Size and Value Effects in the Visegrad Countries

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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 portfolios serve as factors in addition to the market portfolio. The regional three-factor outperforms country-specific versions of the model and 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.

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1 Introduction

The present study analyzes stock markets emerging in Eastern and Central Europe. Specifically, the focus is on the Visegrad countries, i.e. the Czech Republic, Hungary, Poland, and Slovakia. The choice of the countries is driven by their relative homogeneity, data availability, and size.[1] Our objectives in this paper are testing for presence of size and value effects on the four markets as in Fama and French (1992) and a formulating a plausible model of the cost of capital in the spirit of Fama and French (1993). We propose a regional model of the cost of capital, which maximizes the use of available data and performs at least as well as country specific models. Moreover, the country specific models are difficult to estimate since the early 2000s due to the small number of stocks traded on the stocks of exchanges. The regional model of the cost of capital is therefore useful for companies making direct investment in the region. Subject to data availability, the model can be easily extended to cover other countries with relatively small stock markets.

The Capital Asset Pricing Model (CAPM) is a standard model to calculate the cost of capital. According to the model, the only thing that matters to investors is market risk. In a country-specific version of CAPM for the United States, this risk is approximated by some measure of the value-weighted market return such as the return on the S&P 500 index. However, numerous authors have found that other, non-market factors matter for stock returns. Size (market equity, ME) and book-to-market equity (BE/ME) have emerged as the main variables needed in addition to the market proxy - see Fama and French (1992).[2] In a global version of CAPM, one needs a proxy for the global portfolio

[1] Homogeneity reflects convergence to a legislative framework due to joining the European Union in 2004, and both political and economic coordination, which has continued in the framework of the Visegrad Group even after joining the European Union (see http://www.visegradgroup.eu/). The data in all countries start in the early 1990s. Finally, the size of considered countries in 2007 is approximately measured by the Gross Domestic Product (GDP, in terms of purchasing power parity) and by the foreign direct investment (FDI). In all Visegrad countries, GDP is above 100 billion USD and FDI above 3 billion USD, respectively (International Monetary Fund is the original source of this data). The lower bounds for size are given by Slovak numbers. Slovakia is still larger than, say, Baltic countries and we decided to keep it in our data due to its historical, political, and economic ties to the other Visegrad countries.

[2] Banz (1981) observes that the returns on stocks of relatively small firms tend to do better then predicted by the CAPM. This is the so called size effect. Similar observations were made using other

such as the Morgan Stanley Capital International Index (see Shultz 1995a,b). In the international context, there are in fact two dimensions in an attempt to characterize behavior of stock returns. The first is the question of whether the size and value effects are an international phenomenon and are not limited to the United States. The second issue is whether any factors affecting stock returns are mainly country-specific or of a global nature. The main factors considered are the market portfolio, size, and value. Addressing the two issues can be used as a basis to construct a proper cost-of-capital model.

Fama and French (1998) extend the analysis value effects from the United States to thirteen developed and sixteen emerging stock markets, not including countries in Central and Eastern Europe (CEE). 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). Claessens, Dasgupta, and Glen (1995) study nineteen emerging markets, again not including countries in Central and Eastern Europe. They provide evidence supporting the value effect and suggest that the size effect is weaker in emerging markets as compared to the developed ones. Similar findings are reported in Bary, Goldreyer, Lockwood, and Rodriguez (2002). This is to the best of our knowledge the only paper regarding the impact of size and book-to-market variables, which includes some Central and Eastern European countries in the analysis.[3] However, the sample ends in 2000 and CEE is not

firm-specific characteristics. Bhandari (1988) finds that there is a positive relation between average returns and leverage. Rosenberg, Reid, and Lanstein (1985) show that BE/ME is also positively related to average returns. 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.

[3]Fedorova and Vaihekoski (2009) examine the impact of currency risk on stock returns in this region. Another important issue, which has been partially addressed in the literature for Visegrad countries is the volatility of returns. Patev and Kanaryan (2003) investigate the reasons behind time varying volatility in Poland, Czech Republic, Hungary, and Slovenia. They show that there is no positive relation between stock volatility and expected return in these countries. Fiszeder (2006) models the time-varying volatility in the Polish stock market using GARCH-M models.

the focus of this particular study.

