SIZE AND VALUE EFFECTS IN THE VISEGRAD COUNTRIES

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September 2009

Abstract

The paper has two main objectives. The first is to test for the presence of the size and book-to-market value effects in the Visegrad countries. Such effects have been found in the United States and many other developed stock markets. The Visegrad countries consist of the Czech Republic, Hungary, Poland, and Slovakia. We demonstrate that size and value do in fact explain the expected return/cost of capital in Eastern Europe. Based on this result, we proceed by constructing regional size and book-to-market portfolios for a combined Visegrad market. Returns on these port-folios serve as factors in addition to the market portfolio. The regional three-factor model performs as well as country-specific versions of the model. However, it can be estimated for a more current sample in Prague, Warsaw, Budapest, and Bratislava. Therefore it is a plausible model for the cost of capital in this region and we use it to calculate the cost of capital for the following industries: banks; capital goods; food, beverage and tobacco; materials; and utilities.

Abstrakt

Článek má dva cíle. Prvním je test přítomnosti efektů velikosti firem a poměru účetní a tržní hodnoty jejich akcií v zemích Vyšehradské čtyřky, tj. České Republiky, Maďarska, Polska a Slovenska. Tyto efekty jsou zdokumentovány pro Spojené Státy a mnoho jiných rozvinutých zemí. Ukazujeme, že oba zmíněné efekty skutečně vysvětlují očekávaný výnos kapitálu ve východní Evropě. Na základě tohoto výsledku jsme vytvořili regionální portfolia dle velikosti firem a dle velikosti poměru účetní a tržní hodnoty. Výnosy z těchto portfolií slouží jako determinanty výnosu spolu s tržním portfoliem. Tento regionální tří faktorový model je stejně úspěšný jako verze tohoto modelu pro danou zemi. Výhodou regionálního modelu je, že jeho parametry lze odhadnout pro poslední dostupná data v Praze, Varšavě, Budapešti a Bratislavě. Proto je to adekvátní model pro kapitálové výnosy v tomto regionu a my jej používáme k výpočtu těchto výnosů pro následující odvětví: bankovnictví; investiční zboží; potraviny, nápoje a tabákové výrobky; suroviny a komunální služby.

KEY WORDS: CAPM; Fama and French factors; Regional Asset Pricing Model; size; book-to-market; Visegrad countries; emerging markets.
JEL CLASSIFICATION: G10, G11, G12.

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1 Introduction

The Capital Asset Pricing Model (CAPM) is a standard model to calculate the cost of capital. The CAPM is very intuitive, describes the trade-off between risk and variance, and is a theoretically well-founded equilibrium model. Practical implementation was very straightforward when the world stock market was essentially equivalent to the US stock market. In this case, one would use some measure of the US value-weighted market return such as the S&P 500 to calculate the risk premium, which is needed to compute the cost of capital. The situation changed in the 1970s, in part due to floating exchange rates and lifted barriers to the movement of capital across borders. This change altered the usage of the CAPM. Shultz (1995a, b) argues that instead of a local country-specific CAPM, one needs to use a global international version of the CAPM with a proxy for the global portfolio such as the Morgan Stanley Capital International Index.

Even the country-specific implementation of the CAPM can be problematic. According to the CAPM the only thing that matters to investors is market risk. However, numerous authors have found that other, non-market factors matter for stock returns. Fama and French (1992) argue that a firm's size and book-to-market equity help explain the cross-section of average returns in the US market.[1] Building on this finding, Fama and French (1993, 1996) construct two factors: SMB (a return on a portfolio of small stocks minus the return of a portfolio of big stocks) and HML (a return on a portfolio of high value

[1] The CAPM has been extensively empirically tested since the beginning of its existence. Early on, during the 1960s and 1970s, the CAPM seemed to capture well both the cross-section and time-series properties of asset returns. One of the first deviations from this conclusion was the size effect identified in Banz (1981). The nature of the size effect lies in the observation that the returns on stocks of relatively small firms tend to do better then predicted by the CAPM. In other words, the market beta is not sufficient to capture the cross-section of asset returns. Similar observations were made using other firm-specific characteristics. Bhandari (1988) finds that there is a positive relation between average returns and leverage, even after controlling for size measured by the market equity (ME). Rosenberg, Reid, and Lanstein (1985) show that the ratio of a firm's book value of equity (BE) to size is also positively related to average returns. Controlling for size and the market beta, Basu (1983) documents that the earnings-price ratio (E/P) adds to the explanatory power of the cross-section of returns. All such evidence is brought together in Fama and French (1992). In a univariate setting, they confirm a strong relationship between the average returns and the market beta, ME, leverage, E/P, and BE/ME. In multivariate regressions, it is ME and BE/ME, whose relation with average returns persists.

stocks minus the return of a portfolio of low value stocks). These factors related to size and the book-to-market ratio when used in a three-factor model together with the market return are able to explain a large part of the variance of average stock returns.

The apparent empirical success of the so-called "Fama and French factors" (FF factors) have started an on-going debate in the literature on the economic meaning of these factors. Several theories regarding the FF factors have emerged. Fama and French (1996) argue that firm size and book-to-market, which underline the SMB and HML factors, proxy for firm distress. Daniel and Titman (1997) point out that the FF factors pick up the co-movements of stocks with similar characteristics. They argue that firm characeristics such as size and book-to market explain stock returns better than the FF factors constructed using these characteristics. Rolph (2003) and Ferguson and Shockley (2003) attribute the significance of FF factors to the leverage effects they explain. On the other hand, Chung, Johnson, Herb and Schill (2004) argue that FF factors proxy for higher order co-moments and become insignificant when these co-moments are included in the model. The significance of these higher order co-moments an be explained by the risk-aversion of the investors, who take into account extreme outcomes.

