HOW DOMESTIC IS THE FAMA AND FRENCH THREE-FACTOR MODEL?

AN APPLICATION TO THE EURO AREA

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ABSTRACT AND KEYWORDS	
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How Domestic is the Fama and French Three-Factor Model? An Application to the Euro Area

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Abstract:

The euro area has faced a high number of monetary and policy changes in the recent past as a consequence of the European integration process and, naturally, these developments have important implications for portfolio diversification and asset pricing. Therefore, this paper concentrates on the performance of a specific asset pricing model: the Fama and French three-factor model. Griffin (2002) shows that the Fama and French factors are country specific for the U.S., the U.K, Canada, and Japan. We apply the same methodology to the euro area countries and find that even in this very integrated area the domestic three-factor model outperforms the euro area three-factor model. However, the relative performance of the euro area wide model is increasing, especially for countries with a high number of listed stocks. This could be interpreted as evidence of a higher level of equity market integration caused by lower investment barriers and a changing point of view of institutional investors. Furthermore, we extend the methodology and also test an industry-specific three-factor model. Our findings suggest that lower pricing can be acquired using an industry-specific model relative to the euro area three-factor model.

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Keywords: Asset pricing, Fama-French factors, industry factor model, European integration, euro area stock markets

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1. INTRODUCTION

Since the introduction of the CAPM by Sharpe (1964) and its extension by Lintner (1965) asset pricing models have been an intensive topic of research. In a fully integrated market where purchasing power parity (PPP) holds, the global CAPM should price all assets (see Grauer, Litzenberger and Stehle, 1976). However, many studies show that PPP usually doesn't hold[1]. In that case, a correct specification of an asset pricing model should entail exchange rate risk factors. Such international asset pricing models are developed by Solnik (1974), Sercu (1980), Stulz (1981) and Adler and Dumas (1983).[2]

Another extension of the CAPM was suggested by Fama and French (1992, 1993, 1995, 1997). Besides the world market factor they included two zero-cost portfolios: a Small minus Big (SMB) portfolio based on the total market capitalization of the firms considered and a High-minus-Low (HML) portfolio which is based on the book-to-market value of the stock. In their studies Fama and French show that their asset pricing model performs better than the traditional CAPM. In a later study (Fama and French, 1998), they provide the international evidence by investigating the model for a number of countries. Despite the good performance of their model several studies question their methodology. Daniel and Titman (1997) find that rather the characteristics than the covariance structure of the returns explain the cross-sectional variance of the stock returns. Other studies (Campbell (1996), Ferson and Harvey (1999) and Lettau and Ludvigson (2001)) show that incorporating conditioning information in a traditional CAPM also increases the ability to explain the returns.

In this paper we do not contribute to the methodological discussion, but try to answer a more practical question. Although Fama and French (1998) advocate a global version of their model, many practitioners and academics use a local version of the three-factor model in order to make correct estimates of the expected stock returns (e.g. for portfolio selection problems and cost-of-capital calculations[3]). Griffin (2002) documents that a local three-factor model is better (in terms of adjusted R^2 and Jensen's alpha) than the global version for the stock markets of the U.S., Canada, the U.K., and Japan. The result is found for both portfolios and individual securities and is also robust for basic methodological changes.

We address the same issue for the euro area. Although not all countries are as integrated with the world market as the four large countries mentioned above, the euro area

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[1] See e.g. Abuaf and Jorion (1990), Froot and Rogoff (1995), Chinn (2002), Koedijk, Tims and van Dijk (2004)
[2] Stulz (1995) gives a comprehensive review of the literature on the different asset pricing models.
[3] See amongst others Stulz(1998), Koedijk, Kool, Schotman and van Dijk (2002) and Karolyi and Stulz (2002) for discussions on the local versus global (I)CAPM, e.g.. for cost of capital calculations.

forms a very integrated area by itself.[4] Over the last decade a number of changes in the European Monetary Union has had a big influence. Besides the harmonization of monetary and policy rules and legislation, the playing field for institutional investors (the largest investors in the European market) changed considerably.[5] During our sample period the restriction on maximum investments in stocks has been relieved and the introduction of the common currency opened up the euro area market for the institutional investors even more. Consequently, the termination of the exchange rate risk within the euro area spurred the (financial) integration process amongst these countries.[6] Given these changes and the resulting union, it is interesting to see what factors drive the stock markets in this area. As discussed above, Griffin (2002) shows that the domestic model is preferred, but which "domestic model" applies to the euro area? Are asset prices driven by local country factors or are euro area factors more appropriate nowadays. In this paper we address this issue and examine the behavior of these asset pricing markets over time as well.

We study the equity markets of all euro-participating countries over the period 1991:07 until 2002:08. We create portfolios for each country based on the book-to-market and the size characteristics of the companies considered. The returns of these portfolios are used to test the different asset pricing models. We find that the domestic three factor model (country 3FM) clearly outperforms the euro area three factor model. Given the European integration during our sample (as evidenced by Hardouvelis, Malliaropoulos and Priestley, 1999), we split the sample in two parts to examine the behavior of the asset pricing models in each sub period. We show that the difference in the first part of the sample is substantial (the mean absolute pricing error of the country 3FM is up to 40% lower than the pricing error of the euro area 3FM). In the second sub sample this difference decreases to approximately 7%. Thus, even though the (relative) performance of the euro area model has increased substantially, the country 3FM still produces the lowest pricing errors on average.

Furthermore, we also group the stocks along another dimension. Among others, Fama and French (1997) show that pricing industry portfolios is very difficult. However, no studies (to the author's knowledge) have implemented an industry-specific three-factor model

[4] Hardouvelis, Malliaropoulos and Priestley (1999) show using a conditional framework that most member states of the European Monetary Union seem to become fully integrated with each other in 1997.

[5] Institutional investors are usually very restricted concerning investments in stock markets, both in the maximum amount invested (in percentages of total assets) and how these investment are allowed to vary over different stock markets (it is very common that the greater part has to be invested in local currency-denominated markets).

[6] Recent studies, that consider the euro area asset markets in particular, find that the changing environment of the euro area is slowly reflected in the financial markets (see e.g. Cavaglia, Brightman and Aked, 2000; Isakov and Sonney, 2002).

(industry 3FM) following the Fama-French methodology. In this paper we address this issue and compare the results with the euro area 3FM. For each sector we create a number of portfolios based on the book-to-market or size characteristics of the firms. As in the country case, we find that an industry 3FM clearly outperforms the euro area 3FM. This result is robust over the sub periods and holds for both book-to-market and size-sorted portfolios.

The rest of the paper is organized as follows. Section 2 provides the methodology used in this paper. Section 3 discusses the data used and explains how the portfolios are constructed. Section 4 presents the results and section 5 concludes.

2. METHODOLOGY

We estimate different versions of the Fama and French three factor model (3FM). We employ the same methodology and same performance measures as Griffin (2002) and apply this approach to the euro area stock markets. This sections covers the applied models in more detail.

The 3FM relates the expected return on a stock or portfolio in excess of the risk free rate to three different factors: (1) the excess return of the market portfolio; (2) the difference between the return on a portfolio of small market capitalization stocks and the return on a portfolio of big capitalization stocks (SMB, small minus big); (3) the difference between the return on a portfolio of high book-to-market stocks and the return on low book-to-market stocks (HML, high minus low), which proxies the value or distress premium. In a regression framework this model can be written as:

$$R_{it} - R_{ft} = \alpha_i + \beta_i \cdot [R_{mt} - R_{ft}] + s_i \cdot SMB_t + h_i \cdot HML_t + \varepsilon_{it} \qquad (1)$$

where R_{it}, R_{ft} and R_{mt} are respectively the return on a stock or portfolio, the risk-free rate and the market return; β_i, s_i and h_i are the unconditional sensitivities of the i^{th} asset for the specific factors, α_i is the pricing error and ε_{it} the error term.

In this paper we focus on the domestic 3FM of Fama & French applied to the euro area (or European Monetary Union). The main research question covered in this paper answers how *domestic* these factors (market return, SMB, HML) should be. A natural definition of domestic factors are country-specific factors. However, given the rate of integration and the introduction of the common currency in the European Monetary Union, a 3FM with euro-area-based factors could also be seen as a domestic model. In section 2.1 we discuss both of these models and examine which model produces the lowest pricing errors. Instead of using geographical characteristics in defining the ‘local factors’, one can also create factors for each different sector. As discussed in the introduction, the regulatory changes in Europe has been numerous and consequently investors should take a sector-based approach in examining the euro area capital markets.[7] Following these lines an industry-based 3FM is perfectly rational. Furthermore, these analyses can bring new insights in the discussion on pricing industry portfolios (which is very hard according to e.g. Fama and French, 1997). The methodology for the industry-based factor models is discussed in section 2.2.