Building on existence of size and value effects, Fama and French (1993) 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 stocks minus the return of a portfolio of low value stocks). These Fama and French (FF) factors are able to explain a large part of the variance of average US stock returns when used in a three-factor model together with the market return.[4] Fama and French (1998) demonstrate that the international CAPM (ICAPM) is not able to explain the value premium in international markets but a two-factor model with global market return and a global version of the HML factor can account for this phenomenon. Griffin (2002) finds that country-specific versions of the Fama and French three-factor model can explain the variation in stocks returns better than the world three-factor model. He concludes that cost of capital calculations, performance measurement, and risk analysis using models with FF-style factors should be performed on a within-country basis.

Fedorova and Vaihekoski (2009) study six Eastern European stock markets. Their results suggest importance of the emerging market risk as opposed to the global market risk. This observation leads us to consider testing for regional size and value effects and to formulate a regional multi-factor model for expected returns. While country-specific tests and models are preferable, their potential use is limited due to the lack of data

[4]Several theories regarding economic meaning of 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. Rolph (2003) and Ferguson and Shockley (2003) attribute the significance of these factors to the leverage effects they explain. On the other hand, Chung, Johnson, Herb and Schill (2004) claim that the factors proxy for higher order co-moments and become insignificant when these co-moments are included in the model. Lakonishok, Shleifer, and Vishny (1994) assert that the empirical significance of the Fama and French factors is due to sub-optimal behaviour of the investors rather than fundamental risk. Berk (1995) suggests 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. From the international perspective, Vassalou and Liew (2000) use data from ten 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.

on the small stock markets. We start with size and value effects. The stock markets in Prague, Warsaw, Bratislava and Budapest are fairly small as measured by size and the number of traded stock. This severely reduces the sample size in all countries except for Poland. Therefore we 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. 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 their 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. The regional Fama and French three factor actually outperforms its country-specific counterpart. Moreover, the regional model coefficients can be estimated for a current sample. The model therefore provides a suitable way of calculating the cost of capital in 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. By the cost of capital we mean the expected asset return implied by a particular empirical pricing model. A natural start in this context is a country-specific Capital Asset Pricing Model (CAPM):

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

where R_i denotes a (stock) return on an asset i, R_m^C a return on a local stock market index, and R_F the risk-free rate, respectively. MRF^C is the market return for a given country (hence the superscript C) in excess of the risk-free rate and b_i is the sensitivity to the country-specific market index (beta). $E[R_i]$ is the cost of capital. The CAPM is and equilibrium model and equation (1) is implied by an interaction of demand from expected utility maximizing investors and a supply of shares, which can be modelled in a number of ways (e.g. see Pennacchi 2008 for a derivation of this standard equation). 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:

$$E[R_i] = R_F + b_i\ E[MRF^C] + s_i\ E[SMB^C] + h_i\ E[HML^C]. \tag{2}$$

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 (2):

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

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 (3) 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 (3) 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 (2) and the global specification (3) 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:

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

We will call (4) 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 weighted average of returns on the local market indices. All returns are in Euros.

3 Data

The stock market variables are from the S&P Emerging Markets Database (EMDB) complemented by information from Amadeus for the period 2007:03-2007:12. Individual monthly returns are calculated for individual stocks as follows:

$$R_{i,t} = \frac{P_{i,t}\ C_{i,t}/e_t + D_{i,t}/e_t}{P_{i,t-1}/e_{t-1}} - 1, \tag{5}$$

where $P_{i,t}$ is the closing price in local currency per share of the stock i at the end of the last trading day of the month t. $C_{i,t}$ stands for capital adjustment, which accounts for stock splits and rights offerings (see EMBD 2007), e_t is the exchange rate from Eurostat.[5]

[5]This means we do not treat exchange rates as specific risk factors, similarly to Fama and French (1998). On the other hand, Fedorova and Vaihekoski (2009) do study the impact of exchange rates in Central and Eastern Europe by explicitly defining the exchange rate risk factor. One could use the Fama and MacBeth (1973) methodology to see if the exchange rate risk factor is priced under different exchange rate regimes listed in Kočenda (2005, see his Table 1).