There is also a strain of literature that argues that FF factors may be mistakenly taken as useful risk factors, while in fact they have no power in explaining any of the fundamental risk. Lakonishok, Shleifer, and Vishny (1994) argue that the empirical significance of the FF factors is due to sub-optimal behaviour of the investors rather than fundamental risk. Others point to the fact that explanatory power of the FF factors may be simply due to the construction of these factors. Berk (1995) argues that high book-to-market and small companies by construction will earn higher mean returns. In a similar mode, Ferson, Sarkissian, and Simin (1999) demonstrate that if stocks are sorted by some attributes that are empirically related to stock returns, such portfolios will likely appear as useful risk factors even if these attributes have nothing to do with fundamental risk. Therefore, they caution against using empirical regularities as "self-explanatory risk factors".

Some argue that a real test for the empirical importance of FF factors is to use them in an international context and to verify whether they still appear to have explanatory power. Fama and French (1998) have themselves attempted to extend their three-factor model to a global context. They find that value stocks (stocks with high ratios of book-to-market equity, earnings to price or cash flows to price) have higher returns than growth stocks (stocks with low ratios of book-to-market equity, earnings to price or cash flows to price) in twelve out of the thirteen developed markets they study. They also perform some out-of-sample tests for emerging markets and confirm that the value premium is also present in these markets. The international CAPM (ICAPM) is not able to explain this value premium in international markets but a two-factor model with global market return and a risk factor for relative distress can account for this phenomenon. Fama and French argue that this two-factor model provides a parsimonious way of summarizing the general patterns in international returns and is not meant to challenge the existing asset-pricing theory.

Vassalou and Liew (2000) use data from 10 developed markets and find that FF factors predict future GDP growth even when business cycle variables are included in the analysis. Thus, their evidence supports a risk-based hypothesis for the performance of FF factors. Daniel, Titman and Wei (2001) argue that its the firm characteristics not the factor loadings that explain stock returns in Japan. Griffin (2002) poses an interesting question of whether FF factors are global or country-specific and he argues for the latter. Specifically, he finds that country-specific versions of the Fama and French three-factor model can explain the variation in stocks returns (both portfolios and individual stocks) better than a world three-factor model. Therefore, he argues that cost of capital calculations, performance measurement, and risk analysis using models stylized on Fama-French three-factor models should be performed on a within-country basis.

The present study analyzes financial markets emerging in Eastern and Central Europe. Specifically, the focus is on the Visegrad countries, i.e. the Czech Republic, Hungary, Poland, and Slovakia. Our objectives in this case are a confirmation of stylized facts for stock returns on the four markets and a formulation of a plausible model of the cost of capital. We start with size and value effects. Similarly to Fama and French (1993) for the US market and Connor and Sehgal (2001) for the Indian market, we first construct regional size- and value-sorted portfolios. The stock markets in Prague, Warsaw, Bratislava and Budapest are fairly small in size, which in all countries expect for Poland severely reduces sample size. Therefore, we adopt a different approach and first combine all the markets in one to increase the overall market value, as well as the number of traded stocks. Only then we rank the stocks according to capitalization and book-to-market ratios using data pooled from all four Visegrad countries. This approach is likely to work for a fairly homogeneous market and also in the situations when a local market is too small to calculate the relevant factor returns without a large measurement error. The stock markets emerging in the Czech Republic, Hungary, Poland, and Slovakia are good candidates for this type of analysis. Moreover, these markets have not yet been studied from this perspective. Our investigation of the portfolio properties reveals that the size and value effects are present in our data. Even though the effects (especially the size effect) are smaller than in the case of the US data, the found patterns are qualitatively similar to those reported in Fama and French (1993). Next we conduct the Fama and MacBeth (1973) method for individual stock returns in our sample starting in the early 1990s and demonstrate the existence of size and value effects in the four countries.

In the next step, we construct a regional multi-factor model of expected returns for the Visegrad countries. Fama and French (1998) and Griffin (2002) construct the factors within each country in his sample and then uses their value-weighted averages. We again combine the stocks in all countries first and only then construct the regional market, size, and book-to-market factors. In time series regressions with six size- and value-sorted portfolios as dependent variables, the regional CAPM is easily outperformed by the regional Fama and French three-factor model. This provides additional evidence in favor of the presence of value and size effects in the Visegrad countries. We compare the regional and country-specific factor models, with the local models being estimated using a restricted series due to data limitations. The regional CAPM does a better job at explaining the expected returns than the local version of the model. There is no difference in the performance of the regional and country-specific Fama and French three factor models. However, the regional model coefficients can be estimated for a current sample and hence provides a suitable cost of capital model for the Visegrad countries. We confirm this conclusion by running time series regressions with individual stock returns as dependent variables. The market factor is significant in a majority of the cases though the size and value factors are mainly important when a local risk free rate is used as a reference but not when a risk-free rate of an outside investor is employed (Germany's in our case). Finally, we compute the cost of capital for five major industries for all four countries to illustrate the use of our regional three-factor model and demonstrate that it works well for other than size- and value-related excess returns.

The rest of the paper is organized as follows. Section 2 discusses the relevant pricing models, Section 4 provides details of the implemented econometric methodology, Section 3 describes our data sources, Section 5 comments on our results and Section 6 concludes.

2 Pricing Models

Our primary objective is the calculation of the cost of capital in the Visegrad countries. A natural start in this context is a country-specific Capital Asset Pricing Model (CAPM):

$$E[R_i] = R_F + b_i E[MRF^C], \tag{1}$$

where R_i denotes a (stock) return on an asset i. MRF^C is the market return for a given country (hence the superscript C) in excess of the risk-free rate:

$$MRF^C = R_m^C - R_F, \tag{2}$$

with R_m^C being a return on a local stock market index, and R_F the risk-free rate. b_i is the sensitivity to the country-specific market index (beta). $E[R_i]$ is the cost of capital. Stultz (1995a,b) points out that the single-factor country-specific CAPM is valid only in a fairly closed stock market. The alternative in this case is a global CAPM where the local market index would be replaced by of a global market index as a measure of R_m.

