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An alternative three-factor model for international markets: Evidence from the European Monetary Union

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ABSTRACT

In this paper, we construct the three-factor model introduced by Chen et al. (2010) for a European sample covering 10 countries from the European Monetary Union and the period from 1990 to 2006. Two key findings result. First, we show that the properties of the European factors are comparable to those of the US factors. Second, we show that the alternative three-factor model's explanatory power is either equal or superior to the explanatory power of traditional models when applied to five commonly known stock market anomalies. Our results thus suggest the use of international versions of the Chen et al. (2010) factor model in addition to traditional factor models in international empirical finance research.

1. Introduction

Over the last decades, various stock market anomalies such as the asset growth effect (see e.g., Cooper et al., 2008), the short-term prior return effect (see e.g., Jegadeesh and Titman, 1993), or the net stock issues effect (see e.g., Pontiff and Woodgate, 2008) have been discovered and empirically analyzed. These persistent return patterns are called anomalies because they cannot be explained by traditional factor models such as the Fama and French (1993, 1996, FF) three-factor model.

Chen et al. (2010, CNZ) suggest an alternative three-factor model, consisting of a market factor, an investment factor, and a return on asset (RoA) factor. The motivation behind this alternative three-factor model comes from investment-based asset pricing. In such an investment-based model, firms make optimal investment decisions given discount rates and expected future profitability. The actual investment of a company thus reveals information about the discount rate. All else being equal, a higher discount rate leads to lower net present values and thus lower investment, a lower discount rate leads to higher net present values and higher investment. Investment predicts returns because high costs of capital imply low net present values of new capital and low investment. Low costs of capital, on the other hand, imply high net present values of new capital and thus high investment. Performing a sort on investment is thus equivalent to sorting on the discount factor. This is the intuition behind CNZ's investment factor. As for the RoA factor, firms with higher expected RoA should have higher discount rates. These high discount rates are needed to offset the high RoA and generate low net present values of new capital and consequently low investment. If the discount rates are not high enough, these firms would experience high net present values of new capital and invest more. For the US stock market sample used in CNZ, this alternative three-factor model outperforms the traditional FF model and is able to better explain a number of previously documented anomalies.

Given this evidence for the US market, the natural question that arises is whether the alternative three-factor model has more explanatory power than the traditional factor models in international markets as well. An evaluation of the international potential of the three-factor model proposed by CNZ is especially relevant given the growing number of empirical research that uses local versions of traditional factor models, for instance Ang et al. (2009) or Bekaert et al. (2009). If the alternative three-factor model is able to perform well internationally, this would call for its applicability not only in future US studies but also in studies covering international stock markets. In this paper, we contribute to the literature on empirical factor models by constructing and evaluating the performance of the three-factor model proposed by CNZ in a pan-European sample covering the period from 1990 to 2006. The sample includes the main countries of the European Monetary Union (EMU), namely Austria, Belgium, Finland, France, Germany, Italy, Ireland, Netherlands, Portugal, and Spain. The choice of this

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pan-European sample is based on its economic relevance, its high development stage, the large number of available sample companies even in earlier years, and especially the mitigation of potential currency effects.

In a first step, we construct the investment factor and the RoA factor for our European sample. The return of the investment factor, r_{INV}, is calculated as the difference between the performance of a portfolio that is long in low investment growth stocks and short in high investment growth stocks. The return of the RoA factor, r_{RoA}, is calculated as the difference between the performance of a portfolio that is long in high RoA stocks and short in low RoA stocks. Following CNZ, the formula for the alternative three-factor model is then

$$E[r] - r_f = \beta_{MKT} E[r_{MKT}] + \beta_{INV}[r_{INV}] + \beta_{RoA}[r_{RoA}] \quad (1)$$

where $E[r_{MKT}]$, $E[r_{INV}]$, and $E[r_{RoA}]$ are expected premia and β_{MKT}, β_{INV}, and β_{RoA} are the factor loadings. We document that the investment factor has a time-series average of 0.44% per month, and the RoA factor has a time-series average of 0.84% per month. These properties are comparable to those reported by CNZ for the US, where the investment factor has a time-series average of 0.28% per month, and the RoA factor has a time-series average of 0.76% per month.