$D_{i,t}$ denote the dividends for the company i at time t. Dividends for most companies in our sample are typically paid only once a year. Suppose this annual dividend happens to be paid at time t^*. Let us denote it D^A_{i,t^*}. The dividends for the next n periods are then calculated as

$$D_{i,t^*+j-1} = \frac{D^A_{i,t^*}}{n+1}, \quad j = 1, ..., n. \tag{6}$$

n equals 11 for dividends paid exactly after one year, but it can also be 10 if the next dividends are paid earlier and 11 if they are paid later. We use this forward way of calculating dividends since in the last year of our sample dividends are not yet paid for some stocks before December and we would still like to calculate the returns. In addition, while we are using realized returns as dependent variables, we would like the dividend yield to be available ex-ante, as it is for a much longer period than one month. Prior to the first dividend payment in our sample for a particular stock, we estimate the dividends the same way as in (6) but going backwards rather then forward. This means that the first dividend is used to calculate returns for both before and after the dividend date. We do this to keep our sample as long as possible.[6]

The local country return R^C_m is computed using stocks and weights from June prior to a given date. This means that transaction costs are low and the portfolios are investable.[7] The market capitalization or market equity (ME) is calculated for each stock as the number of shares outstanding*closing price. Then it is converted into Euros. The number of outstanding shares changes irregularly, it can remain the same for some stocks for several years. Book equity (also referred to as net worth or book value) is simply the difference between total assets and total liabilities and it is updated each time new information is available. In markets with high inflation, S&P may make adjustments to net worth for inflation. This adjustment is likely to be minor in the Visegrad countries since according

[6]Note that we use nominal returns. Since all our regression equations are in the terms of various excess returns, inflation cancels out. However, the various risk premia could be higher at times of higher inflation rates. This effect would have to be captured via an inflation-related factor and we abstract from it in this paper.

[7]See Vaihekoski (2004) for discussion of issues related to portfolio construction.

to the data from the International Financial Statistics, the monthly inflation rate from February 1993 to December 2007 was only 0.8% in Poland, 0.9% in Hungary, 0.4% in the Czech Republic, and 0.4% in Slovakia, respectively. BE/ME is the book value per share divided by the stock price. We briefly comment on this in the paper.

The number of listed companies in our sample is in Figure 1. The total number of listed companies in all countries together reached 100 only in the years 1997-1999. The number of listed firms 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 in Table 1 for the variables to be used later in our subsequent econometric analysis. 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. The total market capitalization is between 2 billion Euros for Slovakia and 102 billions Euros for Poland. By comparison, the overall market capitalization of the stocks listed at the New York Stock Exchange reached 8 trillion USD in January 2006 (see www.nyse.com).

For excess returns used later, we need a measure of the risk-free rate. We use the three-months EURIBOR rate from EUROSTAT. The interest rate is quoted in percent per annum and we simply divide it by 1200.[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). The maturities of these bonds are also for 3 months and we use the same calculation for the monthly rates as in the case EURIBOR rates.

Fama and French (1993) introduce two additional factors in addition to the market

[8]See Vaihekoski (2009) for comparison of various methods of adjustment for cases where the maturity is greater than the data frequency.

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. The division is based on size and value in June prior to the current month. Now we have 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 returns are denoted $R_t^{SH}, R_t^{SM}, R_t^{SL}, R_t^{BH}, R_t^{BM}$, and R_t^{BL}, respectively. The combined sample starts in 1993:07 and ends in 2007:12. 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. We intend to show that the performance of the regional factor models are as good as the performance of the country-specific factor models. However, the coefficients of the regional factor model can be estimated for the whole sample while the coefficients of the country-specific models cannot be estimated for some countries at some periods. The Fama and French (1993) factors are then calculated as

$$SMB_t^R = 1/3\;[R_t^{SH} + R_t^{SM} + R_t^{SL}] - 1/3\;[R_t^{BH} + R_t^{BM} + R_t^{BL}] \tag{7}$$

and

$$HML_t^R = 1/2\;[R_t^{SH} + R_t^{BH}] - 1/2\;[R_t^{SL} + R_t^{BL}], \tag{8}$$

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. All these 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 2. There is a negative relation between size and average returns for stocks of all values. There is a positive relation between value and average return irrespective of size.This is similar to what is observed in the United States (see Fama and French 1993).