2.1 Euro area vs. the country three factor model

In a fully integrated market there is only one set of factors that prices all assets of each country. Assuming that the euro area is a highly integrated area, we can define the euro area three-factor regression model (euro area-3FM) as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_i \cdot EMRF_t + s_i \cdot ESMB_t + h_i \cdot EHML_t + \varepsilon_{it} \qquad (2)$$

where $EMRF_t$ is the euro area market excess return, $ESMB_t$ represents the small minus big portfolios for the euro area and $EHML_t$ is the euro area high minus low portfolio. For the definition of the EMU risk factors, we follow the methodology of Griffin (2002), who defines the global risk factors as the weighted averages of all domestic risk factors under consideration.

$$EMRF_t = w_{Dt-1} \cdot DMRF_t + w_{Ft-1} \cdot FMRF_t \qquad (3)$$

where $DMRF_t$ and $FMRF_t$ are the domestic excess market return and the foreign excess market return respectively; the weight w_{Dt-1} is equal to the country’s total market capitalization in the previous month over the total EMU market capitalization in the previous month and w_{Ft-1} is the weight for all foreign countries and by definition the complement of w_{Dt-1}. The other two factors ($ESMB_t$ and $EHML_t$) are defined in a similar way.

[7] See e.g. Cavaglia, Brightman and Aked (2000), Rouwenhorst (1999), Isakov and Sonney (2002) and

The three-factor model described in equation (2) restricts the domestic and the foreign factors to have the same impact on stock returns. If one allows the foreign factors to have a different influence on the returns, the following international country factor model regression can be defined:

$$\begin{aligned} R_{it} - R_{ft} = \alpha_i + \beta_{Di} \cdot (w_{Dt-1} \cdot DMRF_t) + s_{Di} \cdot (w_{Dt-1} \cdot DSMB_t) + h_{Di} \cdot (w_{Dt-1} \cdot DHML_t) \\ + \beta_{Fi} \cdot (w_{Ft-1} \cdot FMRF_t) + s_{Fi} \cdot (w_{Ft-1} \cdot FSMB_t) + h_{Fi} \cdot (w_{Ft-1} \cdot FHML_t) + \varepsilon_{it} \end{aligned} \quad (4)$$

We will refer to this as the international country 3FM. It is formed by decomposing the global model into the specific domestic-related components and foreign country components.[8]

If the foreign factors are irrelevant, the international country 3FM collapses to the country 3FM:

$$R_{it} - R_{ft} = \alpha_i + \beta_{Di} \cdot DMRF_t + s_{Di} \cdot DSMB_t + h_{Di} \cdot DHML_t + \varepsilon_{it} \quad (5)$$

In order to assess the performance of the three different models considered, we apply two separate performance measures. First of all, the adjusted R^2s of the different regressions are compared. Although the R^2 rises when useful factors are added, it is not the best statistic to compare models. A more reliable performance measure is the pricing error of the regression (α_i). On average, the most effective model is best able to price (portfolios of) assets and hence produces a lower pricing error (in absolute terms). The models are tested on different groups of portfolios. Following the literature we will mainly focus on BE/ME-sorted portfolios and on size-sorted portfolios.

2.2 The industry asset pricing model

This section covers another possible avenue for a "domestic model". Instead of defining a local asset pricing factor model for each country, we also consider asset pricing models for each industry category. As mentioned before, the European (Monetary) Union is in the middle of an integration process. Given this dynamic environment many studies have been done in order to test for structural changes in the European financial markets. Some of these studies

[8] In case of highly integrated markets, this specification is not identified. The factor-pairs (e.g. DMRF and FMRF) are then highly correlated. We will therefore not pay a lot of attention to this model, but do report the results in order to be able to compare them with Griffin (2002).

argue that industry factors are becoming more important relative to country factors (see footnote 5). From this point of view an industry asset pricing model is an interesting topic of research. Furthermore, it is well-known that industry portfolios are hard to price using the normal CAPM or 3FM.[9] The rest of this section discusses the methodology used for this model.[10]

For every industry we create an industry return, a SMB portfolio and a HML portfolio. Thus, we can now split up the euro area 3FM (as in equation 2) into an international industry model:

$$\begin{aligned} R_{it} - R_{ft} = \alpha_i + \beta_{Ii} \cdot (w_{It-1} \cdot IMRF_t) + s_{Ii} \cdot (w_{It-1} \cdot ISMB_t) + h_{Ii} \cdot (w_{It-1} \cdot IHML_t) \\ + \beta_{Oi} \cdot (w_{O,t-1} \cdot OMRF_t) + s_{Oi} \cdot (w_{Ot-1} \cdot OSMB_t) + h_{Oi} \cdot (w_{Ot-1} \cdot OHML_t) + \varepsilon_{it} \end{aligned} \quad (6)$$

where $IMRF_t$, $ISMB_t$ and $IHML_t$ are the factors for a specific industry and $OMRF_t$, $OSMB_t$ and $OHML_t$ are the risk factors for the other industries. The model is similar to the international country model with the exception that the factors are now industry-based. The parameterization allows us to check which factors are the most important in explain the cross-section of returns. In case the factors of the other sectors are irrelevant, the international industry model collapses to the industry 3FM:

$$R_{it} - R_{ft} = \alpha_i + \beta_{Ii} \cdot IMRF_t + s_{Ii} \cdot ISMB_t + h_{Ii} \cdot IHML_t + \varepsilon_{it} \quad (7)$$

We use BE/ME-sorted and size-sorted industry portfolios for testing the different asset pricing models. The performance criteria used for the comparison are the same as mentioned above: the (absolute) pricing error (α_i's) and the adjusted R^2's.

Unfortunately, we cannot compare the country and industry model directly, since they are not nested. Moreover, there is a slight difference between the two European models, which comes from the methodological assumptions that we make (following Griffin, 2002). Appendix A discusses this in more detail. Furthermore, we tested an alternative specification

[9] See, amongst others, Fama and French (1997), Hussain, Diacon and Toms (2002), Van Vliet and Post (2004).
[10] To our knowledge, the industrial Fama & French model has not been a topic of research yet. Hussain & Toms (2002) study a related topic. They consider industry portfolios and regress these on the standard (domestic) risk factors for the UK. However, the risk factors are still country-based and not industry based.

where the European models are exactly the same, but this doesn't give major changes for our results.[11]

3. DATA

We apply our methodology to stocks from the euro-participating countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. Luxembourg is the twelfth country that belongs to the euro area, but it is usually ignored in this type of studies because of the small number of stocks in this country. The monthly stock returns (including dividends and capital gains) are downloaded from Datastream[12]. For each asset we also retrieve the FTSE industry classification (see Table 1 for the different classifications), market capitalization and the book-to-market (BE/ME) ratio for each month. As a conditionally risk-free asset we use the return on the one-month euro-mark deposit quoted in London (also extracted from Datastream). All asset returns (before the introduction of the common currency) are translated into Deutsche marks using the bilateral exchange rates.[13] The monthly excess returns are computed by subtracting the risk-free rate from the monthly return of each security.

The biggest difference of European data versus US data concerns the number of stocks. This holds especially for this paper, since we investigate a domestic 3FM for each country (and for each industry). Table 2 shows the number of stocks that are used for the creation of the different factors at the beginning of July for each year. This number can decline throughout the year, because of mergers, takeovers, bankruptcies or any other reason of delisting. Considering Table 2 we see that there are huge differences between the European countries and industries. Germany and France are the largest countries with approximately 200 listed stocks, while Ireland and Greece are the smallest countries with less than 20 stocks in the beginning of the sample. The same holds for the different sectors that we consider. There are big differences in the number of stocks of different industries, ranging from less than 20 for the Information Technology sector in the first four years of our sample to almost

[11] The results of this model are available upon request from the author.

[12] For each country we selected the stocks that are listed in the Datastream total market index of the countries under consideration. These indices cover 80% of all available stocks, which suggests that it covers more than 99% of the market capitalization of each country. The delisted stocks are taken from the Datastream dead stocks lists.

[13] The same holds for the market value and the book-to-market ratio. In order to make a smooth transition to the euro-nominated returns, we multiplied all values with the frozen exchange rate, which is available at: European Central Bank, http://www.ecb.int (accessed 3 October, 2003)

250 in some years for the Financials. We will take this into account during the interpretation of the results by presenting our results both for the whole euro area as well as for the bigger countries/industries only.

The sample runs from July 1991 till August 2002. Although this is a fairly short sample for this type of studies, we chose to stick to recent data only. The reasons for this choice are twofold. First, a much longer time series would lower the listed stocks per country even more. Secondly, the local versus global discussion on the Fama and French 3FM is based on the assumption of market integration. Although one can argue that the markets in the beginning of our sample might not be fully integrated, Hardouvelis, Malliaropulos and Priesley (2001) find that most of these markets do around 1998. Hence, the start of the sample is a consideration between more available data versus complying with the null hypothesis of integrated markets.