The single-factor CAPM equation (1) is theoretically well founded but not as successful empirically. It has been demonstrated that firm-specific information is needed to achieve more accurate expected stock returns. Fama and French (1992) use all major previously used variables and provide evidence that it is mainly size and book-to-market ratio that are important in explaining the time-series and cross-sectional properties of stock returns. Based on this evidence, Fama and French (1993) construct the following country-specific three-factor model:

$$E[R_i] = R_F + b_i\ E[MRF^C] + s_i\ E[SMB^C] + h_i\ E[HML^C]. \tag{3}$$

SMB^C is a premium on small stocks vs. big stocks (*Small Minus Big*) and HML^C is a premium on the stocks with high book-to-market ratio vs. stocks with low book to market ratios (*High Minus Low*). The superscript C stresses the country-specific nature of the two additional factors.

Fama and French (1998) also propose a global version of their three-factor model (3):

$$E[R_i] = R_F + b_i\ E[MRF^G] + s_i\ E[SMB^G] + h_i\ E[HML^G]. \tag{4}$$

HML^G is again the value premium. Fama and French (1998) assume there is no size related factor in this case ($s_i \equiv 0$) since the size effect has proved to be spurious in the international context while the value effect has been shown to be more robust. A crucial point in the formulation of the global Fama and French model (4) is the calculation of $HML.^G$ They first compute a value-weighted difference in returns of value portfolios with high book-to-market ratios and growth portfolios with low book-to-market ratios within a country. HML^G is then a weighted average across countries where weights are given by the capitalization of each country within a sample of all countries. Griffin (2002) uses the model (4) with $s_i \neq 0$ and in some specifications allows for a different impact of domestic and foreign components of the three factors.

Assuming that there are value and size effects in our four countries (this assumption is confirmed below), we can propose a version of the Fama and French three-factor model. However, both the country-specific specification (3) and the global specification (4) of the model require a calculation of the country-specific factors. This is problematic for the stock markets in the Visegrad countries. Only a small number of stocks is traded on each date, which may induce unnecessary variability in the three risk premia. To circumvent this problem, we consider the following specification:

$$E[R_i] = R_F + b_i\ E[MRF^R] + s_i\ E[SMB^R] + h_i\ E[HML^R]. \tag{5}$$

We willcall (5) the Regional Three Factor Fama and French Model. The novel feature of this model is the calculation of the regional size and value factors SMB^R and HML^R, respectively. We first combine stocks from all the Visegrad countries and form a regional stock market. Only then do we rank them by size and book-to-market ratio and compute the corresponding risk premia. The regional market excess return MRF^R is calculated as a value or equally weighted average of returns on the local market indexes. All returns are in Euros.

3 Data

The stock market variables are from the S&P Emerging Markets Database (EMDB). Individual returns are calculated from indexes for individual stocks. The index is given by (closing price*100)/intitial closing price. The closing price is the price in local currency per share of the stock at the end of the last trading day. The prices are not adjusted to changes in capitalization such as a two-for-one split. To calculate returns and capitalization in Euros, exchange rates from International Financial Statistics are used. The local index

R_m^C is computed in the same fashion as R_i using the major indexes for the Visegrad countries: PX 50 (Prague, Czech Republic), BUX (Budapest, Hungary), WIG (Warsaw, Poland), and SAX (Bratislava, Slovakia). The market capitalization or market equity (ME) is calculated for each stock as the number of shares outstanding*1000000*closing price. Then it is converted into Euros. Book equity (also referred to as net worth or book value) is simply the difference between total assets and total liabilities. In markets with high inflation, S&P may make adjustments to net worth for inflation. BE/ME is the book value per share divided by the stock price.

The number of observations is in Figure 1. The total number of observations in all countries reached 100 only in the years 1997-1999. The number of traded items has been under 20 in all countries except for Poland over the whole sample starting in 1993. Sample mean, standard deviation, maximum and minimum values are reported by a country for the variables used in the FMB and time series regressions in Table 1. These statistics are reported for the cross sectional distribution, where the number of firms in a given month varies from 2 to 74 depending on the country. The average capitalization of firms is similar across countries though the book-to-market values differ. The only country with negative mean returns for individual stocks and a market index is the Czech Republic. Volatilities of the market indexes are similar across countries. Volatilities of individual stock returns are higher and again similar across countries with the exception of Slovakia. Table 2 presents the summary statistics for the combined sample. The market return is now the value-weighted regional market return with weights given by capitalization in Euros. For excess returns used later, we need a measure of the risk-free rate. In most cases, we use the rate for German government bonds. Since they are not available for the last four months in our sample (2007:9-2007:12), we employ the LIBOR rate minus the average risk premium of the LIBOR rate over the German government bond rate until 2007:8. For the country-specific versions of the CAPM and the three-factor FF model, it is also appropriate to use local risk-free rates. We get the treasury bill rate for each country from the International Financial Statistics database maintained by the IMF (with the exception of Slovakia for which the data comes from Global Financial Data).

Fama and French (1993) introduce two additional factors in addition to the market excess return, which are motivated by the size and value effects. Similar factors are calculated for the combined stock markets in the Visegrad countries. To construct these factors, all available stocks are divided into two groups based on median market equity (size), Small (S) and Big (B). The stocks are also divided into three groups based on the 30th and 70th percentile of their median book-to-market equity ratios (BE/ME) into High (H), Medium (M), and Low (L) categories. This gives us six groups of stocks which can be used to form six corresponding portfolios. We denote them SH, SM, SL, BH, BM, and BL, respectively. The return on each of these portfolios is an equally-weighted return on stocks in the corresponding groups. The Fama and French (1993) factors are then calculated as

$$SMB_t^R = 1/3\ [R_t^{SH} + R_t^{SM} + R_t^{SL}] - 1/3\ [R_t^{BH} + R_t^{BM} + R_t^{BL}] \tag{6}$$

and

$$HML_t^R = 1/2\ [R_t^{SH} + R_t^{BH}] - 1/2\ [R_t^{SL} + R_t^{BL}], \tag{7}$$

where R_t^{SH} denotes the equally weighted return on a portfolio of stocks, which belong to the small size and high book-to-market categories. The remaining returns are denoted in a similar fashion. The returns are equally weighted, following Connor and Sehgal (2001, who cite suggestions from Lakonishok, Shliefer and Vishny 1994) that these portfolios tend to perform better in explaining the stock returns. This suggestion is also confirmed in Fama and French (1996).