This outcome is in contrast with studies that find the size effect spurious internationally while the value effect is fairly robust.[9] 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 probably has 'fat-tails'. This is most extreme for high value stocks. Non-normality of returns does not bias estimates of OLS coefficients in time series regressions though it might affect statistical inference. The 'fat tails' are likely to generate higher variance, which would increase standard errors of the OLS estimates. Higher standard errors lead to smaller t-statistics. Therefore, if an estimate is in fact statistically different from zero in spite of the likely effect of the lack of normality, the result is fairly reliable. Both SMB and HML are negatively correlated with the market return - see Table 3. The correlation between SMB^R with HML^R is positive but small.

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

[9] 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.

observations in the four markets in our sample is not sufficient for such a fine distinction and we therefore compute the cost of capital only for five industries in each country. The industries are based on the Global Industry Classification Standard (GICS) and we only use industries with uninterrupted observations for at least five years, which are available at EMDB. Our five industries are banks (GICS 4010), capital goods (GICS 2010), food, beverage and tobacco (GICS 3020), materials (GICS 1510), and utilities (GICS 5510). We calculate equally weighted returns on stocks for a given industry in a given country.

4 Econometric Methodology

The Fama and MacBeth (1973) method (FM henceforth) 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:

$$R_t = \gamma_t' e + \delta_t \hat{F}_t + \varepsilon_t, \tag{9}$$

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:

$$R_{it} = \phi_i + F_t' \, X_{it} + \epsilon_{it}, \quad i = 1, ..., N, \tag{10}$$

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 (9) and (10) with excess returns does not change the results. The cross-sectional regression (9) 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

$$t_{\delta_i} = \frac{\tilde{\delta}_i}{\tilde{\sigma}_i}, \tag{11}$$

where

$$\tilde{\delta}_i = \sum_{t=1}^{T} \hat{\delta}_i / T \ \text{ and } \ \tilde{\sigma}_i^2 = \frac{1}{T(T-1)} \sum_{t=1}^{T} (\hat{\delta}_i - \tilde{\delta}_i)^2 \quad i = 1, ..., K. \tag{12}$$

It is expected that all the three factors are priced. [10]

In the next step, we follow Fama and French (1993) and Connor and Sehgal (2001) and run the following time series regressions of 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.

In the time series regressions (13), 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

[10] Estimates of coefficients from the cross-sectional regression (9) are subject to a measurement error because the factors have to be estimated from the time series regression (10). A standard way of mitigating this problem is a joint estimation of equations (9) and (10) by the Generalized Method of Moments (GMM) - see Cochrane (2005). We have done it only for Poland due to technical difficulties with the weighting matrix. The results are broadly consistent with the results calculated using the FM methodology.

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.

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:

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

The cost of capital is then the expected industry return:

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

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. Adjusted 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.

5 Results

We first investigate whether capitalization and book-to-market ratios are priced. Table 4 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 not priced. There is enough evidence in Table 4 to believe that size and value matter in the Visegrad countries.

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 5.[11] 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 and so do we. Similarly, we find that the value effect is negative for low and medium book-to-value ratios (only with big size). Fama and French (1993) make a similar observation with the negative effect appearing in the first two quantiles of the book-to-value ratios. Except for one case, the intercepts are insignificantly different from zero. This is an interesting finding indicating a well-specified asset pricing model. Fama and French (1993) report higher R^2's and mostly insignificant constants in the country-specific version of their model using US data. We have also investigated an out-of-sample performance. We estimated the regional three-factor model using data up to 2006:12 and calculated predictions of excess returns for the period 2007:1-2007:12, conditional on actual values of explanatory variables. The root

[11] All the employed series are stationary according to the results of the Fisher panel data unit root test. In addition, standard F-tests indicate joint significance of estimated coefficients in all specifications.

mean square error is always smaller for the three-factor model as compared with CAPM and the predicted excess returns tend to follow the actual ones fairly closely.