For the construction of the risk factors we follow Griffin (2002) by applying the Fama and French (1992, 1993, 1996) methodology. For stocks to be included in the analysis the firm must have a stock price for June of year t. Furthermore, the firm should have a market value for June of year t and a book-to-market value for December of year t-1. Firms that have a negative book-to-market value on December of year t-1 are not included in the sample. This selection procedure is used for all stocks in the DataStream total market index. Given this selection of firms, in June of year t all stocks are ranked on size. The sample is then split using the median market capitalization of all firms of a country (or industry) into a small (S) and a big (B) portfolio. The stocks are also ranked on their book-to-market equity of December of year t-1. For the book-to-market classification, the bottom 30% are classified as low book-to-market firms (L), the middle 40% into the middle (M) portfolio and the top 30% as high book-to-market firms (H). Using the intersection of these independent stock splits we can construct six portfolios: BH, BM, BL, SH, SM and SL. The SMB-portfolio is defined as the simple average of all small-stock portfolio returns minus all big stock portfolio returns, or SMB=(SH + SM + SL - BH – BM – BL)/3 for each month. The HML portfolio is the simple average of all high BE/ME stock portfolio returns minus all low stock portfolio returns, or HML=(SH + BH – SL – BL)/2 for each month[14].

The test assets are in line with the existing literature. We create portfolios based on the ranking of the assets on the BE/ME-ratio or on size. The number of tested portfolios is varied,

[14] In the case of Ireland and Greece, the middle book-to-market portfolio does not exist. Because of the limited number of stocks in the beginning of the sample, we decided to split the sample into two book-to-market portfolios.

changing from 3 to 6 and 10. By this variation we can test the robustness of our results. However, we should note again that the number of stocks is limited for the smaller European countries: the larger the number of portfolios, the less stocks that are on average in a portfolios. For example, in the beginning of the sample Greece only contained eleven stocks. When these are divided over 10 portfolios, it means that 9 out of 10 portfolios only contain one stock! For completeness, we apply our methodology on all euro-participating countries, but we will check the robustness of the results with respect to the inclusion of these smaller countries or industries.

4. RESULTS

We use the same performance criteria for measuring the performance of the different asset pricing models as Griffin (2002). The first criterion is the pricing error, also called Jensen's alpha. Under the null hypothesis that the factor model is indeed the data generating process, the predicted value of alpha in the estimated equation should be equal to zero (see equation 2, 4 or 5 for the European, the international or the domestic model respectively). The estimated value of alpha then gives the pricing error of the asset-pricing model under consideration. For each group of assets we report the mean absolute pricing error.[15] The second criterion is the average adjusted R-squared, which is the explanatory power of the regression.

4.1 The country vs. the euro area 3FM

For every country in our sample we regress the time series of returns of the different book-to-market sorted portfolios on three versions of the 3FM: the euro area 3FM, the international country 3FM and the (local) country 3FM (see equations 2,4 and 5). The results are summarized in the Table 4. The first three rows cover the average results. The following three rows contain the same results but only concerning the bigger countries (Germany, France, Italy and the Netherlands), while the rest of the table presents the performance measures for each country separately.

[15] One can also test the pricing errors using the statistical procedures as proposed by Gibbons, Ross and Shanken (1989). These tests showed that most pricing models didn't have significant alpha's. This is partly caused by the fact that our sample period is relatively short and the Gibbons-Ross-Shanken-test only holds asymptotically under normally distributed errors. Furthermore, the results are very similar to the mean absolute pricing error criterion. Since this last criterion is more relevant in economic terms, we chose to only report the results on the absolute pricing errors.

For example, when the stocks are divided into three book-to-market sorted portfolios we find that the euro area 3FM performs worse than the other two models based on both performance criteria. The mean absolute pricing error for the euro area 3FM (0.449) is more than double compared to the international model (0.191) or the domestic model (0.189). The adjusted R^2 of the euro area 3FM (0.482) is also substantially lower than 0.859 and 0.851 of the international and the domestic asset-pricing model respectively. The results stated in the second and third row represent the cases where the number of portfolios is increased to six or ten. The overall performance of the asset pricing models declines (the mean absolute pricing errors rise, while the R^2s drop), but the relative conclusions stay the same: both the domestic 3FM and the international country 3FM are clearly better in explaining the cross-section of stock returns than the euro area 3FM is. This result is robust over the number of portfolios used.[16]

When we compare the international (country) 3FM with the country 3FM the differences are much less pronounced. First of all, the adjusted R^2s of the international model are marginally higher. This means that the foreign factors hardly have any extra explanatory power compared to the domestic factors, which is in line with expectation, since these factors are highly correlated. However, the international version of the 3FM is not necessarily better in explaining the portfolio returns. In all cases for BE/ME-sorted portfolios the country model has a better performance measured by the mean absolute pricing error. This result is somewhat striking at first glance, but is also reported by Griffin (2002). He finds the same result using data for the UK, US, Japan and Canada. Apparently, the local factors are far more informative in terms of asset pricing than the other factors are. As a robustness check, we also averaged the results for the bigger countries only (rows 4-6). In that case, all conclusions are the same, except for the 3-sort, where the international country 3FM has a lower mean absolute pricing error than the country 3FM. Also, the difference between the domestic and the euro area 3FM is less pronounced, but the domestic 3FM is clearly favorable on both performance measures.

Table 5 shows the results for size-sorted portfolios and the same asset pricing models. Again we see that euro area 3FM has the worst performance of three models by far. The R^2s

[16] In case we only use three portfolios, we know that the portfolios contain enough stocks, but on the other hand this favors the country model. After all, the domestic market is split into three smaller subsets and hence the explanatory variables in the country three-factor model are more correlated with the dependent variables. Therefore, we should also consider a higher number of portfolios (in our case we used 6 and 10 portfolios). The drawback of using more different portfolios is that the number of stocks per portfolio is decreasing. This holds especially for smaller countries, like Greece and Ireland that have less than 20 stocks in the beginning of the sample. For this reason we also check all our results in case we only consider the bigger countries (or in the following section industries), which contains at least 50 stocks throughout the whole sample.

almost double and the mean absolute pricing errors lower substantially ranging from 30% to 60% of the absolute pricing error of the euro area 3FM. The performance of the international and the country model are again very similar. The R^2s of the international 3FM are slightly higher than those of the country 3FM, while the results based on the absolute pricing errors differ over the different number of portfolios used. Either way, it can be concluded that the three added factors in the international model don't add much explanatory power.

4.2 The industry vs. the euro area 3FM

Several studies (amongst others, Fama and French, 1997; Van Vliet and Post, 2004) show that pricing industry(-sorted) portfolios is very difficult. Most of the studies, however, use global factors in the asset-pricing models. We propose to use a different specification of the Fama-French 3FM: a factor-model using industrial factors. We test the performance of a pure industry 3FM against a euro-area 3FM, as given by equations (2) and (7). For reasons of comparison we also include an international industry 3FM (similar to the international country 3FM) as denoted by equation (6). The test assets for these models are formed by sorting all assets of a specific industry on book-to-market or on size. Thus, we use BE/ME-sorted industry portfolios and size-sorted industry portfolios in this section.

The results presented in Table 6 coincide with the results of the previous subsection. The euro area 3FM does not contain enough information to price the BE/ME-sorted portfolios as efficient as the international and the industry 3FM, that both contains the local industry factors. The R^2s of the euro area 3FM are significantly lower and mean absolute pricing error is higher. The difference between the international industry and (local) industry 3FM is very small. The industry model does have lower absolute pricing error for all number of book-to-market sorted portfolios (3,6 and 10), but this only holds on average and not for each industry separately. The results on the size-sorted portfolios contain no surprises (see Table 7). The conclusions are the same as for the book-to-market sorted sector portfolios stating that the more local 3FM is better capable in explaining the cross-section of stock returns. In order to test whether our results are not driven by outliers in smaller industries, we also present the performance measures for the bigger sectors only. These are reported on rows 4-6 of Table 6 and 7. The performance for all models improves slightly, which might be explained by the fact that the test portfolios contain more stocks than the industry portfolios of smaller sectors. The relative performance, however, remains the same. Summarizing, Tables 6 and 7 show that a local industry three factor model is more capable of explaining the cross-section of industry returns than a euro area version of this model. The result is very interesting and shows that an industry-perspective might be more appropriate in terms of pricing industry portfolios. Clearly, more research needs to be done in this area, but we leave this for future research.

