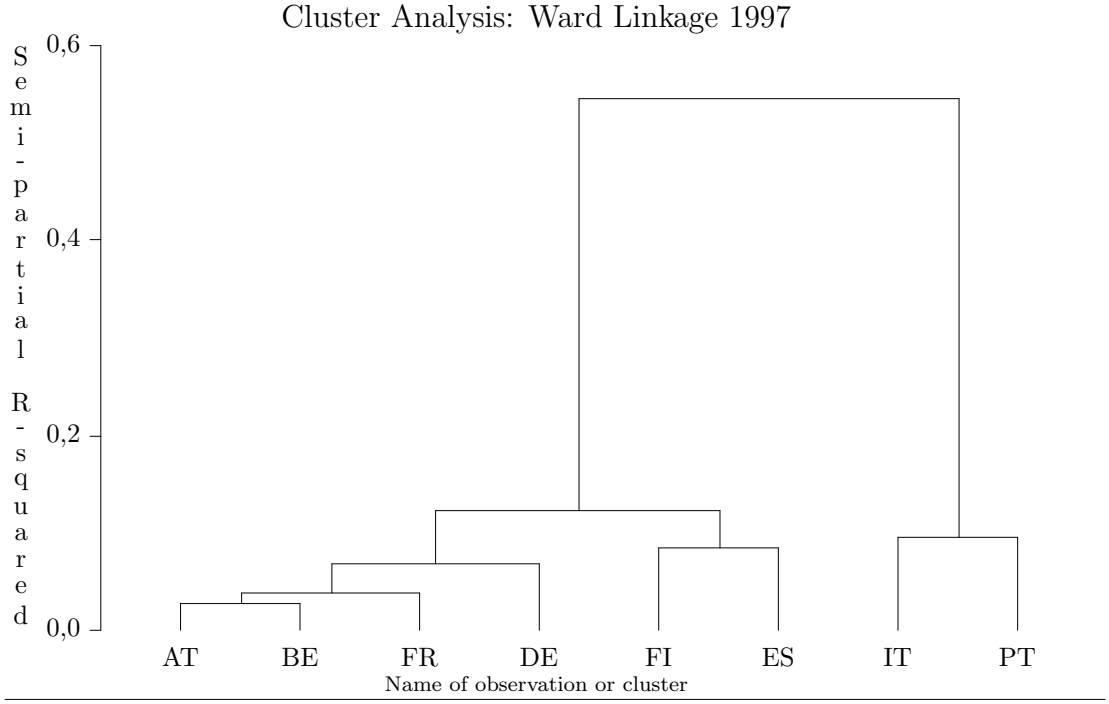

Source: Own illustration.

Figure 3: Evidence of group building: Dendrogram for 1995




Source: Own illustration.

Figure 4: Evidence of group building: Dendrogram for 1996



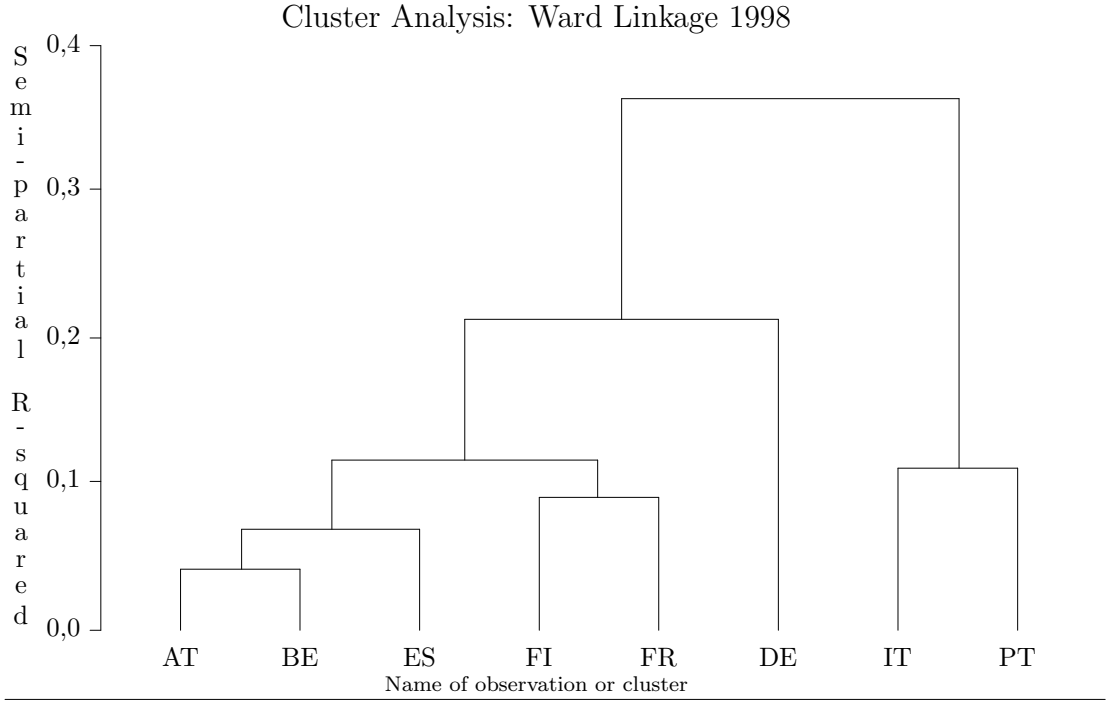

Source: Own illustration.

Figure 5: Evidence of group building: Dendrogram for 1997

Figure 4, in combination with the corresponding fusion curve, demonstrates that this dichotomy between the degree of integration of euro area countries was stable. Again, two groups of financially more closely integrated countries can be identified in 1996. The composition and characteristics of these two country groups are unchanged in comparison with the previous year. All t-values for G1 have remained below zero, all t-values for G2 are above zero, and the absolute deviation of all group mean values from zero is greater for G2 than for G1.

A combination of the findings for 1995 with those for 1996 suggests that geographical proximity might have played a role in the divide of the euro area into two groups of financially more closely integrated countries in this period. The southern European countries Italy, Portugal and Spain have formed a stable 'Club Med' group, as one could casually label G2. If one momentarily puts aside the recommendations of the fusion curve and takes the analysis one level deeper, a closer analysis of the composition of G1 indicates that country size may also have played a role. In 1996, the three smaller-sized countries Austria, Belgium and Finland have formed a sub-group, and the two largest EU economies France and Germany another one.

