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CROSS SECTIONAL ANALYSIS OF THE SWEDISH

STOCK MARKET[*]

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Abstract

This paper analyses the ability of beta and other factors, like firm size and book-to-market, to explain cross-sectional variation in average stock returns on the Swedish stock market for the period 1980-1990. We correct for errors in variables problem of the estimated market beta. Since this method takes into account the measurement error we do not have to form portfolios and thereby losing information. We use both separate cross-sectional regressions and a pooled regression model to estimate the risk premiums of the different factors. An Extreme Bounds Analysis is utilised for testing the sensitivity of the estimated coefficients to changes in the set of the included explanatory variables. Since the tests are carried out on realised returns, which presumably are quite noisy approximations of expected returns, we study if beta can systematically explain cross-sectional differences among realised stock returns conditional on the sign of the realised market excess return. Our results show that the coefficient for beta is never significantly different from zero, but the estimates differ across the methods mentioned above. However, we find that beta is priced differently in periods with positive versus periods with negative realised market return. In the Extreme Bounds Analysis, the coefficient for the size variable is always significantly negative.

Keywords: Cross sectional model; Swedish stock returns; errors in variables; extreme bound analysis.

JEL classification: G12

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1   Introduction

Some years ago Fama and French (1992) published an empirical investigation from the U.S. stock market which suggested that if firm size and book-to-market were included as explanatory variables then beta made no marginal contribution for explaining cross sectional differences among average stock returns. These findings go against the empirical prediction of the Capital Asset Pricing Model, CAPM, where factors besides market beta, "idiosyncratic" factors from a CAPM perspective, should have no power in explaining the cross-section of average returns. As expected, this article has spurred a vivid debate among financial economists discussing the pros and cons of Fama and French's result, some of the more well known contributions have come from Kothari et al (1995), Lakonishok et al (1994) and Jagannathan and Wang (1996).

Particular to Fama and French's methodology is the use of a two-pass estimation method, which was already implemented by Fama and MacBeth (1973). In the first-pass regression one has to estimate market beta for each asset from time-series data, since the true betas are unobservable. In a second-pass regression cross-sectional stock returns are regressed on these betas and other explanatory variables in order to estimate the risk premiums of the different factors. In this regression beta is measured with an error, which generally results in an underestimation of the risk premium of beta and an overestimation of the coefficients for the idiosyncratic factors, and this effect increases with the correlation between the estimated betas and the idiosyncratic variables. This is an errors in variables problem and to diminish its effect Fama and MacBeth (1973) constructed portfolios on the basis of historical betas, and since then this method has been commonly used in most investigations. A different method to tackle this problem is presented by Litzenberger and Ramaswamy (1979), where they derive consistent methods within the two-pass test methodology. Their correction method is *N*-

consistent, i.e. consistent when the size of time-series sample, T, is fixed and the number of assets N is allowed to increase without bound. Thus, there is an advantage in using individual stocks in the tests and it is not necessary to form portfolios.

Most other studies following Fama and MacBeth (1973) use the means and standard errors of the time series of the estimated coefficients to compute t-statistics. Therefore, when performing the significance test they ignore the standard errors of the coefficients estimated by the cross-sectional regressions. This approach implicitly assumes that coefficient variances are constant over time, which is not necessarily true. As a remedy we follow the procedure in Litzenberger and Ramaswamy (1979) where the coefficients from the cross sectional model are weighted by their variances.

CAPM is a one-period model expressed in terms of expected returns while several tests are performed on realised values over several periods. The common explanation is to rely, explicitly or implicitly, on a period by period rational expectation equilibrium and thereby presuming that expectations are on average correct. Therefore, for positive stock betas cross-sectional relations between realised stock returns should on average conform to a positive linear relation between stock returns and market portfolio return. It is obvious that this average may appear to be quite weak if the sample contains a substantial number of observations with negative excess market return, and excess return is generally considered to be a very noisy approximation of expected return (see Merton 1980). From this perspective it is interesting to analyse separately the role of beta in situations where the excess market return is negative and vice versa. To reach a testable hypothesis one can start from a one-factor asset pricing model where the riskiness of a stock is directly related to its covariance with market, which means that high risk stocks have large outcomes in states where market

wealth is high and vice versa. In this model agents try to smooth consumption and the only source of risk is variation in aggregate wealth. Since CAPM can be deduced from this more general model it seems reasonable that by analogy a similar relation may be valid for CAPM: high beta stocks have large outcomes in states where the value of the market portfolio is high and vice versa and the states are approximated by realised excess market return. This idea can be tested via the following hypothesis: there is a positive relation between realised stock return and beta conditional on excess market return being positive and a negative relation for negative excess market return (see Pettengill et al (1995), Chan and Lakonishok (1993), Isakov (1997)). This is not an equilibrium model that estimate the risk premium for beta, but an analysis of the factors driving returns in bad and good states respectively. Such an analysis is of course important for an individual investor who changes her prior subjective beliefs for good and bad states. For example, if she thinks that a bear market is more imminent she increases the weights of low-beta stocks.