The sections 4.1 and 4.2 have shown that a local 3FM is preferred over the euro area version of the model over the whole sample. Using BE/ME- and size-sorted portfolios we have shown that a domestic 3FM or an industry 3FM has a clear outperformance compared to the euro area 3FM in terms of both R^2s and the mean absolute pricing error. In the following section we will present the results in case the methodology is applied to sub periods of our sample in order to test the behavior of these models over time.

4.3 European integration and the relative performance of asset pricing models

The European Monetary Union has been a very dynamic environment during our sample period. A number of changes in the monetary and legislation system have been implemented in order to achieve a higher level of (real) integration. For example, institutional investors were restricted concerning investments in foreign stocks (stocks denoted in different currency). This restriction is relaxed with respect to other euro-participating countries and since the advent of the euro this restriction was relaxed in a more natural way. Clearly, this might have a considerable impact on financial markets. For example, if financial integration has increased during our sample period, we would expect that the (relative) performance of the euro area 3FM would increase compared to the country/industry (and international) 3FM. Therefore, we want to split our sample in two halves to test for differences over the two sub periods. Table 8 contains the results of the country, international and euro area 3FM model for both sub samples, for the book-to-market sorted test portfolios and for size-sorted portfolios. Table 9 presents the same results of the industry portfolios using the industry, international industry and euro area 3FM.

Due to different market conditions the actual level of the performance measures are not directly comparable, but the conclusions to be drawn on the relative performance of the models are similar. In almost all cases, the euro area factor model is not able to perform better than any of the other models in both of the sample periods. Also, the performances of the international and local (both the (local) country and the (local) industry model) are not very much apart. More interesting, however, is to compare the relative performances over the different periods with each other. Let's define $\kappa_{i,j}$ as the ratio of the mean absolute pricing error of the model *i* over the corresponding value of the model *j*:

$$\kappa_{i,j} = \frac{\frac{1}{n}\sum_{p} |\alpha_{p,i}|}{\frac{1}{n}\sum_{p} |\alpha_{p,j}|} \tag{8}$$

Since a lower value of the alpha corresponds with a better performance of the model, a value of $\kappa_{country,euro\ area}$ that is lower than one, means that the country factor model performs better than the euro area factor model in terms of absolute pricing errors. This κ-indicator summarizes the relative performance of the two models into one number. In the rest of the analysis, we will only use the κ-indicator with the alphas of the euro area 3FM in the denominator. Then, in case the level of equity market integration between different countries (industries) has increased during our sample period, the κ-indicator shows a higher value for the second sub sample compared to the first sub sample.

Figure 1 shows the values of the κ-indicator for the different models and each sub sample.[17] The first two pairs of bars relate the mean absolute pricing error of the country 3FM with the euro area 3FM. We see a slight increase in the relative performance of the euro-area 3FM for the book-to-market sorted portfolios, while for the size-sorted portfolios κ hardly changes over the different sub samples. The results for the comparison of the industry 3FM with the euro area 3FM are depicted in the two other pairs of bars. These show mixed evidence with respect to the κ-indicator. The value of κ for the book-to-market sorted portfolios increases, while it decreases for the size-sorted industry portfolios. One could conclude that there are no significant changes in the relative performance of the different factor models over the sub samples. We should, however, bear in mind that these results are based on the whole sample and thus includes the smaller countries and industries. As mentioned before, this can influence our results. First of all, the portfolios of these countries are very small and we should be careful in interpreting their results. Secondly, although these countries have adopted the euro, they might still be less integrated with the European Monetary Union than other, bigger countries.

[17] In order to calculate the values for κ we used the average value of the absolute alphas of the ten sorted portfolios. If the number of portfolios is small, we might favor the domestic (country or industry) model over the European model, because of a high correlation between the local market return and the local portfolios. The drawback of using more portfolios is that the number of assets per portfolio decreases. This is especially an issue when we study smaller countries like Greece and Ireland (see Table 2). Therefore, we will also examine the results for the bigger countries (industries) only.

For that reason Figure 2 also depicts the κ-indicators in case only the bigger countries and bigger industries are considered.[18] Concentrating on the results for the industry sorted portfolios we are again confronted with mixed results. The value of κ for the size-sorted portfolios shows no change at all, while the κ-ratio for the book-to-market sorted industry portfolios gives a clear increase. The ratio is still below 1, which means that on average the local industry 3FM is better in terms of mean absolute pricing error than the euro area version of the model, but the difference is almost negligible. When we compare the country 3FM with its euro area counterpart, however, a clear difference between the first and second sub sample can be found. Where the euro area 3FM clearly performs worse in the first part of the sample (with κ-values of 63% for the book-to-market portfolios and 58% for the size-sorted portfolios), the performance of the two models is almost similar in the second part of the sample (the values of κ increased to 94% and 93% respectively). This result could likely be a consequence of the increased rate of integration in the EMU and it might indicate that asset pricing in the euro area has been changing.

A more detailed view on the performance measures for the four bigger countries shows that the conclusion is fairly robust. All four countries considered show an increase both for the book-to-market and the size-sorted portfolios, except for Germany in case book-to-market portfolios are studied (the κ-ratio decreased from 87% to 79% in that case). The overall result seems to be fairly robust. The number of portfolios used in the regressions (3 or 6 instead of 10) does not influence the outcome of our conclusions. Furthermore, one can argue that the euro area factors are still based on all countries. Unreported results show that the conclusions are similar when the "global" factors are based on the big countries only.[19]

Concluding we can state the (local) country model is losing field against the European three-factor, although its performance is still slightly better. The industry asset-pricing model, however, outperforms the European version in both sub samples. A tentative conclusion would therefore be that industry factors are nowadays more important in terms of asset pricing than country factors concerning assets from the euro area. Though, we should bear in mind that the European models are not fully comparable given our choice of the methodology. In order to test this conclusion more research attention should be paid to the industry three-factor model.

[18] A country or industry is considered big as soon as the number of assets in this group is higher than 50 for the complete sample. This means that only four countries are considered big in this sample: France, Germany, Italy and the Netherlands. There are six industries that meet this criterion: Basic Industries, General Industries, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services and Financials.
[19] These results are available upon request.

5. CONCLUSIONS

In this paper we examine different asset-pricing models applied to stocks in the euro area. All models are an interpretation of the Fama and French three-factor model, which contains a market factor, a small-minus-big factor and a high-minus-low factor (see equation 1). Although Fama and French (1998) provide evidence for the international version of the model (i.e. when the factors are global), many practitioners and academics use a domestic version of this asset pricing model. Moreover, Griffin (2002) shows that the domestic three factor model clearly outperforms the global model for the US, Canada, Japan and the UK. In this paper we study different domestic versions of the Fama and French three factor model for the euro area. Motivated by the number of regulatory changes in the European Monetary Union, our sample period runs from 1991-2002. This period not only covers the introduction of the common currency, but also numerous harmonizing impulses in order to facilitate real and financial integration in the European Union.

The first part of the paper centers on the euro area 3FM versus a country version for eleven euro-participating countries using both book-to-market and size-sorted portfolios. We show that the euro area 3FM clearly underperforms the country 3FM, as measured by both the mean absolute pricing error and the R^2. The international version of the model (which splits all factors into a domestic and a foreign part) has a similar performance as the country model. In other words, the three foreign factors hardly explain and sometimes even jeopardize the performance of the asset pricing model.

We also test different asset pricing models for industry portfolios. In general, industry portfolios are very hard to price, as reported by Fama and French (1997) and Van Vliet and Post (2004). The models tested include again the euro area 3FM and a local industry asset pricing model. The latter one contains three Fama-French factors that are fully based on stocks of one industry only. We examine the performance of these versions of the 3FM with BE/ME-sorted and size-sorted industry portfolios. The results indicate, similar to the comparison of the country 3FM with the euro area 3FM, that the industry 3FM (the "local" version of the model) outperforms the euro area 3FM. Although this finding is very surprising, it might suggest that industry portfolio returns can be explained by an industry three-factor model more easily. This is an interesting finding from a practical point of view, but more research on industry portfolios is needed in order to understand industry portfolio dynamics.

We executed the same analyses for two equal sub periods. This is a robustness check on the validity of our conclusions. However, one can interpret the outcomes of the analyses as a measure for the European equity market integration. It is well-known that the number of regulatory changes has been huge during the ongoing integration process in the European Union. Next to the harmonization of monetary and policy changes, the relaxation of investment restrictions for European institutional investors has had an enormous impact on the integration process. As a result, the relative performance of the euro area 3FM might increase compared to the local country 3FM. We document this increase in the relative performance for all major euro-participating countries (Germany, France, Italy and the Netherlands). In the first part of the sample the mean absolute pricing error of the local (country) 3FM is on average 40% lower than the euro area factor model, whereas this difference decreased to less than 10% for the second sub period (see Figure 2). This finding suggests that asset pricing in the European Monetary Union is changing as well. For the industry portfolios we find mixed evidence with respect to the relative performance of the different asset pricing models for the book-to-market and size-sorted portfolios. We do find, however, that the industry 3FM outperforms the euro area 3FM for all tested portfolios and periods. We realize that this is – to our knowledge- the first paper applying the Fama-French methodology using industry based factors. Therefore, more research should be dedicated to the industry 3FM.