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. Table 6 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 17 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 in 18 out of 24 cases. In addition, 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 7). For country-specific risk-free rates, the sensitivities are significant in 30% of the cases for the size factor, and in 26% of the cases for the value factor. The constant is significant only in 15% of the cases. This documents fairly good performance of the Fama-French Visegrad model. The results improve when EUROBOR risk-free rate is used.

Finally, Table 8 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 for banks in the Czech Republic is consistent with negative return on equity reported in Mérö, K. and M.E. Valentinyi (2003). Coefficients of the regional

SMB portfolio are significant in 13 out of 17 cases and coefficients of the regional HML portfolio in 9 out of 17 cases. Apparently, both 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.

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 models outperform their country-specific counterparts. 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.The regional model 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. The size and value premia are significant more frequently when EURIBOR risk-free rates are used as opposed to the local risk free rates. Finally, we also 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.

Finally, there is the question of how our regional multi-factor model will perform during various financial crises and recessions, similar to the turbulent period from 2007 to 2009. Vassalou and Liew (2000) demonstrate that size and value factors can predict economic growth in developed markets. Provided this relationship between the Fama and French factors and measures of economic performance persists, our model should generate sensible expected rates of return. The regional three-factor model can easily be applied for other countries in the region with small capitalization of their stock markets.

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Figure 1: Number of Observations for Stock Returns

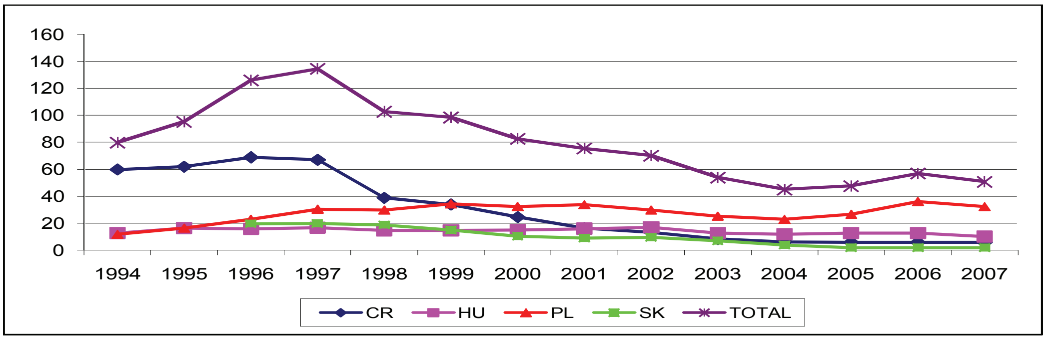

Table 1: Summary Statistics of the Stock and Market Variables by Country

All the variables are reported in euros (ECU before 1999). R_i stands for an individual stock return, R_m^c is a country specific market return, 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; 4964 obs.; 1994:02-2007:12; 2-74 stocks; mkt. cap. 47.6 bil. in Dec 2007				
R_i	-.0050	.1684	-.9072	1.5896
R_m^C	.0039	.0698	-.2318	.2275
$\log ME$	18.10	1.77	12.75	24.14
$\log BE/ME$	.4071	1.0923	-2.8713	3.9120
exrate	34.64	2.04	26.26	38.62
Hungary; 2513 obs; 1993:07-2007:12; 10-18 stocks; mkt. cap. 29.6 bil. in Dec 2007				
R_i	.0163	.1644	-.8939	2.0957
R_m^C	.0255	.0953	-.3606	.3526
$\log ME$	18.82	1.89	14.60	23.28
$\log BE/ME$	-.3842	.7697	-2.5634	1.7148
exrate	224.90	44.87	106.38	283.35
Poland; 4715 obs; 1993:07-2007:12; 11-37 stocks; mkt. cap. 102 bil. in Dec 2007				
R_i	.0111	.1654	-.9999	1.9541
R_m^C	.0143	.1082	-.3526	.5036
$\log ME$	19.85	2.31	14.98	29.54
$\log BE/ME$	-.6158	.7853	-4.2977	3.912
exrate	3.85	.45	2.03	4.87
Slovak Republic; 1427 obs; 1996:02-2007:12; 2-20 stocks; mkt. cap. 2 bil. in Dec 2007				
R_i	.0055	.1883	-.9348	2.1918
R_m^C	.0183	.0564	-.0835	.2508
$\log ME$	17.34	1.53	13.57	21.18
$\log BE/ME$	.7756	1.2352	-6.1051	3.9120
exrate	40.60	2.52	33.16	45.50

Table 2: 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. R_m^R is the regional market return. SMB^R and HML^R are the regional *small minus big* and *high minus low* returns, respectively.