The preparations for EMU have certainly started before 1997, yet the impact of these preparations on the EU financial integration process only becomes slightly visible in group building in 1997. As Figure 5 illustrates, the composition of the Club Med group, which was stable until 1996, started to dissolve in this year. Again, a two group solution is suggested by the fusion curve. Yet, in 1997,



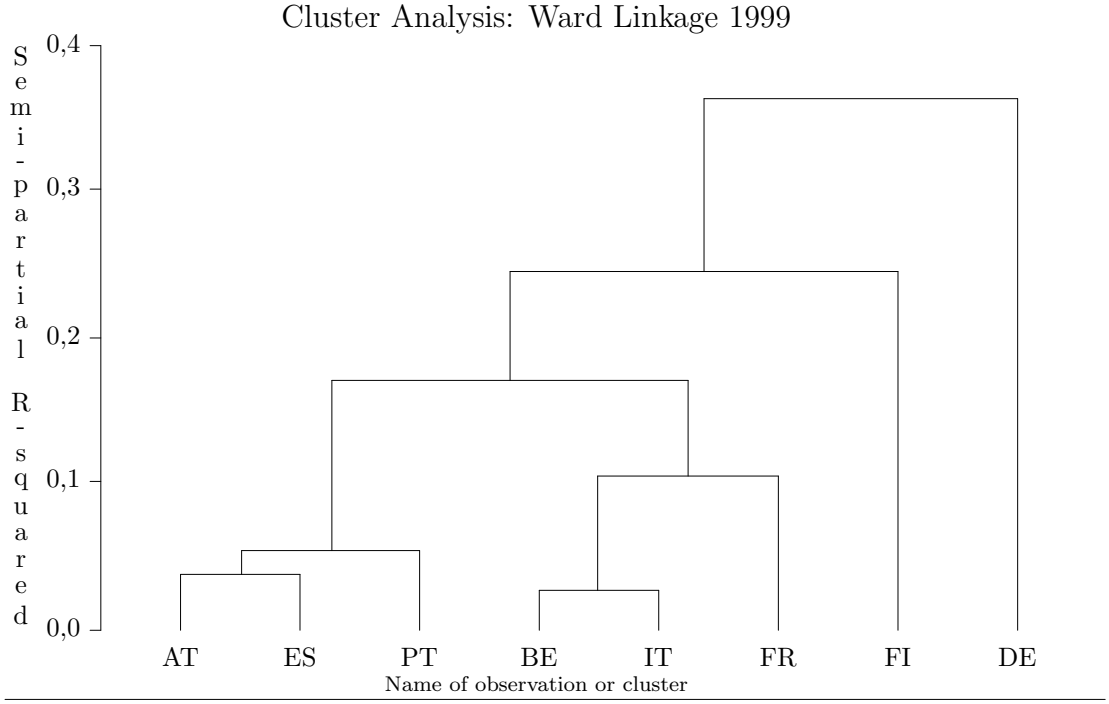

Source: Own illustration.

Figure 6: Evidence of group building: Dendrogram for 1998

Spain has switched into the low interest rate zone G1, whose composition has remained unchanged otherwise. Although all Spanish rates remained higher, the convergence of Spanish rates towards those of the other G1 countries was intense enough to initiate this group change.

These findings for 1995 to 1997 overall suggest that the G1 countries may have initially formed a 'core Europe' and the Club Med countries a 'non-core Europe', or, in less controversial words, a 'core Europe 1' and 'core Europe 2'. In addition, the previously detected slight role of geographic proximity and country size as determinants for group building has diminished as the start of EMU came closer: Taking the analysis further in the enlarged 1997 G1 group shows that Finland has moved closer to Spain, France has become more similar to Austria and Belgium, and Germany has been isolated from the other countries.

The beginning of the end of the divide of the euro area into two distinct groups of financially more closely integrated countries, which the observations for 1997 hinted at, starts in 1998. The fusion curve recommends a three group solution for 1998. Italy and Portugal still form a separate, high interest rate zone area G2, but the formerly stable G1 group has started to dissolve. Austria, Belgium, Finland, France and Spain now form a larger, second group of financially more closely integrated countries. Germany has become more isolated and forms a single group by itself. Germany has the lowest government bond and money market rates, and its credit market seems to be out of step with the rest of the investigated countries: On the one hand, the t-values for the German N2 and



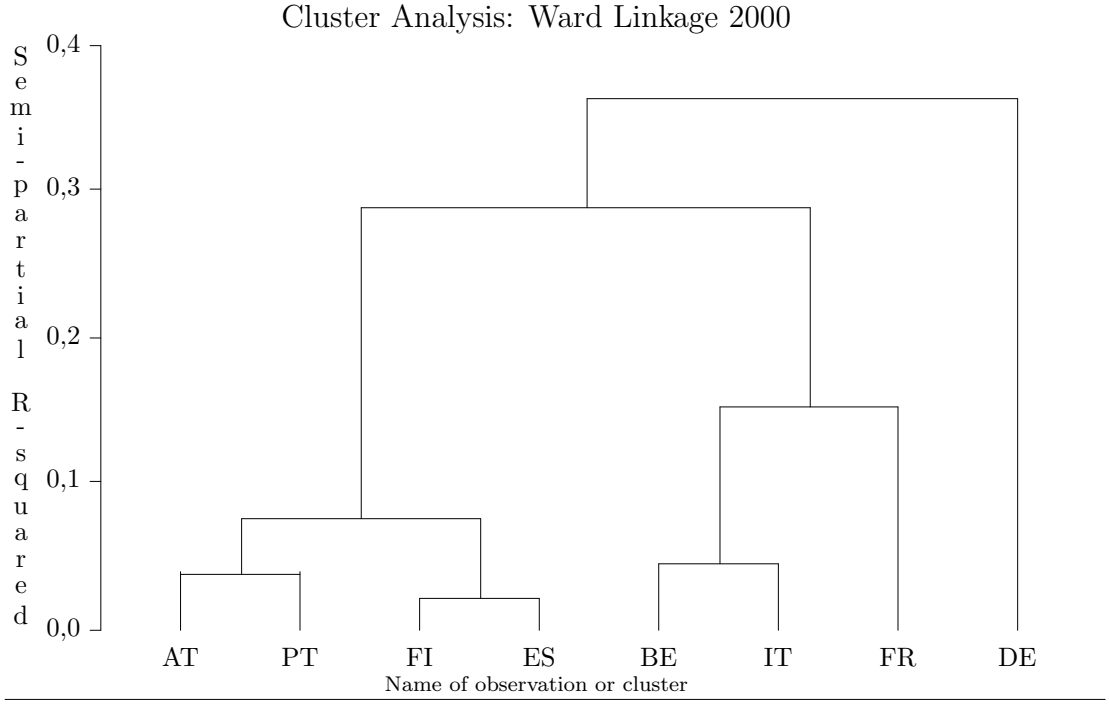

Source: Own illustration.