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7. APPENDIX A

The methodology section explains the construction of all different three-factor models that are tested in this paper. It is stated that the two European versions of the asset-pricing model are not comparable, which is explained in this appendix. The factors is defined as the weighted averages of the local country or local industry factors. For the market factor this does not constitute a difference. The European market factor is exactly the same, regardless whether it is constructed using the different country factors or the different industry factors:

$$
\begin{aligned}
EMRF_t &= w_{Dt-1} \cdot DMRF_t + w_{Ft-1} \cdot FMRF_t \\
&= w_{Dt-1} \cdot \sum_{i=1}^{S_D} w_{it-1}^{D} R_{it} + w_{Ft-1} \cdot \sum_{i=1}^{S_F} w_{it-1}^{F} R_{it} \\
&= \sum_{i=1}^{S_D} w_{it-1}^{EUR} R_{it} + \sum_{i=1}^{S_F} w_{it-1}^{EUR} R_{it} = \sum_{i=1}^{N} w_{it-1}^{EUR} R_{it} \\
&= \sum_{i=1}^{S_I} w_{it-1}^{EUR} R_{it} + \sum_{i=1}^{S_O} w_{it-1}^{EUR} R_{it} \\
&= w_{It-1} \cdot \sum_{i=1}^{S_I} w_{it-1}^{I} R_{it} + w_{Ot-1} \cdot \sum_{i=1}^{S_O} w_{it-1}^{O} R_{it} \\
&= w_{Ft-1} \cdot IMRF_t + w_{Ot-1} \cdot OMRF_t
\end{aligned}
$$

where w_{it-1}^{X} is the weight of asset *i* at time *t-1* measured by the market value of asset *i* relative to the total market value of country/industry *X* (which can be the domestic market *D*, the foreign market *F*, the European market *EUR*, the industry *I* or the other industries denoted by *O*) and S_X is the number of assets in country/industry *X* and *N* is the total number of assets.

The same does not hold for the SMB and HML portfolios. These portfolios are constructed as simple averages of smaller portfolios (SH, SM, SL and so on) and therefore the stocks will not have the same weights in case the portfolios are constructed using country or industry factor portfolios. Intuitively, this is also clear: the large stocks in a small country might not be a large stock in European context. We choose to follow the methodology of Griffin (2002) in order to be able to compare our results with the literature.

Another possibility is to construct the ESMB and EHML independently from the country and industry information. In that case the model would be a true European Fama and French three factor model, but it would not be a nested model of the international country or international industry model anymore. This is a second reason to stick to the methodology of Griffin (2002). We also calculated the results using this other European model, but the results are not very different from the currently used model. In most cases the performance measures are approximately equal to each other.

Table 1: Industry Classification Codes

This table displays the FTSE-industry codes. This industry-categorization is used to divide all assets in industry specific portfolios.

	INDC3	Definitions
00	Resor	Resources
10	Basic	Basic Industries
20	Genin	General Industries
30	Cycgd	Cyclical Consumer Goods
40	Ncyg4	Non-Cyclical Consumer Goods
50	Cyser	Cyclical Services
60	Ncysr	Non-Cyclical Services
70	Utils	Utilities
80	Totlf	Financials
90	Itech	Information Technology

Table 2: Summary Statistics

This table reports the summary statistics on the market indices used in the analysis. The indices are constructed using all available stocks from Datastream that fulfill the criteria (see section 3). Panel A presents the summary statistics and **, *** used for the Jarque-Bera statistic denote significance at the 5% and 1% significance levels respectively. Panel B reports the unconditional correlations between the market indices.

	Euro area index	Germany	Belgium	Spain	Finland	France	Greece	Ireland	Italy	Netherlands	Austria	Portugal
Panel A: Summary Statistics of all market indices												
Mean	0.515	0.319	0.507	0.543	1.171	0.481	0.766	0.693	0.797	0.684	-0.166	0.341
Median	0.401	0.759	0.582	0.311	1.094	0.650	-0.617	1.453	-0.247	1.014	0.288	-0.097
Standard dev.	5.055	5.311	4.597	6.314	10.512	5.447	9.209	6.047	8.287	5.171	5.308	6.014
Skewness	-0.394	-0.532	-0.604	-0.076	0.345	-0.280	0.550	-0.790	0.933	-0.935	-0.403	0.856
Kurtosis	3.772	3.512	4.360	4.545	4.308	3.917	4.440	4.432	4.922	5.485	4.235	8.089
Jarque-Bera	6.79 **	7.78 **	18.5 ***	13.5 ***	12.2 ***	6.45 **	18.3 ***	25.4 ***	40.1 ***	54.0 ***	12.1 ***	161 ***
Panel B: Unconditional correlations between the market indices												
Euro area index	1											
Germany	0.927	1										
Belgium	0.753	0.685	1									
Spain	0.826	0.720	0.684	1								
Finland	0.704	0.634	0.389	0.494	1							
France	0.930	0.837	0.687	0.755	0.609	1						
Greece	0.503	0.492	0.420	0.437	0.348	0.476	1					
Ireland	0.652	0.614	0.625	0.640	0.472	0.567	0.406	1				
Italy	0.705	0.532	0.464	0.614	0.494	0.534	0.263	0.363	1			
Netherlands	0.895	0.845	0.780	0.742	0.614	0.822	0.427	0.678	0.480	1		
Austria	0.616	0.615	0.611	0.542	0.343	0.549	0.379	0.392	0.379	0.610	1	
Portugal	0.700	0.614	0.499	0.661	0.430	0.691	0.379	0.439	0.466	0.597	0.477	1

Table 3: Number of stocks

This table reports the number of stocks that meet the criteria. The asset must have a listed price for June of that respective year, the market value in June should be known and the book-to-market ratio for December of the previous year should also be available. Following the standard Fama and French methodology we find the following number of stocks for the month of June of that year. The number of stocks changes a lot over time due to new issues, mergers, takeovers and bankruptcies. The Fama and French portfolios are updated in June each year and therefore this table reports the number for that month. Due to delistings the number of stocks per country and for some portfolios might decline over the year. The addition of stocks only occurs in June of the following year, when the new portfolios are constructed. Panel A contains the numbers over the different countries included and Panel B covers the same statistic for the different industries.

Panel A: The number of stocks per country for each year

Country	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**
Germany (BD)	177	191	204	211	220	227	211	210	197	215	209	198
Belgium (BG)	46	45	47	51	50	47	50	43	41	38	33	32
Spain (ES)	48	55	64	66	69	72	97	107	108	111	102	101
Finland (FN)	32	34	36	38	56	60	65	66	63	57	53	46
France (FR)	253	253	258	268	266	263	253	247	221	197	177	170
Greece (GR)	11	17	22	24	28	31	42	41	45	50	56	45
Ireland (IR)	15	16	16	17	17	17	18	20	34	36	35	31
Italy (IT)	77	83	90	91	102	114	120	126	132	129	121	111
Netherlands (NL)	149	150	144	142	141	136	138	144	142	124	104	90
Austria (OE)	35	38	40	47	58	64	68	66	57	55	50	47
Portugal (PT)	33	34	42	43	47	45	49	54	54	46	40	41
Total	876	916	963	998	1054	1076	1111	1124	1094	1058	980	912

Panel B: The number of stocks per industry for each year

Sector		**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**
00	Resor	59	55	50	54	54	46	45	41	33	25	23	20
10	Basic	138	140	145	154	165	174	184	184	182	165	158	151
20	Genin	152	155	155	160	170	168	166	154	150	141	127	110
30	Cycgd	84	89	90	96	99	104	106	113	109	106	96	88
40	Ncyg4	89	101	103	104	112	120	111	119	122	117	105	100
50	Cyser	105	106	107	109	121	125	136	146	147	145	145	140
60	Ncysr	39	43	48	46	45	44	46	45	42	44	37	36
70	Utils	33	35	35	36	37	37	37	39	41	38	37	33
80	Totlf	159	174	212	221	230	232	251	251	230	222	196	180
90	Itech	18	18	18	18	21	26	29	32	38	55	56	54
	Total	876	916	963	998	1054	1076	1111	1124	1094	1058	980	912

Table 4. Regression results
Country vs. euro area model, book-to-market sorted portfolios, full sample

This table presents the two performance measures resulting from regressing the book-to-market sorted portfolios of the countries considered using the full sample on three different asset pricing models: the euro area 3FM, the international country 3FM and the country 3FM (see equation 2, 4 and 5 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column contains the average adjusted R^2. The top rows depict the averages of the performance measures for all countries and the three following rows average over the four largest countries (France, Germany, Italy and the Netherlands).