The summary statistics for all these portfolio returns are reported in Table 3. There is a negative relation between size and average returns but only for high value stocks. The relation between size and average returns for low and medium value stocks is positive. There is a positive relation between value and average return irrespective of size. Therefore the size effect seems to be conditional on value, while there is a strong unconditional value effect. The fact that the size effect depends on value makes the SMB^R return negative, contrary to what is observed in the United States (see Fama and French 1993).

This outcome is consistent with studies that find the size effect spurious internationally while the value effect is robust.[2] Chan, Yasushi, and Lakonishok (1991) find the value effect to be pervasive in Japan. The first broader international evidence of the presence of value effect is documented by Capaul, Rowley, and Sharpe (1993). This evidence is then confirmed on a larger group of countries and longer time span of data by Fama and French (1998). They conduct out-of-sample tests for the value premium in international markets and conclude that this premium is present in thirteen major markets, as well as in emerging markets.

Skewness of all returns except on BL is positive (skewness is zero for a normal distribution). Kurtosis is greater than 3 (the value for a normal distribution) in all cases, which indicates that extreme values are more likely - the distribution has 'fat-tails'. This is most extreme for the BH return. HML is negatively correlated with the market return - see Table 4. The correlation between SMB^R with the market and HML^R is negative but small. We have also formed the six portfolios for all the countries individually. The premia can be reasonably calculated for the whole sample (until 2007:12) only for Poland. The sample ends in 2005:6 for the Czech Republic and in Hungary, and in 2004:6 for Slovakia. However, the stock returns from these countries are included when the regional premia are constructed.

Finally, we also construct industry portfolios. A typical number of industries considered in various studies of the US market range from 30 to 48. However, the number of observations in the four markets in our sample is not sufficient for such a fine distinc-

[2]We have also considered the price-to-earnings ratio, which is often used to distinguish between value and growth stocks similarly to the book-to-market ratio. The price-to-earnings ratio is priced and this adds another piece to the international evidence in favor of the value effect. Since our focus is on the universally accepted HML portfolio and there are some potential issues with construction of the price-to-earnings based portfolios, we do not pursue this issue further.

tion and we therefore compute the cost of capital only for five industries in each country. Our five industries are banks, capital goods, food beverage and tobacco, materials, and utilities. We calculate equally weighted returns on stocks for a given industry in a given country if there is at least one observation available.

4 Econometric Methodology

The Fama and MacBeth (1973) method is used to verify if size and book-to-market ratios in fact matter in the stock markets of the Czech Republic, Hungary, Poland, and Slovakia. Consider a cross-sectional regression:

$$R_t = \gamma_t' e + \delta_t \hat{F}_t + \varepsilon_t, \tag{8}$$

where R_t is an $N \times 1$ vector of gross stock returns, e an $N \times 1$ vector of ones, and $\hat{F}_t$ an $K \times 1$ vector of estimated factors. N is given by the number of traded companies on all the four stock markets. γ_t and δ_t are vectors of parameters conformable with e and F_t, respectively. ε_t is an $N \times 1$ vector of error terms. The factors are coefficients from the following time series regression, estimated for a two-year period ending at time t:

$$R_{it} = \phi_i + F_t' \, X_{it} + \epsilon_{it}, \quad i = 1, ..., N, \tag{9}$$

with ϵ_{it} an i.i.d. error term. X_{it} is a $K \times 1$ vector of explanatory variables. $K = 1, 2, 3$ and X includes various combinations of the regional market excess return and firm measures of size (capitalization) and of a book-to-market ratio. Our calculations show that replacing returns in (8) and (9) with excess returns does not change the results. The cross-sectional regression (8) is run at each time $t = 1, ..., T$, so we have sequences of parameter estimates $\{\hat{\gamma}_t, \hat{\delta}_t\}_{t=1}^{T}$. If the time-series average of $\hat{\delta}_i$ is statistically different from zero, the factor F_i is priced. The t-statistic for this test is given by

$$t_{\delta_i} = \frac{\tilde{\hat{\delta}}_i}{\tilde{\sigma}_i}, \tag{10}$$

where

$$\tilde{\delta}_i = \sum_{t=1}^{T} \hat{\delta}_i / T \ \text{ and } \ \tilde{\sigma}_i^2 = \frac{1}{T(T-1)} \sum_{t=1}^{T} (\hat{\delta}_i - \tilde{\delta}_i)^2 \ \ i = 1, ..., K. \tag{11}$$

It is expected that all the three factors are priced.

Estimates of coefficients from the cross-sectional regression (8) are subject to a measurement error because the factors have to be estimated from the time series regression (9). A standard way of mitigating this problem is a joint estimation of equations (8) and (9) by the Generalized Method of Moments (GMM). The moment conditions follow Cochrane (2005). For an asset i and K factors, the conditions can be written as:

$$\left[\begin{array}{ccc} E[R_{it} - \phi_i - F_t' \, X_{it}] & = & 0 \\ E[(R_{it} - \phi_i - F_t' \, X_{it}) X_{it1}] & = & 0 \\ \vdots & & \\ E[(R_{it} - \phi_i - F_t' \, X_{it}) X_{itK}] & = & 0 \\ E[R_{it} - \delta_t \, F_t] & = & 0 \end{array} \right]. \tag{12}$$

Therefore, for N assets and K factors, we have $N(K+2)$ orthogonality conditions. There are $N(K+1)+K$ parameters to be estimated. Consequently, there are $N-K$ overidentifying restrictions for the Hansen J chi-square statistic. Another possibility for reducing the errors-in-variables problem is the use of the Shanken (1992) correction. However, Shanken and Weinstein (2006) suggest that there is a potential issue with a negative positive cross-product matrix of the OLS residuals from the time series regressions. Therefore we do not attempt to use the correction. Moreover, we run into a similar issue when we try to estimate the risk premia using the GMM approach (see Section 5).