Return	Mean	St. Dev.	Skeweness	Kurtosis
R^{SL}	0.0051	0.1072	-0.61	10.54
R^{SM}	0.0124	0.0952	0.16	7.77
R^{SH}	0.0166	0.1583	7.16	78.11
R^{BL}	0.0029	0.1036	1.57	9.62
R^{BM}	0.0119	0.1116	4.26	39.56
R^{BH}	0.0271	0.1321	5.43	48.30
R_m^R	0.0099	0.0787	0.16	7.75
SMB^R	0.0026	0.0630	1.48	8.80
HML^R	0.0179	0.1123	1.90	15.61

Table 3: Correlations for Portfolio Returns, 1993:07-2007:12

	SMB^R	HML^R
R_m^R	-0.33	-0.01
SMB^R		0.20

Table 4: Results of Fama and MacBeth (1973) Regressions, Sample 1993:07-2007:12

Based on the cross-sectional regression:

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

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. Here we report the average of coefficient estimates $\hat{\delta}_i$ from a series of the above cross-sectional regressions. T-statistic in parentheses refers to the test of this average being equal to zero.

R_m	$\log ME$	$\log BE/ME$	const.
0.0031	0.0320	-0.0264	0.0005
(-.65)	(3.00***)	(-2.61***)	(.13)
0.0015			0.0075
(0.29)			(2.05**)
	0.0339		0.0028
	(3.23***)		(0.60)
		-0.0214	0.01
		(-1.92**)	(1.19)
0.0047	0.0439		-0.0010
(0.97)	(3.64***)		(-.27)
0.0029		-0.0207	0.0036
(0.61)		(-1.57*)	(0.95)
	0.0244	-0.0187	0.0037
	(2.81***)	(-2.26***)	(0.80)

Table 5: 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
$R^{SL} - R^F$	-0.01	0.79			0.35
	(-0.88)	(9.71***)			
$R^{SM} - R^F$	0.00	1.10			0.60
	(0.24)	(16.28***)			
$R^{SH} - R^F$	0.02	0.74			0.19
	(2.09***)	(6.46***)			
$R^{BL} - R^F$	-0.01	1.14			0.70
	(-1.31)	(20.28***)			
$R^{BM} - R^F$	0.00	1.12			0.85
	(0.62)	(31.93***)			
$R^{BH} - R^F$	0.01	1.16			0.33
	(0.57)	(9.25***)			
$R^{SL} - R^F$	0.00	0.97	0.71	-0.30	0.56
	(-0.63)	(13.67***)	(7.81***)	(-6.22***)	
$R^{SM} - R^F$	0.00	1.18	0.26	0.21	0.68
	(-0.74)	(18.08***)	(3.17***)	(4.73***)	
$R^{SH} - R^F$	0.00	1.02	1.03	0.60	0.76
	(0.74)	(15.51***)	(12.23***)	(13.44***)	
$R^{BL} - R^F$	0.00	1.06	-0.31	-0.27	0.83
	(0.10)	(23.39***)	(-5.35***)	(-8.78***)	
$R^{BM} - R^F$	0.00	1.10	-0.06	-0.06	0.86
	(1.11)	(30.25***)	(-1.29***)	(-2.42***)	
$R^{BH} - R^F$	-0.01	1.00	-0.63	0.84	0.68
	(-0.96)	(10.85***)	(-5.35***)	(13.37***)	