Figure 7: Evidence of group building: Dendrogram for 1999

N8 rates are negative, indicating a lower level of interest rates than the sample average. This is the case for the new, large group as well, yet, the greater absolute deviation from zero indicates that the German rates are lower than the average of the large second group. On the other hand, the German N3 and N4 rates are higher in comparison with the group formed by Italy and Portugal.

The above discussed view that the euro's introduction has brought an end to the original divide of the EU into two groups, and that 1999 may have been the beginning of a transition phase towards the establishment of new groups is confirmed by the results for the period 1999-onwards. In 1999, the composition of groups is shaken up. In this year, the fusion curve identifies five groups. The 'Club Med' grouping has disappeared: Figure 7 shows that a) Portugal is separated from Italy, b) Italy forms a group with Belgium, and c) Austria, Spain and Portugal have teamed up. Finland, France and Germany each form a separate group in 1999. In addition, the traditional classification of groups as 'high' and 'low' interest rate zones cannot be upheld: The t-values are positive for some interest rates, and negative for others in each of the five groups.

The results for 2000 underscore the transition nature of the immediate post-EMU era. The fusion curve points to a four-group solution. Belgium and Italy remain in the same group, and France and Germany again form isolated groups. Finland has left its isolation and joined Austria, Spain and Portugal. The analysis of the t-values reveals remarkable patterns. Since the money market became fully integrated with the adoption of EURIBOR, only the remaining indicators



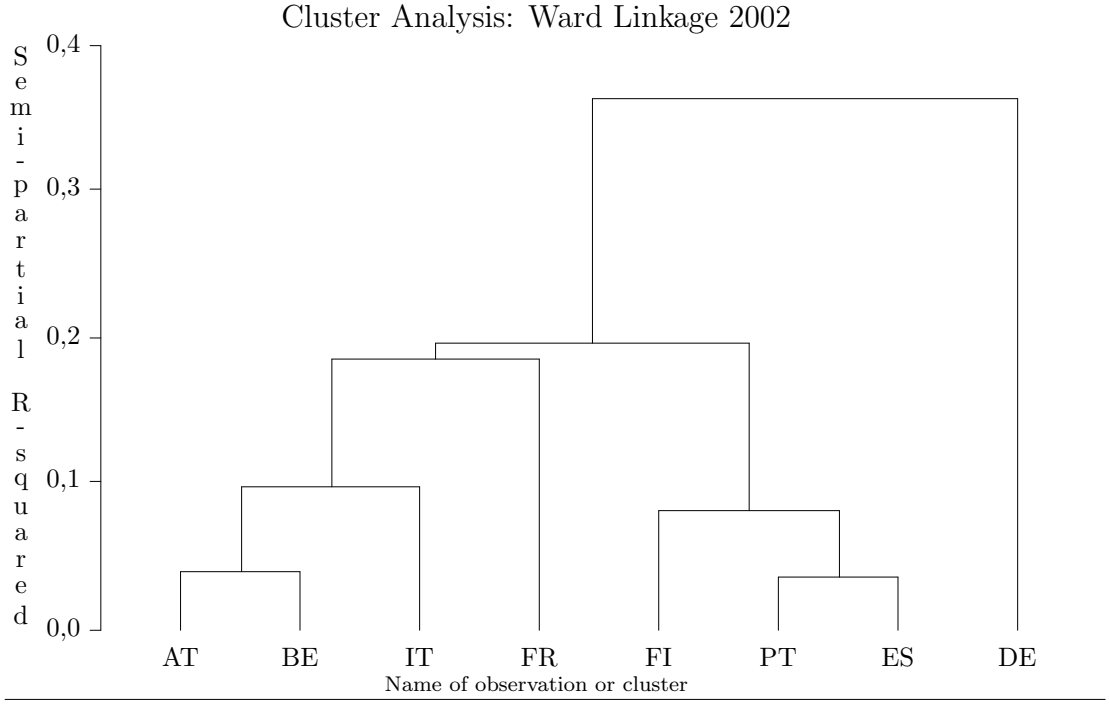

Source: Own illustration.

Figure 8: Evidence of group building: Dendrogram for 2000

contribute to group building. Although the original divide of Europe into a low and a high interest zone was dismantled, as we just demonstrated, the evidence points to the creation of a new set of countries that form not an 'always low', but a 'mostly lower' interest rate zone. Austria, Finland, Portugal and Spain might form this new group, since the t-values in this group are all negative, with the exception of the government bond market. The t-values indicate, as well, that France and Germany, which were members of a low interest rate zone at the beginning of our investigated time period, now form two separate zones of 'higher' interest rate levels, again with the exception of the government bond market.

The findings for 2001 and 2002 confirm this view. In 2001, the fusion curve recommends the choice of three groups, in 2002, it recommends the choice of four groups. In 2001, group composition almost fully reflects the one of 2000.[135] France is the exception, since it is no longer isolated in 2001, instead forming one group together with Belgium and Italy. Yet, if we deviate from the recommendations of the fusion curve and take the cluster procedure one step back, then the four group solution of the year 2000 results again: Both France and Germany are isolated, and the other two groups are identical in their composition compared to 2000. Finally, the four group solution is encountered in 2002 as well. These findings suggest that new, stable groups of financially more closely integrated countries may have been formed, marking the end of the transition phase that started with the euro's introduction in 1999.

[135]The dendrogram for 2001 is available upon request.




Source: Own illustration.