In the next step, we follow Connor and Sehgal (2001) and run the following time series regressions of the six size and book-to-market portfolios on the market excess return and returns on our two newly-constructed factor-portfolios:

$$R_t^{XY} - R_t^F = a^{XY} + b^{XY} \, MRF_t^R + s^{XY} \, SMB_t^R + h^{XY} \, HML_t^R + \nu_t, \tag{13}$$

where X can be S or L and Y can be H, M, or L. We also follow Fama and French (1993) and estimate regression (13) for individual stocks i, i.e.

$$R_{it} - R_t^F = a_i + b_i \, MRF^R + s_i \, SMB_t^R + h_i \, HML_t^R + \eta_{it}, \quad i = 1, \ldots, N. \tag{14}$$

Finally, we use the constructed factors to calculate the cost of capital in the Visegrad countries for individual industries. The cost of capital is based on estimates of sensitivities from the following time-series regressions of industry excess returns:

$$R_{kt} - R_t^F = a_k + b_k\ MRF_t^R + s_k\ SMB_t^R + h_k\ HML_t^R + \eta_{kt}, \quad k = 1, \ldots, K. \qquad (15)$$

The cost of capital is then the expected industry return:

$$E[R_{kt}] = E[R_t^F] + \hat{b}_k + \hat{b}_k\ E[MRF_t^R] + \hat{s}_k\ E[SMB_t^R] + \hat{h}_k\ E[HML_t^R], \quad k = 1, \ldots, K. \qquad (16)$$

The expected results of this exercise is twofold. First, to the best of our knowledge, this is the first rigorous attempt to calculate the cost of capital in these countries. Second, this exercise will enable us to evaluate the performance of the three-factor regional model with dependent variables not sorted by value and/or size but by an industry. R^2 from regression (15) could be a good measure of this performance. The confidence interval for the cost of capital is calculated by regressing the industry excess returns on de-meaned excess returns from (15) plus a constant, and using the 95% confidence interval of the intercept.

Note that the econometric methodology is in part chosen to address the potential problem of biased regression coefficients. In the time series regressions, excess returns on size and book-to-market-sorted portfolios are regressed on excess returns on factor portfolios also related to these stock characteristics. This problem is addressed in several steps. First, the Fama and MacBeth repeated cross-sectional regressions of returns of individual stocks (i.e. not size- or value-related) on size and the book-to-market ratio document the importance of size and value effects. Second, Fama and French (1993) argue that a finer sorting for dependent excess returns implies that there would be no bias in their regressions and document this with a number of robustness checks. In our setting, there are only six size- and value-sorted dependent excess returns due to data limitations. The data limitations also prevent us from doing robustness checks of the sort done by Fama and French since splitting the sample in a number of ways is problematic for the already-small number of stocks. What we do instead is run the time series regression for individual stocks and look at the t-statistics of coefficients. Finally, we follow Fama and French (1997) and use the three-factor returns to calculate the cost of capital for industry related returns, i.e. use an entirely different sorting of the dependent variables.

5 Results

We first investigate whether capitalization and book-to-market ratios are priced. Table 5 reports the results of the Fama and MacBeth method described in the previous section. Each row corresponds to a particular combination of risk factors whose number is $K = 1, 2$ or 3. In the full model with market excess return, capitalization, and the book-to-market ratio, the two latter variables have risk premia significantly different from zero. The market variable is only priced when joined by either the size or the value variables separately. Interestingly, when capitalization and book-equity divided by market equity are considered without the market, they are not significant. There is enough evidence in Table 5 to believe that size and value matter in the Visegrad countries.

We have tried to confirm this finding by GMM to reduce the potential error-in-variables problem. For all countries, the GMM never converged due to a singular weighting matrix either using TSP or EViews. This is clearly the same problem discussed by Shanken and Weinstein (2006). They refer to OLS residuals but one just needs to realize that OLS is but a special case of GMM. In an attempt to analyze this technical issue, we have focused only on Poland. In this case, there are 66 usable stocks and 6 moment conditions for each (see 12), which amounts to 396 moment conditions. At the same time, there are only 179 time series observations. It is clear that a longer sample would be needed for a sensible usage of GMM. Nevertheless, our results regarding the role of size and value stand because the measurement error typically causes a downward bias in the estimates of cross-sectional coefficients.

In the next step, we estimate the time series regression (13) to find whether the newly constructed factors improve the performance of the CAPM. Results are reported in Table 6. First we estimate a standard version of the CAPM with the Visegrad value-weighted excess return as the explanatory variable and the six size- and and book-to-market-sorted portfolio excess returns. The market beta is strongly significant in all cases, which indicates that the joint market variable does have some explanatory power in explaining the time series variation of returns. However, adding the other two factors improves the performance of the model as measured by the adjusted R^2 in all cases. The sensitivities to the size factor are positive for small companies and negative for large companies. Fama and French (1993) consider US data and a 5×5 division of stocks based on size and value vs. our 2×3 division. They find negative betas for the size factor for firms in the biggest capitalization quintile. Similarly, we find that the value effect is negative for low and medium book-to-value ratios. Fama and French (1993) make a similar observation with the negative effect appearing in the first two quintiles of the book-to-value ratios. The intercepts are significantly negative with the exception of R^{SH} for the CAPM when the intercept is significantly positive. This is in contrast to zero for a well-specified asset pricing model where all factors are portfolio (excess) returns. Also, Fama and French (1993) report higher R^2's and mostly insignificant constants in the country-specific version of their model using US data.