Table 6: 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.	Pol. 93:7-07:12	Czech R. 94:7-05:6	Hungary 94:07-07:12	Slovakia 96:7-04:6
		CAPM		
$R^{SL} - R^F$	0.54	0.63	0.78	0.22
$R^{SL} - R^F$	0.53	0.55	0.59	0.34
$R^{SH} - R^F$	0.32	0.38	0.22	0.08
$R^{BL} - R^F$	0.30	0.09	-0.01	0.00
$R^{BM} - R^F$	0.58	0.16	0.39	-0.01
$R^{BH} - R^F$	0.60	0.12	0.24	0.08
		Three-factor Model		
$R^{SL} - R^F$	0.65	0.65	0.79	0.40
$R^{SM} - R^F$	0.58	0.61	0.59	0.33
$R^{SH} - R^F$	0.58	0.62	0.45	0.31
$R^{BL} - R^F$	0.48	0.59	0.82	0.65
$R^{BM} - R^F$	0.63	0.35	0.60	0.31
$R^{BH} - R^F$	0.72	0.82	0.84	0.56

Table 7: 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	0.85	4.15	1.27	1.15
Ratio of sig. values	0.15	0.82	0.30	0.26
Euribor risk free rate				
Avg. abs. values	0.82	3.71	1.50	1.51
Ratio of sig. values	0.10	0.83	0.40	0.37

Table 8: 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 %. t-statistics are reported in parentheses.

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	0.00	0.85	-0.10	0.06	-14.05
		(-0.80)	(8.68***)	(-0.85)	(-0.85)	(-28.16, -0.37)
HU	96:2-07:12	0.01	1.05	-0.25	-0.41	21.66
		1.11	(5.71***)	(-1.08)	(-2.6***)	(3.01,49.30)
PL	93:7-07:12	0.01	1.37	-0.78	-0.32	23.94
		(3.39***)	(24.82***)	(-10.89***)	(-7.61***)	(19.85,36.30)
SK	96:2-07:12	0.01	0.44	0.53	0.22	14.28
		(-0.87)	(2.08**)	(1.99**)	-1.26	(-12.13,40.09)
				Capital Goods		
CR	94:2-01:9	0.00	0.95	0.52	0.31	-24.87
		(-0.32)	(10.84***)	(4.91***)	(4.58***)	(-42.63,-15.89)
HU	93:7-07:12	-0.01	0.91	0.41	0.08	-1.88
		(-1.17)	(10.10***)	(3.12***)	1.28	(-20.68,13.03)
PL	93:7-07:12	-0.01	1.09	-0.50	-0.48	-8.90
		(-0.95)	(12.18***)	(-4.08***)	(-7.08***)	(-20.73,9.94)
SK	96:2-02:8	-0.01	0.34	0.62	0.32	-18.37
		(-0.35)	1.45	(2.09**)	1.57	(-43.21,23.97)
				Food Beverage & Tobacco		
CR	94:2-07:12	0.01	0.92	0.41	0.21	-7.91
		1.07	(8.38***)	(3.07***)	(2.46**)	(-26.49,6.40)
HU	93:7-02:10	0.02	1.19	0.41	0.07	18.36
		(2.10**)	(12.66***)	(3.06***)	0.98	(-0.30,35.21)
PL	93:7-06:10	0.01	0.91	-0.77	-0.48	3.58
		-0.92	(11.78***)	(-7.22***)	(-8.60***)	(-6.00,21.26)
				Materials		
CR	94:2-07:12	0.00	0.81	0.22	0.27	-3.98
		-0.92	(10.20***)	(2.32**)	(4.28***)	(-17.72,5.41)
HU	96:12-07:12	0.00	1.20	0.20	0.05	11.23
		(-0.17)	(10.46***)	1.44	0.48	(-3.65,24.59)
PL	93:7-07:12	0.00	1.48	-0.32	-0.28	13.61
		-0.94	(18.36***)	(-3.05***)	(-4.27***)	(4.50,27.49)
SK	96:2-03:9	0.01	0.86	0.36	0.67	1.72
		-1.29	(5.07***)	(1.68*)	(4.63***)	(-12.54,34.27)
				Utilities		
CR	94:2-07:12	0.02	0.77	0.21	0.07	6.90
		(2.91**)	(9.11***)	(2.06**)	0.99	(-6.55,18.84)
HU	95:2-00:10	0.02	1.25	0.43	-0.17	30.13
		(2.07**)	(6.57***)	(1.75*)	(-1.15)	(8.48,59.22)