Figure 9: Evidence of group building: Dendrogram for 2002

Strikingly, Germany and France seem to be isolated from the rest of the euro zone, and from each other. This deserves special attention. First, our results suggest that the EU financial integration process was quicker and more intense for the smaller-sized as well as the southern European euro members. These findings confirm that "those EMU countries who have often been dubbed as 'non-core EMU' such as Ireland, Italy, Portugal and Spain may have been most effected by integration efforts (...) in the EMU period."[136] In this light, our results provide support to the heated debates on the inability of Germany and France to undertake substantial structural reforms. Second, an isolation of these two countries does not have to be negative. However, against the background of their alleged position as 'engines' of EU integration, it could be argued that their isolation from each other undermines their forerunner ability. Coming back to Prodi's remarks, which were quoted above, our findings implicitly call on France and Germany to step up their joint efforts to retain their 'engine' position and avoid becoming a 'wagon' in the union train.

Third, our results place doubt on the use of Germany as a benchmark in the post-EMU era. Germany is the largest EMU member in economic terms, and it has traditionally been a low-interest rate country overall. Convergence to a German 'standard' seems intuitively right. The isolation of Germany since 1998 underscores that Germany indeed plays a special role in EU financial integration. Yet, our observations put a question mark behind the rationale of treating Ger-

[136] Kleimeier and Sander (2002), p. 20f.

many as a benchmark case in the post-EMU period for all of the investigated financial market segments:[137] Germany's rates are in some segments the lowest, i.e. the government bond market, and in some credit markets among the highest. In the latter case, if one believes that convergence will always take place to the lowest available interest rate, other countries, or, as we have shown, even groups of countries, should in the post-EMU era serve as benchmarks.

# 5 Conclusion and outlook

This paper has shed light on the EU financial integration process from a holistic, macro-level perspective, and has introduced a powerful, yet intuitive methodological tool to the financial integration literature. The research has identified groups of financially more closely integrated countries by combining price-based indicators that meet strict quality requirements. We have applied cross-sectional dispersion statistics, and an inter-temporal cluster analysis to assess if and how financial integration has evolved in the euro area. The inter-temporal nature of the cluster analysis is, to our knowledge, an innovation.

Our research has provided evidence for the existence of distinct groups of financially more closely integrated countries. Initially, the euro area was divided into two stable zones of differing financial integration levels. The southern states Italy, Portugal and Spain had formed a high interest rate zone, and Austria, Belgium, Finland, France and Germany a low interest rate zone. Geographic proximity and country size may have played a role in group building before 1997.

This situation has changed remarkably. In the run-up period to the start of EMU, in which financial integration was progressing rapidly, the original divide started to dissolve. Countries began to leave their traditional group. Our findings have suggested that the euro's introduction has shaken up the number and composition of groups, and that geographic proximity and country size have become less relevant. Our results indicate that the start of EMU has initiated a transition phase towards the creation of new groups of financially more closely integrated countries. These findings convey an important political message: A dismantlement of the formerly stable groups was possible among the 'old' euro countries, which provides comfort to policymakers that the substantial differences between the current and potentially new euro members can be overcome as well.[138]

Our results have put a question mark behind the rationale of using Germany as a benchmark in the post-EMU period in all financial market segments, as prior research has done. Our evidence has suggested that other countries, or even groups of countries, serve in some market segments as better benchmarks. In addition, we have demonstrated that France and Germany form special cases in the euro zone overall. Initially, both were among the 'core' of a group of low

[137] Prior research pursuing this approach includes Adam et al. (2002) and Baele et al. (2004). See Adam et al. (2002), p. 21ff., and Baele et al. (2004), p. 38ff., p. 59. See also FN 116.

[138] See the ECB's biannual convergence reports, e.g. ECB (2004a).

interest rate countries. Yet, Germany has become isolated since 1998, and France since the beginning of EMU. This separation of France and Germany from each other calls on these two countries to step up their joint efforts to retain their position as 'engines' in the EU's integration train. In addition, our results have shown that the financial integration process was quicker and more intense for the smaller-sized as well as for the southern European euro states. This observation reflects the sometimes criticized inability of France and Germany to undertake substantial reforms.

Our research suggests that the EU financial integration process might take place in waves. We have identified three periods of varying integration speeds and intensities. The degree of EU financial integration remained stable in Period 1, comprising 1995-96, with financial integration progressing weakly. The speed and intensity of financial integration increased noticeably in the run-up to EMU in Period 2, i.e. 1996-98. In more recent years, after the euro's introduction, financial integration has lost in momentum considerably.[139] Our results suggest that the road to financial integration is not necessarily a one-way street: We were able to detect an, admittedly slight, disintegration process in the period 1999 to 2001, reflecting the transition nature of the immediate post-EMU years.

Based on the concept of 'maximum similarity', which we introduced in this paper as a key component of a definition of financial integration, our findings have indicated that there exist strong 'maximum similarity barriers'. It takes extraordinary events, such as EMU, to move the degree of financial integration beyond these barriers. The FSAP is a promising start to lowering these barriers, yet our results call upon policymakers to move courageously on with the post-FSAP agenda. The EU financial integration process needs new impetus and policymakers indeed cannot fall into "reform fatigue."[140]

This paper reflects from various angles that EU financial integration has progressed at varying speeds and intensities, and that changing groups of financially more closely integrated countries have existed in the past. In light of current and upcoming EU initiatives to promote financial integration, it seems safe to conclude that future changes in group composition will take place. Monitoring these changes is important. Various extensions of our study are possible. Once data availability and reliability problems have been solved, additional price-, as well as quantity- and news-based indicators could put the research on a broader footing. The research could be extended to the new EU members and the accession countries. It could be performed on a global level to derive insights into the progress of global financial integration. The results of such analyses could be linked to the financial systems literature. In all cases, the identification of groups of financially more closely integrated countries contributes to uncovering areas in which financial integration is hampered by obstacles.

[139] These findings put a different perspective to Adam et al. (2002), who conclude that "in general, convergence accelerates after the adoption of the Euro in 1999." (Adam et al. (2002), p. 22)
[140] Walter (2004), p. 3.