The comparison of our regional model with a country-specific Fama and French US model shows that the model behaves similarly quantitatively though it is somewhat less successful empirically. More appropriate would be a comparison of our regional model with its country-specific versions. Table 7 reports adjusted R^2's from country-specific models. We make several observations. First, the regional CAPM means a significant improvement over the local CAPM in 20 out of 24 cases. Second, the inclusion of the size and value factors increases the R^2 in 24 out of 24 cases. Finally, the regional three-factor model performs better than a country-specific version only in 12 out of 24 cases. However, this means that the regional model is at least as good as the local model but it can be estimated for the whole sample for all countries. The country-specific model can be only estimated for the whole sample for Poland.

As another examination of the regional model performance, we estimate equation (14) for each stock in our sample (see Table 8). For country-specific risk-free rates, the average absolute t-statistic for the size and value factors is slightly below the 10% critical value of the t-distribution, which is 1.68. The sensitivities for the two factors are significant in 37% of the cases and the constant is significant only in 11% of the cases, both documenting fairly good performance of the Fama-French Visegrad model. The results do not support the use of the size and value factors to this extent for the German risk-free rates since the factor loadings are significant only in 14% of the cases for the size factor and 15% of the cases for the value factor.

Finally, Table 9 reports the cost of capital for the five industries for each country. The cost of capital is calculated including the intercept from the time series regression (15) for the sake of consistency with an estimation of the confidence intervals. There are not enough observations to calculate the cost of capital for Slovakia for the food, beverage, and tobacco industry and for utilities. We also do not have enough information to compute the expected return for utilities in Poland. The cost of capital is significantly negative only twice, for banks and capital-goods companies in the Czech Republic. The latter is likely a result of data issues related to a short data series ending in 2001. The negative cost of capital reflects the possibility that Czech banks are undervalued according to our model; assuming that the pricing error (the intercept) is zero, the expected return on investment in the Czech banks is 1% annually. Coefficients of the regional SMB portfolio are significant in 8 out of 17 cases and coefficients of the regional HML portfolio in 10 out of 17 cases. Apparently, the factors matter in the expected return regressions. The signs of the coefficients vary and are probably related to the size of companies in particular countries - this would be a question for future research.

6 Summary

The present study analyzes the stock markets in the Czech Republic, Hungary, Poland, and Slovakia. The first objective is to document the presence of size and value effects in the Visegrad countries. We use the Fama and MacBeth (1973) method to demonstrate that size and book-to-market equity are in fact priced in all Visegrad countries. Based on this result, we construct a three-factor regional Fama and French (1993) model. The model factors include the market, the size, and the value premia. The main innovation is constructing these variables for a regional market across the four Visegrad countries. The model behaves qualitatively similarly to the US-calibrated Fama and French model, replicating the size and value effects. However, the size effect is somewhat less pronounced and the model's R^2 is smaller as compared with the model whose coefficients are estimated using US stocks.

Next, we compare the performance of this model with a country-specific CAPM and a country-specific three-factor Fama and French model. Our dependent variables are six size- and book-to-market-sorted portfolios across our four markets. The regional model outperforms the country-specific CAPM and is comparable to the country-specific three-factor model. However, the main advantage of the regional model is the possibility of the calculation of the premia for the full sample, which is not possible for the country-specific versions of this model because the markets in the Visegrad countries are thin, shallow, and with small capitalization. In this sense the regional model is superior and can be readily used as a basis for cost-of-capital calculations. We also investigate the performance of the model using individual stock returns. The constant is almost never significant, which implies good model performance. However, the size and value premia are significant more frequently when local risk-free rates are used as opposed to the German risk free rates. Interestingly, while the regional CAPM provides a major improvement over the country-specific CAPM, this is not the case for the three-factor model. It seems that the sensitivity to size and value premia is important but it is not relevant whether the premia are local or regional.

Finally, we use the regional three-factor model to calculate the cost of capital for the following industries: banks, capital goods, food, beverage and tobacco, materials, and utilities. The regional market, SMB, and HML factors are significant in these calculations as well.

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Figure 1: Number of Observations for Stock Returns

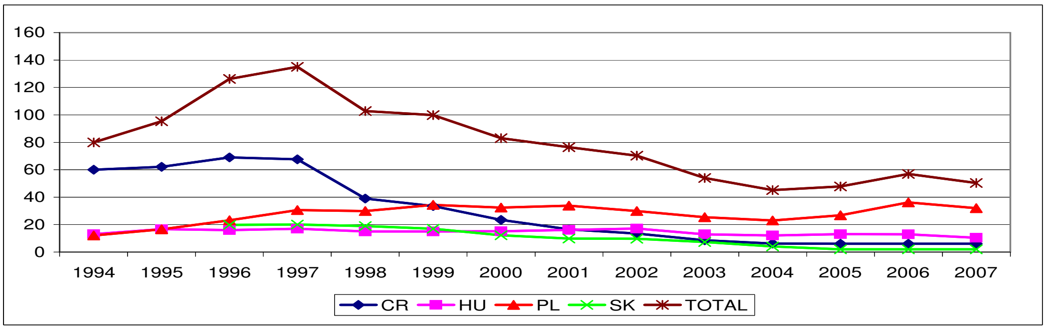

Table 1: Summary Statistics of the Stock and Market Variables by Country

All the variables are reported in euros (ECU before 1999). R_i stands for an individual stock return, R_m^C is a value-weighted country index market index, ME is market equity, BE/BE stands for book-to-market equity, and the *exrate* represents the exchange rate of the local currency against the euro.