The number of portfolios and Country considered	European model		International model		Country model	
	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2
Average, 3	0.449	0.482	0.191	0.859	0.189	0.855
Average, 6	0.428	0.424	0.289	0.737	0.286	0.730
Average, 10	0.483	0.366	0.365	0.628	0.343	0.620
(only big countr.) 3	0.324	0.657	0.181	0.891	0.210	0.887
(only big countr.) 6	0.309	0.590	0.289	0.788	0.270	0.782
(only big countr.) 10	0.336	0.530	0.276	0.709	0.250	0.701
Germany 3	0.309	0.730	0.292	0.880	0.315	0.881
Germany 6	0.239	0.663	0.242	0.795	0.249	0.795
Germany 10	0.233	0.591	0.198	0.713	0.175	0.702
Belgium 3	0.293	0.510	0.022	0.850	0.048	0.850
Belgium 6	0.230	0.423	0.214	0.686	0.242	0.686
Belgium 10	0.402	0.349	0.326	0.565	0.378	0.563
Spain 3	0.185	0.544	0.247	0.854	0.227	0.844
Spain 6	0.252	0.487	0.350	0.770	0.382	0.761
Spain 10	0.324	0.434	0.383	0.672	0.427	0.664
Finland 3	0.718	0.400	0.392	0.825	0.177	0.807
Finland 6	0.697	0.339	0.385	0.682	0.271	0.663
Finland 10	0.692	0.285	0.492	0.575	0.355	0.554
France 3	0.229	0.775	0.217	0.904	0.273	0.903
France 6	0.294	0.684	0.316	0.804	0.338	0.802
France 10	0.289	0.622	0.288	0.734	0.333	0.727
Greece 3	0.579	0.214	0.363	0.907	0.387	0.908
Greece 6	0.586	0.176	0.439	0.792	0.453	0.791
Greece 10	0.749	0.150	0.614	0.680	0.589	0.680
Ireland 3	0.761	0.270	0.211	0.710	0.269	0.707
Ireland 6	0.602	0.247	0.154	0.570	0.304	0.547
Ireland 10	0.558	0.169	0.419	0.393	0.475	0.374
Italy 3	0.330	0.508	0.098	0.916	0.124	0.914
Italy 6	0.360	0.493	0.239	0.857	0.167	0.852
Italy 10	0.400	0.467	0.297	0.794	0.201	0.789
Netherlands 3	0.427	0.616	0.116	0.866	0.127	0.851
Netherlands 6	0.342	0.519	0.361	0.696	0.326	0.679
Netherlands 10	0.423	0.439	0.323	0.596	0.293	0.584
Austria 3	0.885	0.372	0.046	0.901	0.094	0.902
Austria 6	0.830	0.301	0.243	0.732	0.239	0.734
Austria 10	0.852	0.258	0.334	0.619	0.283	0.612
Portugal 3	0.226	0.363	0.096	0.835	0.040	0.836
Portugal 6	0.278	0.336	0.240	0.726	0.173	0.722
Portugal 10	0.390	0.262	0.342	0.571	0.262	0.569

Table 5. Regression results
Country vs. euro area model, size sorted portfolios, full sample

This table presents the two performance measures resulting from regressing the size sorted portfolios of the countries considered using the full sample on three different asset pricing models: the euro area 3FM, the international country 3FM and the country 3FM (see equation 2, 4 and 5 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column containes the average Adjusted R2. The top rows depict the averages of the performance measures for all countries and the three following rows average over the four largest countries (France, Germany, Italy and the Netherlands).

The number of portfolios and Country considered	European model		International model		Country model	
	Av. $\lvert\alpha\rvert$	Av. R^2	Av. $\lvert\alpha\rvert$	Av. R^2	Av. $\lvert\alpha\rvert$	Av. R^2
Average, 3	0.349	0.495	0.139	0.871	0.153	0.864
Average, 6	0.398	0.435	0.236	0.765	0.240	0.757
Average, 10	0.467	0.383	0.329	0.670	0.319	0.661
(only big countr.) 3	0.202	0.676	0.100	0.917	0.087	0.913
(only big countr.) 6	0.238	0.617	0.180	0.831	0.173	0.826
(only big countr.) 10	0.324	0.559	0.265	0.755	0.259	0.747
Germany 3	0.056	0.718	0.081	0.909	0.075	0.908
Germany 6	0.167	0.640	0.144	0.832	0.115	0.830
Germany 10	0.261	0.573	0.184	0.739	0.168	0.738
Belgium 3	0.131	0.542	0.042	0.817	0.054	0.807
Belgium 6	0.197	0.449	0.097	0.701	0.162	0.691
Belgium 10	0.243	0.383	0.158	0.597	0.212	0.585
Spain 3	0.144	0.582	0.156	0.905	0.140	0.904
Spain 6	0.241	0.527	0.195	0.840	0.188	0.839
Spain 10	0.281	0.479	0.356	0.770	0.320	0.769
Finland 3	0.947	0.409	0.192	0.850	0.164	0.826
Finland 6	0.720	0.364	0.387	0.747	0.187	0.711
Finland 10	0.699	0.303	0.446	0.649	0.308	0.619
France 3	0.189	0.734	0.026	0.900	0.034	0.892
France 6	0.330	0.676	0.245	0.804	0.278	0.793
France 10	0.437	0.598	0.449	0.712	0.502	0.696
Greece 3	0.649	0.167	0.257	0.896	0.330	0.895
Greece 6	0.742	0.148	0.328	0.794	0.346	0.795
Greece 10	0.802	0.138	0.386	0.698	0.431	0.696
Ireland 3	0.274	0.344	0.093	0.813	0.239	0.792
Ireland 6	0.429	0.261	0.244	0.630	0.421	0.606
Ireland 10	0.663	0.185	0.469	0.466	0.587	0.454
Italy 3	0.430	0.545	0.182	0.958	0.145	0.958
Italy 6	0.356	0.539	0.210	0.914	0.204	0.913
Italy 10	0.410	0.512	0.238	0.872	0.179	0.871
Netherlands 3	0.131	0.708	0.112	0.901	0.093	0.894
Netherlands 6	0.097	0.611	0.123	0.775	0.094	0.769
Netherlands 10	0.186	0.555	0.191	0.695	0.188	0.682
Austria 3	0.573	0.306	0.096	0.846	0.127	0.844
Austria 6	0.666	0.259	0.216	0.724	0.254	0.725
Austria 10	0.581	0.213	0.246	0.587	0.249	0.585
Portugal 3	0.309	0.386	0.291	0.783	0.281	0.781
Portugal 6	0.436	0.307	0.402	0.657	0.389	0.658
Portugal 10	0.574	0.276	0.491	0.590	0.370	0.579

Table 6. Regression results
Industry vs. euro area model, book-to-market sorted portfolios, full sample

This table presents the two performance measures resulting from regressing the book-to-market sorted portfolios of the industries considered using the full sample on three different asset pricing models: the euro area 3FM, the international (industry) 3FM and the industry 3FM (see equation 2, 6 and 7 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column containes the average Adjusted R2. The top rows depict the averages of the performance measures for all industries and the three following rows average over the six largest industries. (Basic Industries, General Industries, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services and Financials).