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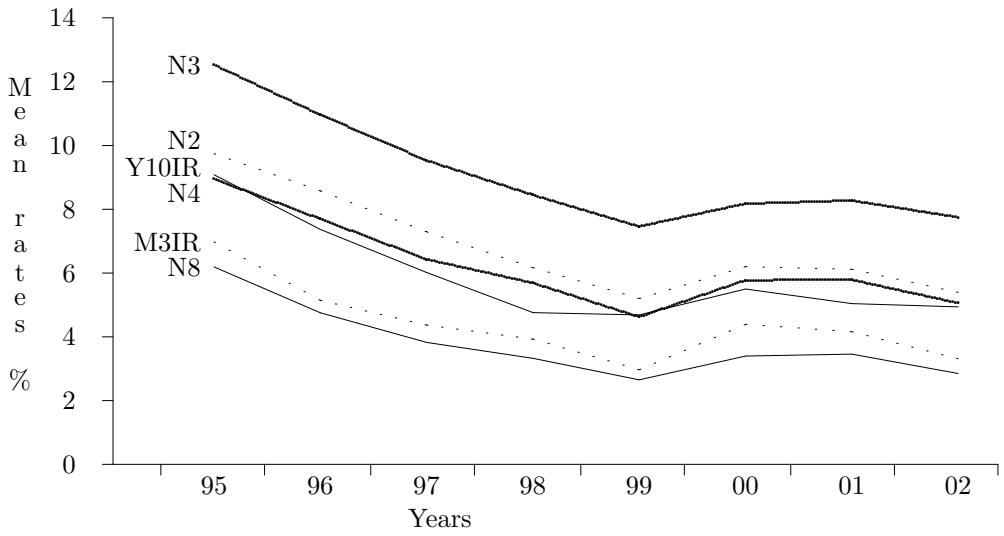
# Appendix

## A.1 Statistics of employed indicators

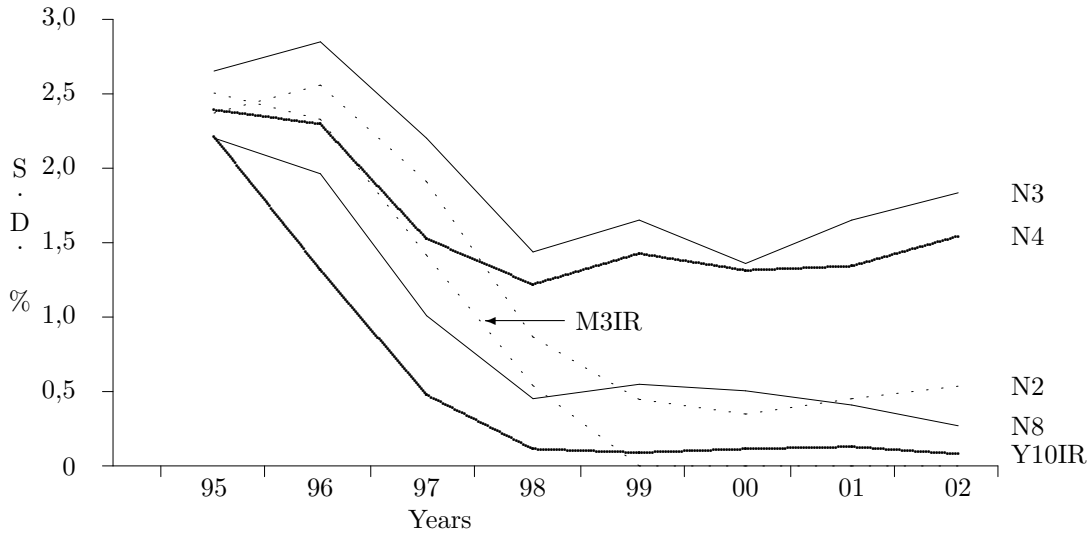
### A.1.1 Development of indicators employed at aggregate level




Source: Own illustration. Data source: DB Research, ECB, own calculations. Mean = Arithmetic average.

Figure 10: Development of interest rate levels: Mean rates across all countries

### A.1.2 Development of cross-sectional dispersion statistics



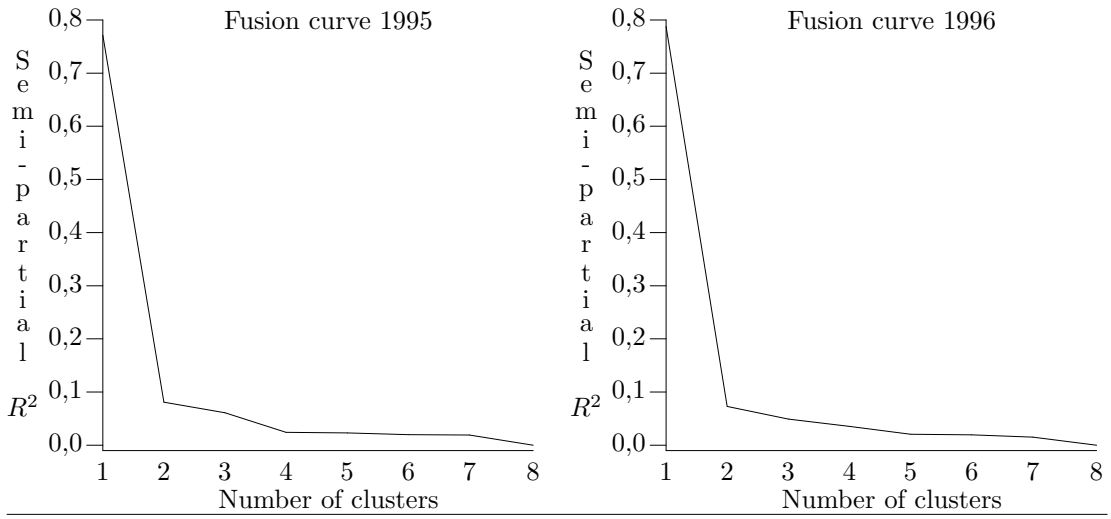

Source: Own illustration. Data source: DB Research, ECB, own calculations. S.D. = standard deviation, CoV = coefficient of variation.

Figure 11: Standard deviations of interest rates


Source: Own illustration. Data source: DB Research, ECB, own calculations. S.D. = standard deviation, CoV = coefficient of variation.