In a second step, we test the performance of the alternative three-factor model. To do so, we compare the ability of the model to explain five anomalies (the asset growth effect, the short-term prior return effect, the net stock issues effect, the total accruals effect, and the value effect) with the corresponding performance of the FF model and the CAPM one-factor model. Our results indicate that, depending on the anomaly investigated, the alternative three-factor model either performs similarly well or better than traditional models. When using our version of the CNZ model and comparing it to a single-factor CAPM or the FF model, the alphas generated by the asset growth effect, the short-term prior returns effect, and the total accruals effect are substantially reduced in size and significance. For the net stock issues effect and the value effect, the performance of the alternative three-factor model is comparable to the performance of the traditional FF model. Overall, our evidence indicates that the ability of the alternative three-factor model to potentially better explain stock market anomalies can also be observed in an international sample. Our results thus suggest that future empirical finance research using international samples could consider international versions of the CNZ three-factor model in addition to the CAPM and the traditional FF model.

The paper proceeds as follows. In Section 2, we describe the data used in our paper and detail the way in which we construct the CNZ three-factor model as well as the FF benchmark model for our sample. In Section 3, we compare the performance of the alternative factor model to the performance of the FF model and the CAPM. Section 4 concludes.

2. Data and factor construction

In this section, we first describe the data used in this paper. We then describe how we construct the international version of the CNZ factors and the FF benchmark model for our sample.

2.1. Data

We perform our analyses on an integrated European sample, which consists of the largest countries in the European Monetary Union (EMU), namely Austria, Belgium, Finland, France, Germany, Italy, Ireland, Netherlands, Portugal, and Spain.[1] We choose this integrated European sample because of its important economic relevance, the high development stage of those markets, the large number of available sample companies even in earlier years, and especially the mitigation of potential currency effects. To be able to meaningfully construct the factor models, a sufficiently large number of observations is imperative.[2] For the construction of the factors, we use data from two data providers: Thompson Datastream for monthly observations of market values (MV), book-to-market ratios (BM) and stock returns and Thomson Worldscope for end-of-year accounting data. Table 1 provides an overview of the countries included in our sample and the resulting number of observations per year. Due to lack of data availability in earlier years, we start our sample in 1990 only, even though Worldscope provides data for some countries beginning in 1987 or even earlier. We use all companies for which data is available on Datastream and Worldscope and exclude financial firms because of their special balance sheet composition by excluding companies with a four digit SIC-code starting with a six.

Table 2 presents descriptive statistics for the main variables of interest in our sample. We calculate the means and medians as time-series averages of the respective yearly cross-sectional values. The large difference between means and medians is responsible for the left-tailed yearly cross-sectional dispersion of total assets and MV among companies in our sample. Although these differences might be surprising at first sight, comparable samples for the US market show similar characteristics (see e.g., Cooper et al., 2008). To mitigate concerns about results being driven by outliers, we repeat all empirical analyses in the following sections after trimming our sample at the 1% and 5% level. The results remain virtually the same, therefore we do not report these results.

2.2. Benchmark FF model

We construct the benchmark FF model for our European sample by following the methodology for local FF risk factors applied by Ang et al. (2009). The market factor r_{MKT} of the European sample is defined as the value-weighted excess return of the specific European market portfolio over the risk-free interest rate. To construct *SMB* and *HML*, we calculate returns of zero-cost portfolios. For *SMB*, we go long in the bottom tercile of the sample companies and short in the top tercile of the largest companies after we sort companies by their market value. For *HML*, we go long in the top BM tercile and short in the bottom BM tercile. All portfolios are formed on the first day of each month and are held for 1 month before rebalancing. To calculate abnormal returns (alphas), we use

$$r - r_f = \alpha_{FF} + \beta_{MKT} r_{MKT} + \beta_{SMB} r_{SMB} + \beta_{HML} r_{HML} + \varepsilon \quad (2)$$

where r is the portfolio return of the European sample, r_f the risk-free interest rate, α_{FF} the risk-adjusted return, r_{MKT}, r_{SMB}, and r_{HML} are the respective factor returns, and β_{MKT}, β_{SMB}, and β_{HML} are the respective factor loadings.

2.3. The investment factor

Investment growth (*INVESTG*) is defined as the absolute change in PPE (Property, Plant, and Equipment) and Inventory from fiscal year ending in $t-2$ to fiscal year ending in $t-1$ divided by total assets of year $t-2$:

$$INVESTG_t = \frac{(PPE_{t-1} + Inventory_{t-1}) - (PPE_{t-2} + Inventory_{t-2})}{Total\ Assets_{t-2}} \quad (3)$$

[1] Officially, Cyprus, Greece, Luxembourg, Malta, Monaco, San Marino, Slovakia, Slovenia, and the Vatican are also members of the EMU but not considered in our paper due to lack of data.

[2] One potential concern resulting from pooling the data across countries might be that our results could be driven by certain countries. To determine if our results are mainly driven by certain countries, we repeat all analyses in the paper for different sub-samples, excluding one country at a time. The results we obtain from these analyses are in line with the full sample results reported throughout the paper, indicating that our results do not seem to be driven by single countries.