The number of portfolios and Industry considered	European model		International model		Industry model	
	Av. $\lvert\alpha\rvert$	Av. R^2	Av. $\lvert\alpha\rvert$	Av. R^2	Av. $\lvert\alpha\rvert$	Av. R^2
Average, 3	0.380	0.576	0.237	0.843	0.225	0.833
Average, 6	0.421	0.490	0.295	0.688	0.275	0.674
Average, 10	0.445	0.422	0.317	0.581	0.311	0.568
(only big industr.) 3	0.287	0.652	0.203	0.865	0.201	0.852
(only big industr.) 6	0.320	0.569	0.254	0.732	0.251	0.717
(only big industr.) 10	0.346	0.506	0.287	0.640	0.275	0.626
Resor 3	0.465	0.338	0.236	0.691	0.254	0.680
Resor 6	0.443	0.275	0.327	0.487	0.289	0.475
Resor 10	0.497	0.222	0.339	0.390	0.348	0.375
Basic 3	0.189	0.628	0.229	0.853	0.214	0.835
Basic 6	0.193	0.576	0.212	0.699	0.278	0.676
Basic 10	0.221	0.511	0.202	0.609	0.255	0.582
Genin 3	0.361	0.741	0.375	0.862	0.421	0.851
Genin 6	0.612	0.632	0.446	0.733	0.383	0.719
Genin 10	0.553	0.576	0.381	0.665	0.325	0.651
Cycgd 3	0.252	0.618	0.166	0.859	0.155	0.852
Cycgd 6	0.123	0.518	0.220	0.704	0.281	0.698
Cycgd 10	0.300	0.460	0.352	0.608	0.387	0.600
Ncycg 3	0.459	0.498	0.095	0.833	0.093	0.814
Ncycg 6	0.448	0.422	0.128	0.674	0.123	0.657
Ncycg 10	0.459	0.347	0.258	0.557	0.256	0.548
Cyser 3	0.208	0.667	0.088	0.846	0.099	0.828
Cyser 6	0.285	0.554	0.241	0.704	0.199	0.678
Cyser 10	0.329	0.489	0.281	0.595	0.214	0.576
Ncysr 3	0.487	0.536	0.233	0.867	0.295	0.857
Ncysr 6	0.434	0.456	0.214	0.722	0.274	0.701
Ncysr 10	0.466	0.358	0.283	0.585	0.333	0.571
Utils 3	0.114	0.424	0.063	0.866	0.060	0.868
Utils 6	0.194	0.312	0.179	0.644	0.132	0.639
Utils 10	0.361	0.236	0.260	0.481	0.244	0.471
Totlf 3	0.253	0.760	0.264	0.934	0.222	0.934
Totlf 6	0.262	0.713	0.278	0.878	0.244	0.877
Totlf 10	0.214	0.654	0.246	0.806	0.214	0.801
Itech 3	1.009	0.550	0.616	0.814	0.440	0.809
Itech 6	1.216	0.445	0.708	0.631	0.552	0.624
Itech 10	1.050	0.364	0.566	0.519	0.531	0.509

Table 7. Regression results
Industry vs. euro area model, size-sorted portfolios, full sample

This table presents the two performance measures resulting from regressing the size-sorted portfolios of the industries considered using the full sample on three different asset pricing models: the euro area 3FM, the international (industry) 3FM and the industry 3FM (see equation 2, 6 and 7 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column containes the average Adjusted R2. The top rows depict the averages of the performance measures for all industries and the three following rows average over the six largest industries. (Basic Industries, General Industries, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services and Financials).

The number of portfolios and Industry considered	European model		International model		Industry model	
	Av. |α|	Av. R^2	Av. |α|	Av. R^2	Av. |α|	Av. R^2
Average, 3	0.359	0.624	0.182	0.838	0.173	0.822
Average, 6	0.376	0.540	0.224	0.720	0.218	0.700
Average, 10	0.465	0.464	0.337	0.612	0.320	0.593
(only big industr.) 3	0.259	0.704	0.126	0.877	0.113	0.858
(only big industr.) 6	0.306	0.630	0.187	0.775	0.173	0.752
(only big industr.) 10	0.349	0.556	0.239	0.673	0.222	0.650
Resor 3	0.273	0.445	0.114	0.710	0.098	0.686
Resor 6	0.233	0.336	0.159	0.542	0.129	0.517
Resor 10	0.493	0.253	0.359	0.433	0.373	0.422
Basic 3	0.190	0.717	0.135	0.880	0.123	0.861
Basic 6	0.321	0.658	0.241	0.783	0.189	0.757
Basic 10	0.354	0.583	0.316	0.683	0.244	0.654
Genin 3	0.344	0.788	0.189	0.894	0.081	0.842
Genin 6	0.537	0.652	0.350	0.778	0.214	0.726
Genin 10	0.654	0.600	0.363	0.701	0.322	0.650
Cycgd 3	0.209	0.698	0.108	0.873	0.113	0.863
Cycgd 6	0.159	0.603	0.103	0.750	0.169	0.738
Cycgd 10	0.207	0.520	0.173	0.644	0.187	0.633
Ncycg 3	0.253	0.587	0.093	0.831	0.101	0.814
Ncycg 6	0.228	0.514	0.162	0.703	0.186	0.685
Ncycg 10	0.210	0.444	0.157	0.597	0.159	0.582
Cyser 3	0.371	0.679	0.111	0.869	0.115	0.859
Cyser 6	0.335	0.635	0.115	0.775	0.132	0.753
Cyser 10	0.349	0.560	0.179	0.663	0.184	0.634
Ncysr 3	0.423	0.565	0.369	0.806	0.399	0.795
Ncysr 6	0.475	0.457	0.420	0.669	0.480	0.657
Ncysr 10	0.593	0.373	0.611	0.554	0.599	0.540
Utils 3	0.351	0.411	0.131	0.784	0.161	0.782
Utils 6	0.403	0.330	0.184	0.642	0.176	0.638
Utils 10	0.397	0.261	0.212	0.510	0.266	0.505
Totlf 3	0.187	0.752	0.121	0.915	0.142	0.911
Totlf 6	0.255	0.718	0.149	0.859	0.151	0.850
Totlf 10	0.321	0.630	0.244	0.753	0.239	0.747
Itech 3	0.985	0.599	0.451	0.822	0.396	0.813
Itech 6	0.816	0.502	0.361	0.696	0.359	0.680
Itech 10	1.075	0.419	0.760	0.579	0.632	0.566

Table 8. Regression results
Country vs. euro area model, results for the sub samples

This table presents the two performance measures resulting from regressing the book-to-market sorted and size-sorted portfolios of the industries considered for two different sub samples on three different asset pricing models: the euro area 3FM, the international (industry) 3FM and the industry 3FM (see equation 2, 6 and 7 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column contains the average adjusted R^2. The first three rows of each panel depict the averages of the performance measures for all countries and the three following rows average over the four largest countries (France, Germany, Italy and the Netherlands). Panel A and B present the figures for both sub samples for the book-to-market sorted portfolios. Panel C and D present the same statistics for the size-sorted portfolios.

The number of portfolios and industries considered	European model		International model		Industry model	
	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2
PANEL A: FIRST SUBSAMPLE 1991:07 – 1997:01, BOOK-TO-MARKET SORTED PORTFOLIOS						
Average, 3	0.439	0.458	0.181	0.894	0.175	0.889
Average, 6	0.501	0.409	0.303	0.783	0.292	0.776
Average, 10	0.590	0.353	0.417	0.667	0.399	0.656
(only big countr.) 3	0.364	0.599	0.173	0.920	0.140	0.914
(only big countr.) 6	0.359	0.549	0.238	0.839	0.204	0.832
(only big countr.) 10	0.388	0.495	0.284	0.757	0.244	0.743
PANEL B: SECOND SUBSAMPLE 1997:02 – 2002:08, BOOK-TO-MARKET SORTED PORTFOLIOS						
Average, 3	0.653	0.515	0.348	0.851	0.332	0.847
Average, 6	0.613	0.454	0.423	0.725	0.411	0.717
Average, 10	0.675	0.401	0.538	0.627	0.499	0.616
(only big countr.) 3	0.438	0.705	0.298	0.878	0.324	0.871
(only big countr.) 6	0.464	0.636	0.465	0.769	0.422	0.760
(only big countr.) 10	0.469	0.580	0.467	0.695	0.439	0.685
PANEL C: FIRST SUBSAMPLE 1991:07 – 1997:01, SIZE-SORTED PORTFOLIOS						
Average, 3	0.492	0.482	0.175	0.891	0.178	0.886
Average, 6	0.539	0.424	0.273	0.797	0.272	0.791
Average, 10	0.571	0.366	0.357	0.691	0.352	0.688
(only big countr.) 3	0.350	0.621	0.107	0.928	0.094	0.924
(only big countr.) 6	0.374	0.567	0.165	0.849	0.131	0.846
(only big countr.) 10	0.388	0.514	0.229	0.776	0.224	0.772
PANEL D: SECOND SUBSAMPLE 1997:02 – 2002:08, SIZE-SORTED PORTFOLIOS						
Average, 3	0.520	0.529	0.238	0.864	0.197	0.854
Average, 6	0.547	0.467	0.316	0.759	0.313	0.748
Average, 10	0.714	0.421	0.495	0.669	0.450	0.655
(only big countr.) 3	0.248	0.732	0.212	0.920	0.177	0.915
(only big countr.) 6	0.360	0.674	0.321	0.837	0.312	0.829
(only big countr.) 10	0.496	0.620	0.483	0.766	0.460	0.753

Table 9. Regression results
Industry vs. euro area model, results for the sub samples

This table presents the two performance measures resulting from regressing the book-to-market sorted and size-sorted portfolios of the industries considered for two different sub samples on three different asset pricing models: the euro area 3FM, the international (industry) 3FM and the industry 3FM (see equation 2, 6 and 7 respectively). For each model the mean absolute pricing error is stated in the first column of the model and the second column contains the average adjusted R^2. The first three rows of each panel depict the averages of the performance measures for all industries and the three following rows average over the six largest industries. (Basic Industries, General Industries, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services and Financials). Panel A and B present the figures for both sub samples for the book-to-market sorted portfolios. Panel C and D present the same statistics for the size-sorted portfolios.