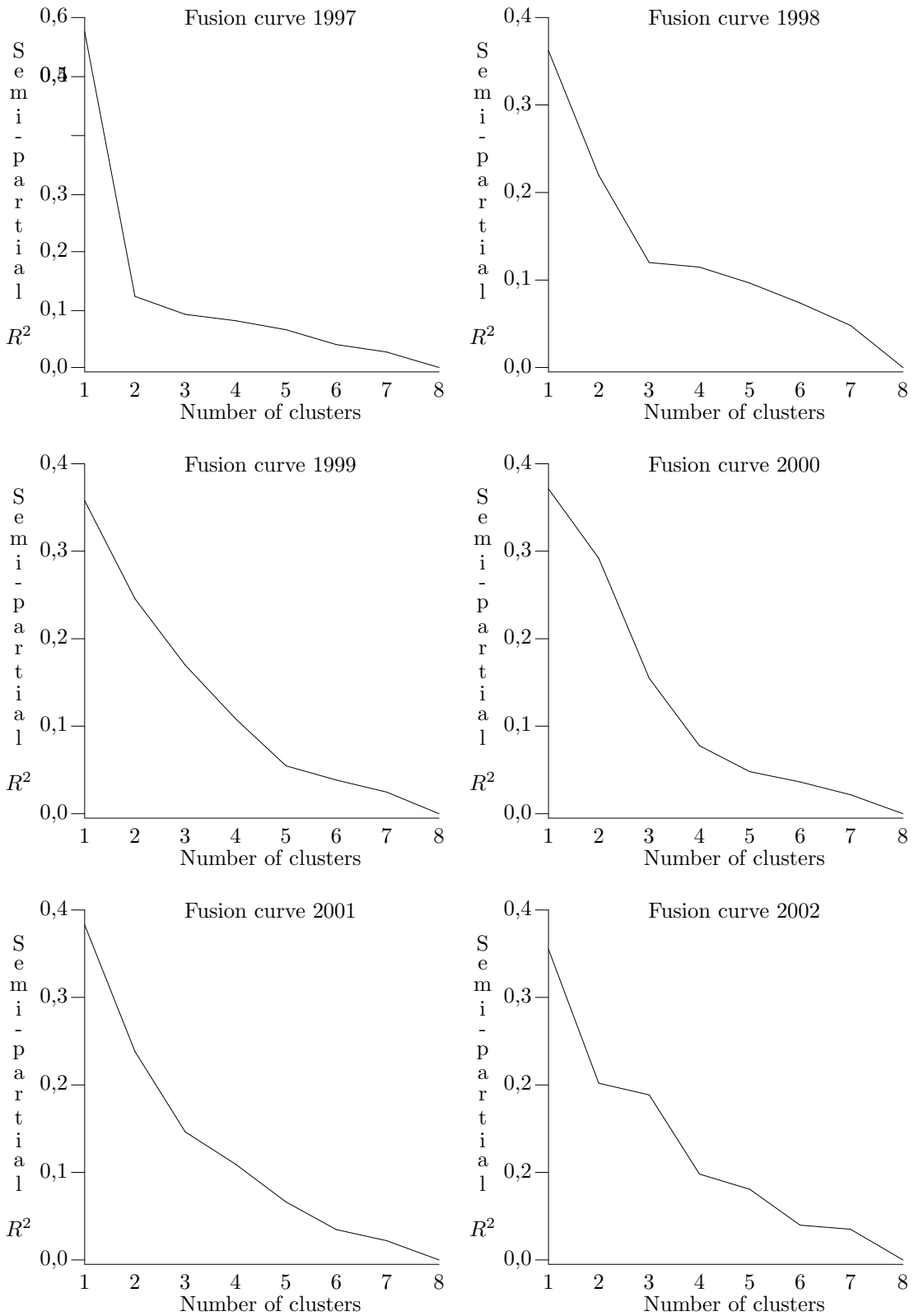
Figure 12: Coefficients of variation of interest rates

## A.2 Fusion curves 1995-2002




Source: Own illustration.

Figure 13: Fusion curves for 1995-1996




Source: Own illustration.

Figure 14: Fusion curves for 1997-2002

## A.3 Descriptive statistics of group building 1995-2002

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 5.622 | 7.042 | 5.726 | 4.858 | 6.274 | 4.907 |
| | Standard deviation | 2.371 | 2.654 | 2.393 | 2.204 | 2.505 | 2.215 |
| | Coefficient of variation | 0.243 | 0.212 | 0.267 | 0.356 | 0.359 | 0.244 |
| | Mean | 9.74 | 12.54 | 8.95 | 6.19 | 6.98 | 9.08 |
| G1 | Mean | 8.12 | 11.10 | 7.62 | 4.79 | 5.24 | 7.54 |
| | Variance | 0.578 | 2.140 | 1.513 | 1.869 | 0.803 | 0.561 |
| | Standard deviation | 0.760 | 1.463 | 1.230 | 1.367 | 0.896 | 0.749 |
| | t-value | -0.681 | -0.540 | -0.554 | -0.636 | -0.692 | -0.695 |
| | F-value | 0.103 | 0.304 | 0.264 | 0.385 | 0.128 | 0.114 |
| G2 | Mean | 12.43 | 14.93 | 11.16 | 8.53 | 9.87 | 11.65 |
| | Variance | 1.118 | 6.652 | 5.290 | 0.156 | 0.308 | 0.243 |
| | Standard deviation | 1.057 | 2.579 | 2.300 | 0.394 | 0.555 | 0.493 |
| | t-value | 1.136 | 0.901 | 0.924 | 1.060 | 1.154 | 1.159 |
| | F-value | 0.199 | 0.945 | 0.924 | 0.032 | 0.049 | 0.050 |

Source: Own illustration, own calculations.

Table 6: Descriptive statistics for group building in 1995

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 6.544 | 8.121 | 5.283 | 3.850 | 5.426 | 1.744 |
| | Standard deviation | 2.558 | 2.850 | 2.298 | 1.962 | 2.329 | 1.321 |
| | Coefficient of variation | 0.298 | 0.260 | 0.298 | 0.413 | 0.453 | 0.179 |
| | Mean | 8.58 | 10.96 | 7.70 | 4.75 | 5.14 | 7.37 |
| G1 | Mean | 6.92 | 9.33 | 6.45 | 3.43 | 3.49 | 6.45 |
| | Variance | 1.007 | 3.493 | 2.608 | 0.688 | 0.085 | 0.128 |
| | Standard deviation | 1.004 | 1.869 | 1.615 | 0.829 | 0.291 | 0.358 |
| | t-value | -0.647 | -0.574 | -0.543 | -0.670 | -0.709 | -0.697 |
| | F-value | 0.154 | 0.430 | 0.494 | 0.179 | 0.016 | 0.074 |
| G2 | Mean | 11.33 | 13.69 | 9.78 | 6.94 | 7.89 | 8.90 |
| | Variance | 2.644 | 3.586 | 2.894 | 0.570 | 0.647 | 0.192 |
| | Standard deviation | 1.626 | 1.894 | 1.701 | 0.755 | 0.804 | 0.438 |
| | t-value | 1.078 | 0.957 | 0.905 | 1.117 | 1.181 | 1.162 |
| | F-value | 0.404 | 0.442 | 0.548 | 0.148 | 0.119 | 0.110 |

Source: Own illustration, own calculations.