Variable	Mean	Std. Dev.	Min	Max
Czech Republic; 4942 obs; 1994:02 - 2007:12; up to 79 stocks				
R_i	-.0067	.1679	-.9839	1.5562
R_m^C	-.0048	.0737	-.2798	.1962
$\log ME$	18.12	1.76	12.75	24.14
$\log BE/ME$	.3229	1.0601	-2.8898	3.9120
exrate	33.7806	2.7645	26.2610	38.6249
Hungary; 2559 obs; 1993:01-2007:12 up to 29 stocks				
R_i	.0118	.1651	-.9137	2.2073
R_m^C	.0157	.0906	-.2798	.5988
$\log ME$	18.78	1.90	14.59	23.28
$\log BE/ME$	-.3721	.7718	-2.5634	1.7148
exrate	222.5687	42.9413	101.7910	283.3500
Poland; 4751 obs; 1993:02-2007:12 up to 66 stocks				
R_i	.0136	.1673	-.9469	1.9149
R_m^C	.01304	.0766	-.2798	.5987
$\log ME$	19.90	2.37	14.98	29.54
$\log BE/ME$	-.6126	.7850	-4.2977	3.9120
exrate	3.7267	.5023	1.9290	4.8721
Slovak Republic; 1476 obs; 1996:02-2007:12 up to 23 stocks				
R_i	.0071	.3022	-1.0040	8.9833
R_m^C	.0023	.0668	-.2798	.1506
$\log ME$	17.17	1.78	10.07	21.18
$\log BE/ME$	.8774	1.3371	-6.1051	4.60517
exrate	39.8628	2.6817	33.1610	45.5000

Table 2: Summary Statistics for Stock Returns in the Combined Visegrad Market, 13728 obs.

All the variables are reported in euros (ECU before 1999). R_i stands for an individual stock return, R_m is a value-weighted country index market index, ME is market equity, and BE/BE stands for book-to-market equity.

Variable	Mean	Std. Dev.	Min	Max
R_i	.0052	.1866	-1.0040	8.9833
R_m	.0052	.07578	-.2728	.5076
$\log ME$	18.76	2.22	10.07	29.54
$\log BE/ME$	-.0708	1.0917	-6.1051	4.6052

Table 3: Summary Statistics for Portfolio Returns 1993:07-2007:12

S and B denote small and big capitalization, respectively. H, M, and L are high, medium, and low book-to-market ratios. R_{XY} are returns on portfolios with size X and book-to-market ratio Y.

Return	Mean	St. Dev.	Skeweness	Kurtosis
R^{SL}	-.0009	.0966	1.61	10.20
R^{SM}	-.0016	.0520	.4163	4.69
R^{SH}	.0087	.0834	2.35	16.12
R^{BL}	.0009	.0856	-.17	7.43
R^{BM}	.0042	.0829	.51	12.72
R^{BH}	.0055	.1146	6.50	99.59
R_m^R	.0047	.0743	.26	7.61
SMB^R	-.0016	.0520	.41	4.69
HML^R	.0071	.0797	.86	13.13

Table 4: Correlations for Portfolio Returns, 1993:07-2007:12

	SMB^R	HML^R
R_m^R	-0.33	-0.06
SMB^R		-0.03

Table 5: Results of Fama and MacBeth (1973) Regressions, Sample 1993:07-2007:12

R_m	$\log ME$	$\log BE/ME$	const.
0.0068	0.0332	-0.0269	-0.0054
(1.1151)	(3.2135***)	(-2.8438***)	(-1.0429)
0.0062			0.0009
(0.9685)			(0.2032)
	0.0263		0.0022
	(2.5495***)		(0.4473)
		-0.0120	0.0055
		(-0.7911)	(0.9408)
0.0091	0.0492		-0.0084
(1.5059*)	(3.9651***)		(-1.7070**)
0.0081		-0.0275	-0.0047
(1.3454*)		(-2.2818**)	(-1.0230)
	0.0117	-0.0059	0.0056
	(0.8556)	(-0.4143)	(0.8502)

Table 6: Regional Factor Models, 1993:07-2007:12

Based on the regression equation

$$R_t^{XY} - R_t^F = a^{XY} + b^{XY}\ MRF_t^R + s^{XY}\ SMB_t^R + h^{XY}\ HML_t^R + \nu_t,$$

where X is either S or L and Y is H, M, or L. $s^{XY} \equiv 0$ and $h^{XY} \equiv 0$ for CAPM. t-statistics are reported in parentheses.

Dependent Var.	a^{XY}	b^{XY}	s^{XY}	h^{XY}	Adj. R^2
$R^{SL} - R^F$	-0.0091	0.7733			0.32
	(-12.58***)	(79.48***)			
$R^{SM} - R^F$	-0.0080	0.8952			0.58
	(-16.44***)	(136.90***)			
$R^{SH} - R^F$	0.0027	0.7374			0.40
	(4.64***)	(95.12***)			
$R^{BL} - R^F$	-0.0076	1.1019			0.75
	(-18.72***)	(202.24***)			
$R^{BM} - R^F$	-0.0031	1.0650			0.78
	(-8.49***)	(219.22***)			
$R^{BH} - R^F$	-0.0003	0.9193			0.33
	(-0.37)	(81.78***)			
$R^{SL} - R^F$	-0.0044	0.8821	0.6774	-0.4097	0.54
	(-7.41***)	(104.23***)	(56.71***)	(-56.27***)	
$R^{SM} - R^F$	-0.0089	0.9670	0.2540	0.1297	0.61
	(-19.03***)	(145.10***)	(27.01***)	(22.62***)	
$R^{SH} - R^F$	-0.0018	0.9554	0.6937	0.5556	0.81
	(-5.55***)	(205.62***)	(105.78***)	(138.98***)	
$R^{BL} - R^F$	-0.0048	0.9539	-0.4820	-0.3538	0.90
	(-18.45***)	(259.93***)	(-93.06***)	(-112.04***)	
$R^{BM} - R^F$	-0.0030	0.9699	-0.3945	-0.0516	0.83
	(-9.44***)	(212.93***)	(-61.37***)	(-13.16***)	
$R^{BH} - R^F$	-0.0074	0.8807	-0.4984	0.6809	0.60
	(-11.32***)	(95.29***)	(-38.21***)	(85.63***)	

Table 7: Adjusted R^2 for Country-specific Factor Models

Based on the regression equation

$$R_t^{XY} - R_t^F = a^{XY} + b^{XY}\ MRF_t^C + s^{XY}\ SMB_t^C + h^{XY}\ HML_t^C + \nu_t,$$

where X is either S or L and Y is H, M, or L. $s^{XY} \equiv 0$ and $h^{XY} \equiv 0$ for CAPM.