The number of portfolios and industries considered	European model		International model		Industry model	
	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2	Av. $\|\alpha\|$	Av. R^2
PANEL A: FIRST SUBSAMPLE 1991:07 – 1997:01, BOOK-TO-MARKET SORTED PORTFOLIOS						
Average, 3	0.433	0.634	0.262	0.837	0.234	0.820
Average, 6	0.493	0.528	0.337	0.680	0.292	0.665
Average, 10	0.556	0.444	0.447	0.571	0.415	0.555
(only big industr.) 3	0.323	0.717	0.197	0.889	0.148	0.882
(only big industr.) 6	0.397	0.619	0.259	0.754	0.209	0.743
(only big industr.) 10	0.445	0.545	0.356	0.658	0.309	0.646
PANEL B: SECOND SUBSAMPLE 1997:02 – 2002:08, BOOK-TO-MARKET SORTED PORTFOLIOS						
Average, 3	0.407	0.560	0.312	0.850	0.344	0.844
Average, 6	0.578	0.482	0.483	0.696	0.483	0.686
Average, 10	0.530	0.420	0.434	0.600	0.457	0.591
(only big industr.) 3	0.341	0.633	0.263	0.868	0.313	0.857
(only big industr.) 6	0.472	0.557	0.409	0.741	0.422	0.729
(only big industr.) 10	0.443	0.502	0.386	0.655	0.422	0.643
PANEL C: FIRST SUBSAMPLE 1991:07 – 1997:01, SIZE-SORTED PORTFOLIOS						
Average, 3	0.374	0.669	0.264	0.843	0.243	0.825
Average, 6	0.413	0.577	0.335	0.726	0.314	0.706
Average, 10	0.561	0.485	0.530	0.604	0.486	0.582
(only big industr.) 3	0.267	0.762	0.192	0.888	0.170	0.878
(only big industr.) 6	0.324	0.672	0.237	0.786	0.229	0.774
(only big industr.) 10	0.393	0.588	0.330	0.679	0.299	0.662
PANEL D: SECOND SUBSAMPLE 1997:02 – 2002:08, SIZE-SORTED PORTFOLIOS						
Average, 3	0.409	0.613	0.155	0.840	0.209	0.826
Average, 6	0.499	0.536	0.279	0.725	0.335	0.707
Average, 10	0.556	0.467	0.395	0.630	0.430	0.617
(only big industr.) 3	0.328	0.687	0.108	0.883	0.166	0.867
(only big industr.) 6	0.445	0.626	0.252	0.784	0.293	0.763
(only big industr.) 10	0.487	0.556	0.333	0.691	0.357	0.673

Figure 1
The values for κ averaged over all countries or industries

This figure shows the values for κ (as defined in equation 8) for all tested portfolios. κ is the ratio of average absolute alpha of the country or the industry 3FM over the corresponding value of the euro area 3FM.

$$\kappa_{i,EUR} = \frac{\frac{1}{n}\sum_{p} |\alpha_{p,i}|}{\frac{1}{n}\sum_{p} |\alpha_{p,EUR}|}$$

The first two couples of bars indicate the $\kappa_{country,EUR}$ for the book-to-market sorted portfolios and the size-sorted portfolios. The third and fourth pair depict $\kappa_{industry,EUR}$ for these portfolios. The left bar of each pair represents the κ-indicator in the first sub sample and the right bar for the second sub sample. We used the pricing errors of 10-sorts in each case, but using a 3-sort or 6-sort gives similar conclusions. The ratios can easily be calculated using the numbers from the tables 8 and 9 for the countries and industries respectively. For example, the most left bar uses the performance measures from Table 8, panel A, of the ten book-to-market portfolios (3rd row containing numbers): $\kappa = 0.399/0.590 = 0.68$.

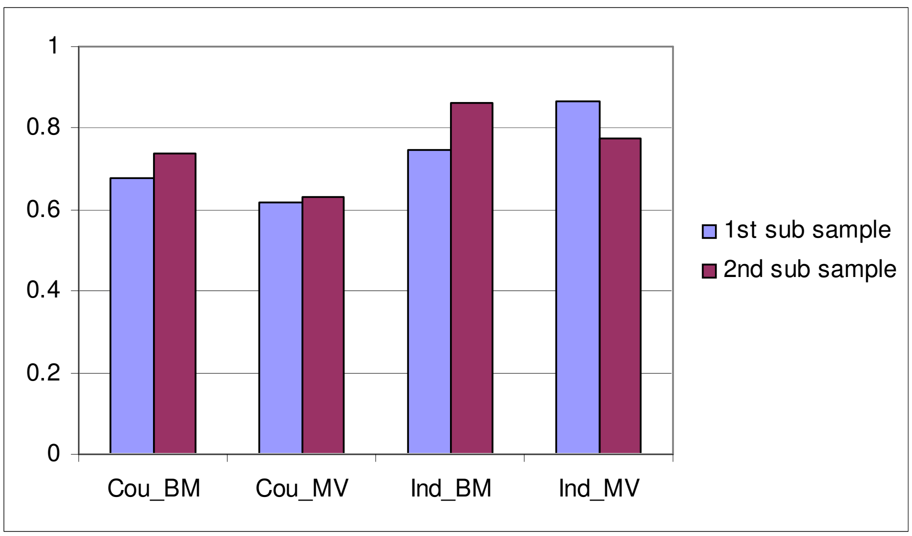


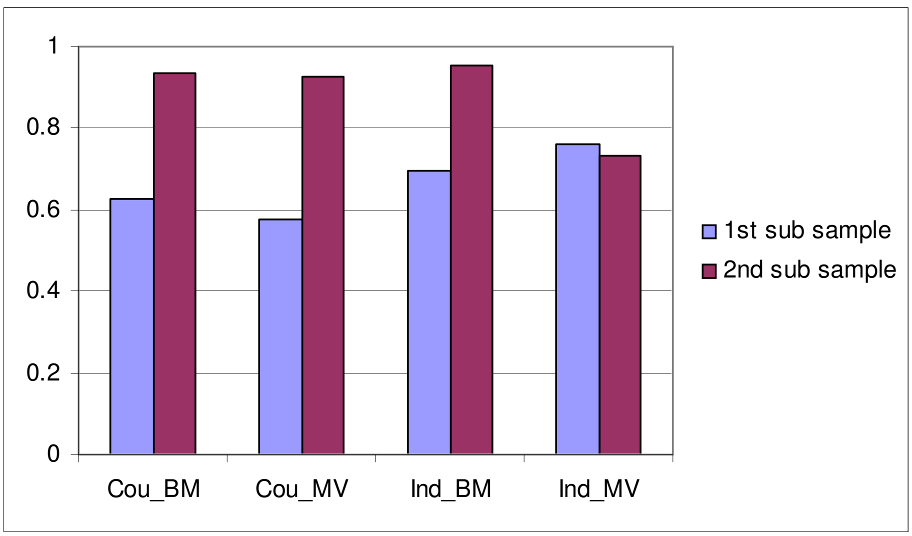
Figure 2

The values for κ averaged over all bigger countries (4) or industries (6)

This figure shows the values for κ (as defined in equation 8) for all tested portfolios. κ is the ratio of average absolute alpha of the country or the industry 3FM over the corresponding value of the euro area 3FM.

$$\kappa_{i,EUR} = \frac{\frac{1}{n}\sum_p |\alpha_{p,i}|}{\frac{1}{n}\sum_p |\alpha_{p,EUR}|}$$

The first two couples of bars indicate the $\kappa_{country,EUR}$ for the book-to-market sorted portfolios and the size-sorted portfolios based on the bigger countries only (France, Germany, Italy and the Netherlands). The third and fourth pair depict $\kappa_{industry,EUR}$ for these portfolios base on the bigger industries (Basic Industries, General Industries, Cyclical Consumer Goods, Non-Cyclical Consumer Goods, Cyclical Services and Financials). The left bar of each pair represents the κ-indicator in the first sub sample and the right bar for the second sub sample. We used the pricing errors of 10-sorts in each case, but using a 3-sort or 6-sort gives similar conclusions. The ratios can easily be calculated using the numbers from the tables 8 and 9 for the countries and industries respectively using the values based on the bigger groups only. For example, the most left bar uses the performance measures from Table 8, panel A, of the ten book-to-market portfolios based on the biggest countries (6th row containing numbers): κ = *0.244/0.388 = 0.63.*



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