Table 7: Descriptive statistics for group building in 1996

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 3.644 | 4.848 | 2.330 | 1.019 | 2.001 | 0.229 |
| | Standard deviation | 1.909 | 2.202 | 1.527 | 1.009 | 1.415 | 0.478 |
| | Coefficient of variation | 0.262 | 0.231 | 0.237 | 0.264 | 0.324 | 0.080 |
| | Mean | 7.29 | 9.53 | 6.44 | 3.82 | 4.37 | 6.02 |
| G1 | Mean | 6.35 | 8.83 | 5.92 | 3.41 | 3.72 | 5.81 |
| | Variance | 0.738 | 2.955 | 1.451 | 0.590 | 0.664 | 0.103 |
| | Standard deviation | 0.859 | 1.719 | 1.204 | 0.768 | 0.815 | 0.322 |
| | t-value | -0.493 | -0.320 | -0.335 | -0.406 | -0.457 | -0.420 |
| | F-value | 0.203 | 0.610 | 0.622 | 0.580 | 0.332 | 0.452 |
| G2 | Mean | 10.12 | 11.65 | 7.97 | 5.05 | 6.31 | 6.62 |
| | Variance | 0.555 | 7.233 | 2.791 | 0.154 | 0.643 | 0.118 |
| | Standard deviation | 0.745 | 2.689 | 1.671 | 0.392 | 0.802 | 0.343 |
| | t-value | 1.479 | 0.961 | 1.004 | 1.217 | 1.372 | 1.259 |
| | F-value | 0.152 | 1.492 | 1.197 | 0.151 | 0.321 | 0.514 |

Source: Own illustration, own calculations.

Table 8: Descriptive statistics for group building in 1997

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 0.749 | 2.064 | 1.489 | 0.203 | 0.290 | 0.013 |
| | Standard deviation | 0.866 | 1.437 | 1.220 | 0.451 | 0.539 | 0.114 |
| | Coefficient of variation | 0.140 | 0.170 | 0.214 | 0.136 | 0.137 | 0.024 |
| | Mean | 6.16 | 8.45 | 5.70 | 3.33 | 3.92 | 4.75 |
| G1 | Mean | 5.89 | 7.80 | 5.11 | 3.25 | 3.71 | 4.74 |
| | Variance | 0.32 | 1.13 | 0.54 | 0.25 | 0.09 | 0.01 |
| | Standard deviation | 0.57 | 1.06 | 0.74 | 0.50 | 0.30 | 0.08 |
| | t-value | -0.32 | -0.45 | -0.48 | -0.17 | -0.40 | -0.16 |
| | F-value | 0.43 | 0.55 | 0.36 | 1.22 | 0.31 | 0.48 |
| G2 | Mean | 5.41 | 10.66 | 7.64 | 2.98 | 3.54 | 4.58 |
| | Variance | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Standard deviation | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | t-value | -0.87 | 1.54 | 1.60 | -0.76 | -0.70 | -1.50 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G3 | Mean | 7.23 | 8.97 | 6.18 | 3.69 | 4.65 | 4.89 |
| | Variance | 0.735 | 2.380 | 2.299 | 0.025 | 0.234 | 0.000 |
| | Standard deviation | 0.857 | 1.543 | 1.516 | 0.159 | 0.484 | 0.006 |
| | t-value | 1.233 | 0.363 | 0.396 | 0.802 | 1.352 | 1.160 |
| | F-value | 0.981 | 1.153 | 1.544 | 0.124 | 0.805 | 0.003 |

Source: Own illustration, own calculations.

Table 9: Descriptive statistics for group building in 1998

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 0.200 | 2.728 | 2.036 | 0.301 | 0.000 | 0.008 |
| | Standard deviation | 0.447 | 1.652 | 1.427 | 0.549 | 0.000 | 0.089 |
| | Coefficient of variation | 0.086 | 0.222 | 0.308 | 0.207 | 0.000 | 0.019 |
| | Mean | 5.20 | 7.45 | 4.63 | 2.65 | 2.97 | 4.68 |
| G1 | Mean | 4.99 | 7.75 | 4.93 | 2.26 | 2.97 | 4.73 |
| | Variance | 0.036 | 1.915 | 0.718 | 0.033 | 0.000 | 0.002 |
| | Standard deviation | 0.189 | 1.384 | 0.848 | 0.181 | 0.000 | 0.048 |
| | t-value | -0.475 | 0.176 | 0.216 | -0.701 | n.a | 0.502 |
| | F-value | 0.178 | 0.702 | 0.353 | 0.109 | n.a. | 0.294 |
| G2 | Mean | 5.46 | 6.10 | 3.40 | 2.52 | 2.97 | 4.72 |
| | Variance | 0.077 | 0.541 | 0.423 | 0.019 | 0.000 | 0.0001 |
| | Standard deviation | 0.278 | 0.735 | 0.651 | 0.137 | 0.000 | 0.011 |
| | t-value | 0.582 | -0.818 | -0.857 | -0.232 | n.a. | 0.425 |
| | F-value | 0.387 | 0.198 | 0.208 | 0.063 | n.a. | 0.014 |
| G3 | Mean | 5.98 | 8.27 | 4.25 | 2.97 | 2.97 | 4.61 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | 1.745 | 0.494 | -0.261 | 0.578 | n.a. | -0.845 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G4 | Mean | 4.59 | 5.76 | 3.68 | 3.85 | 2.97 | 4.73 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | -1.357 | -1.023 | -0.664 | 2.183 | n.a. | 0.554 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G5 | Mean | 5.14 | 10.16 | 7.47 | 2.54 | 2.97 | 4.50 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | -0.127 | 1.636 | 1.992 | -0.193 | n.a. | -2.064 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |

Source: Own illustration, own calculations.