Dependent Var.	Regional M. 93:7-07:12	Pol. 93:7-7:12	Czech R. 94:7-05:6	Hungary 94:7-05:6	Slovakia 96:7-04:6
			CAPM		
$R^{SL} - R^F$	0.32	0.37	0.18	0.15	0.01
$R^{SM} - R^F$	0.58	0.59	0.30	0.46	0.01
$R^{SH} - R^F$	0.40	0.61	0.26	0.29	0.00
$R^{BL} - R^F$	0.75	0.75	0.68	0.84	0.23
$R^{BM} - R^F$	0.78	0.73	0.70	0.61	0.45
$R^{BH} - R^F$	0.33	0.34	0.38	0.14	0.01
			Three-factor Model		
$R^{SL} - R^F$	0.54	0.62	0.55	0.45	0.59
$R^{SM} - R^F$	0.61	0.73	0.57	0.68	0.32
$R^{SH} - R^F$	0.81	0.84	0.83	0.83	0.91
$R^{BL} - R^F$	0.90	0.85	0.68	0.87	0.28
$R^{BM} - R^F$	0.83	0.77	0.75	0.62	0.45
$R^{BH} - R^F$	0.60	0.70	0.69	0.68	0.47

Table 8: T-statistics from Regressions of Individual Stock Excess Returns on the Visegrad Market Excess Return, and on Returns on the Size and Value Factor Portfolios

Based on the regression equation

$$R_{it} - R_t^F = a_i + b_i\,(R_{mt} - R_t^F) + s_i\,SMB_t + h_i\,HML_t + \eta_{it}, \quad i = 1, \ldots, N.$$

	t_{a_i}	t_{b_i}	t_{s_i}	t_{h_i}
Country-specific risk-free rates				
Avg. abs. values	0.83	4.18	1.46	1.50
Ratio of sig. values	0.11	0.86	0.37	0.37
German risk free rate				
Avg. abs. values	-0.01	1.01	0.1	0.06
Ratio of sig. values	0.03	0.86	0.14	0.15

Table 9: Industry Cost of Capital

Based on the time-series regressions:$R_{kt} - R_t^F = a_k + b_k\ MRF_t^R + s_k\ SMB_t^R + h_k\ HML_t^R + \eta_{kt}, \quad k = 1,\ldots,K$. The cost of capital is defined as: $E[R_{kt}] = E[R_t^F] + \hat{a}_k + \hat{b}_k\ E[MRF_t^R] + \hat{s}_k\ E[SMB_t^R] + \hat{h}_k\ E[HML_t^R], \quad k = 1,\ldots,K$. CR is the Czech Republic, HU Hungary, PL Poland, and SK Slovakia. The cost of capital is annualized, in %.

Country	Sample	$\hat{a}^k$ (se)	$\hat{b}^k$ (se)	$\hat{s}^k$ (se)	$\hat{h}^k$ (se)	Cost of capital (95% conf.int)
			Banks			
CR	94:2-07:12	-0.01	0.86	-0.38	0.07	-17
		(-1.96**)	(9.78***)	(-3.34***)	(-0.89)	(-30,-3)
HU	96:2-07:12	0.01	1.06	-0.01	-0.31	18
		(-0.89)	(6.53***)	(-0.07)	(-2.09**)	(-4,41)
PL	93:7-07:12	0.01	1.19	-0.82	-0.32	23
		(3.07***)	(22.85***)	(-11.04***)	(-7.37***)	(15,32)
SK	96:2-07:12	0.01	0.35	0.33	0.14	14
		(-0.81)	(1.92*)	(-1.29)	(-0.84)	(-12,40)
			Capital Goods			
CR	94:2-01:9	0.00	1.30	0.40	0.32	-25
		(-0.88)	(17.11***)	(4.19***)	(4.58***)	(-38,-13)
HU	93:7-03:10	-0.01	0.81	0.11	-0.03	-4
		(-1.33)	(8.41***)	(-0.76)	(-0.43)	(-23,16)
PL	93:7-03:10	-0.01	1.06	-0.54	-0.24	-11
		(-1.47)	(11.64***)	(-3.95***)	(-3.32***)	(-28,6)
SK	96:2-02:8	0.00	0.49	0.87	0.61	-26
		(-0.33)	(2.17**)	(2.86**)	(2.91**)	(-58,6)
			Food Beverage & Tobacco			
CR	94:2-02:10	0.00	0.95	0.19	0.14	-12
		(-0.41)	(8.58***)	(1.32)	(1.37)	(-31,6)
HU		0.01	1.04	0.09	0.00	13
		(0.79)	(11.26***)	(0.63)	(-0.00)	(-5,31)
PL	93:7-02:10	0.01	0.70	-0.72	-0.49	7
		(0.95)	(9.16***)	(-6.14***)	(-8.07***)	(-8,22)
			Materials			
CR	94:2-07:12	0.00	0.91	0.09	0.22	-6
		(-0.22)	(12.90***)	(0.97)	(3.46***)	(-17, 6)
HU	96:12-07:12	0.00	1.03	0.04	-0.09	9
		(0.06)	(10.59***)	(0.29)	(-1.07)	(-5,23)
PL	93:7-07:12	0.00	1.31	-0.32	-0.31	11
		(0.66)	(18.23***)	(-3.11***)	(-4.93***)	(-1,22)
SK	96:2-03:9	0.01	0.73	0.19	0.50	-1
		(0.65)	(4.71***)	(0.91)	(3.46***)	(-25,22)
			Utilities			
CR	94:2-00:10	0.01	0.96	0.05	0.10	1
		(2.07**)	(11.47***)	(0.48)	(1.33)	(-12,15)
HU	95:2-00:10	0.00	1.23	0.27	-0.40	-6
		(0.22)	(5.69***)	(0.90)	(-2.19**)	(-40,27)

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