Table 10: Descriptive statistics for group building in 1999

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 0.121 | 1.854 | 1.730 | 0.256 | 0.000 | 0.013 |
| | Standard deviation | 0.347 | 1.362 | 1.315 | 0.506 | 0.000 | 0.113 |
| | Coefficient of variation | 0.056 | 0.167 | 0.228 | 0.149 | 0.000 | 0.021 |
| | Mean | 6.20 | 8.18 | 5.77 | 3.40 | 4.39 | 5.50 |
| G1 | Mean | 5.92 | 8.08 | 5.72 | 3.04 | 4.39 | 5.54 |
| | Variance | 0.025 | 1.248 | 0.438 | 0.069 | 0.000 | 0.002 |
| | Standard deviation | 0.159 | 1.117 | 0.661 | 0.263 | 0.000 | 0.048 |
| | t-value | -0.804 | -0.071 | -0.037 | -0.715 | n.a. | 0.399 |
| | F-value | 0.209 | 0.673 | 0.253 | 0.271 | n.a. | 0.177 |
| G2 | Mean | 6.42 | 7.01 | 4.65 | 3.53 | 4.39 | 5.57 |
| | Variance | 0.051 | 1.133 | 1.076 | 0.006 | 0.000 | 0.000 |
| | Standard deviation | 0.226 | 1.064 | 1.037 | 0.076 | 0.000 | 0.004 |
| | t-value | 0.609 | -0.853 | -0.853 | 0.256 | n.a. | 0.670 |
| | F-value | 0.422 | 0.611 | 0.622 | 0.023 | n.a. | 0.001 |
| G3 | Mean | 6.36 | 10.45 | 8.45 | 3.60 | 4.39 | 5.27 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | 0.442 | 1.670 | 2.032 | 0.386 | n.a. | -2.027 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G4 | Mean | 6.75 | 8.62 | 5.54 | 4.39 | 4.39 | 5.39 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | 1.558 | 0.323 | -0.177 | 1.960 | n.a. | -0.908 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |

Source: Own illustration, own calculations.

Table 11: Descriptive statistics for group building in 2000

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 0.205 | 2.729 | 1.803 | 0.167 | 0.000 | 0.016 |
| | Standard deviation | 0.452 | 1.652 | 1.343 | 0.408 | 0.000 | 0.128 |
| | Coefficient of variation | 0.074 | 0.200 | 0.232 | 0.118 | 0.000 | 0.025 |
| | Mean | 6.12 | 8.28 | 5.79 | 3.46 | 4.16 | 5.04 |
| G1 | Mean | 6.61 | 7.51 | 4.95 | 3.73 | 4.16 | 5.06 |
| | Variance | 0.0142 | 1.2673 | 0.3096 | 0.2175 | 0.0000 | 0.0154 |
| | Standard deviation | 0.1190 | 1.1257 | 0.5564 | 0.4663 | 0.0000 | 0.1240 |
| | t-value | 1.0953 | -0.4655 | -0.6210 | 0.6513 | n.a. | 0.1929 |
| | F-value | 0.0692 | 0.4644 | 0.1717 | 1.3057 | n.a. | 0.9344 |
| G2 | Mean | 5.68 | 10.75 | 8.77 | 3.64 | 4.16 | 4.80 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | -0.961 | 1.499 | 2.217 | 0.438 | n.a. | -1.857 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G3 | Mean | 5.86 | 8.24 | 5.67 | 3.22 | 4.16 | 5.08 |
| | Variance | 0.067 | 2.886 | 0.333 | 0.083 | 0.000 | 0.006 |
| | Standard deviation | 0.259 | 1.699 | 0.577 | 0.288 | 0.000 | 0.080 |
| | t-value | -0.581 | -0.026 | -0.088 | -0.598 | n.a. | 0.320 |
| | F-value | 0.329 | 1.057 | 0.185 | 0.498 | n.a. | 0.387 |

Source: Own illustration, own calculations.

Table 12: Descriptive statistics for group building in 2001

| Group | Country / Statistics | N2 | N3 | N4 | N8 | M3IR | Y10IR |
|---|---|---|---|---|---|---|---|
| All | Variance | 0.288 | 3.371 | 2.379 | 0.073 | 0.000 | 0.006 |
| | Standard deviation | 0.536 | 1.836 | 1.542 | 0.271 | 0.000 | 0.080 |
| | Coefficient of variation | 0.100 | 0.237 | 0.305 | 0.095 | 0.000 | 0.016 |
| | Mean | 5.39 | 7.75 | 5.06 | 2.85 | 3.31 | 4.94 |
| G1 | Mean | 4.80 | 7.84 | 4.62 | 2.92 | 3.31 | 4.99 |
| | Variance | 0.059 | 4.642 | 0.140 | 0.022 | 0.000 | 0.001 |
| | Standard deviation | 0.242 | 2.155 | 0.374 | 0.150 | 0.000 | 0.023 |
| | t-value | -1.096 | 0.049 | -0.284 | 0.259 | n.a. | 0.579 |
| | F-value | 0.204 | 1.377 | 0.059 | 0.306 | n.a. | 0.082 |
| G2 | Mean | 5.72 | 6.54 | 4.48 | 2.66 | 3.31 | 4.97 |
| | Variance | 0.057 | 0.486 | 1.360 | 0.055 | 0.000 | 0.005 |
| | Standard deviation | 0.239 | 0.697 | 1.166 | 0.234 | 0.000 | 0.070 |
| | t-value | 0.614 | -0.658 | -0.375 | -0.699 | n.a. | 0.329 |
| | F-value | 0.198 | 0.144 | 0.572 | 0.747 | n.a. | 0.755 |
| G3 | Mean | 6.02 | 8.14 | 4.65 | 3.32 | 3.31 | 4.86 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | 1.180 | 0.213 | -0.261 | 1.745 | n.a. | -0.988 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |
| G4 | Mean | 5.53 | 10.71 | 8.51 | 2.73 | 3.31 | 4.80 |
| | Variance | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Standard deviation | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | t-value | 0.265 | 1.614 | 2.238 | -0.423 | n.a. | -1.738 |
| | F-value | 0.000 | 0.000 | 0.000 | 0.000 | n.a. | 0.000 |

Source: Own illustration, own calculations.

Table 13: Descriptive statistics for group building in 2002

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