The purpose of this paper is to analyse the ability of beta and other factors, like firm size and book-to-market, to explain cross-sectional variation in average stock returns on the Swedish stock market for the period 1980-1990. To correct for errors in variables problem of the estimated market beta we use the method of Litzenberger and Ramaswamy (1979). Since this method takes into account the measurement error we do not have to form portfolios and thereby losing information. Besides, this has a great advantage in our study since most of the time we have less than one hundred stocks and could therefore only form a few portfolios. To do justice to the fact that the tests are carried out on realised returns, which presumably are quite noisy approximations of expected returns; we will study if beta can systematically explain cross-sectional differences among realised stock returns conditional on the sign of realised market excess return. In this study we also use Extreme Bounds Analysis (EBA), see

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Leamer (1983), for analysing the sensitivity of the estimated coefficients to changes in the set of the included explanatory variables. The EBA analysis is used on an estimated pooled model of the time-series and cross-section model that is more efficient than the estimator in Fama and MacBeth (1973) (see Amihud et al (1992)).

The contribution of this paper is the first in-depth study of the capacity of market beta and other relevant factors to capture the cross-section of expected return on the Swedish stock market. Other studies like for example Heston et al (1977) only use beta together with size as the relevant explanatory variables. Our study is robust to errors in variables and applies a pooled regression for the estimation of the coefficients of the factors generating returns.

The outline of the paper is as follows: section *2* discusses the methods used in our analysis, section *3* presents the data, section *4* analyses the empirical results and there is finally a conclusion in section *5*.

2 *Method*

The CAPM, when there exists a risk free asset, implies the following cross-sectional relationship between ex ante risk premiums and β's:

$$E[R_i] = E\left[R_{zc(m)}\right] + \beta_{im}\left(E[R_m] - E\left[R_{zc(m)}\right]\right) \tag{1}$$

$$\beta_{im} = \frac{\mathrm{cov}(R_i, R_m)}{\mathrm{var}(R_m)}$$

where R_i and is the return on security i in excess of the risk free rate, R_m is the excess return on the market portfolio, $R_{zc(m)}$ is the excess return on the frontier portfolio having a zero covariance with respect to the market portfolio and β_{im} is the amount of market risk of asset i. If borrowing and lending are unconstrained at a constant riskless interest rate, the CAPM implies that the expected return on *zc(m)* is equal to the riskless rate. Thus the expected

excess return on *zc(m)*, $R_{zc(m)}$, is zero and the expected risk premiums on asset *i* is proportional to its beta. In this case, we have

$$E[R_{zc(m)}] = 0 \qquad \text{and} \qquad E[R_m] > 0 \qquad (2)$$

If borrowing is constrained CAPM implies

$$E[R_{zc(m)}] \geq 0 \qquad \text{and} \quad E[R_m] - E[R_{zc(m)}] > 0. \qquad (3)$$

An approach to test CAPM is to estimate a series of cross-sectional regressions of realised excess return on betas. The model, allowing the beta to differ through time, is[1]

$$R_{it} = \gamma_{0t} + \gamma_{1t}\beta_{i,t} + \varepsilon_t$$

$$\gamma_{0t} = R_{zc(m),t} \qquad (4)$$

$$\gamma_{1t} = R_{mt} - R_{zc(m),t}$$

Fama and MacBeth (1973), assuming stationary distributions for γ_{0t} and γ_{1t}, tested the hypotheses

$$\frac{\sum_t \hat{\gamma}_{0t}}{T} = 0 \qquad \text{and} \qquad \frac{\sum_t \hat{\gamma}_{1t}}{T} > 0 \qquad (5)$$

The cross-sectional model applied in this study is an improvement of the two-pass methodology of Fama and MacBeth (1973), which was also used by Fama and French (1992). We introduce the following improvements: GLS is used to take into consideration that the error term in the cross-sectional regression is heteroskedastic; beta is corrected for errors in variables; the inference for the risk price, see (5), relaxes the stationarity assumption for γ_{0t} and γ_{1t}; finally we use a pooled regression model.

Our version of the extended model looks as follows

$$\mathbf{R}_t = \mathbf{I}_N \gamma_{0t} + \boldsymbol{\beta}_t \gamma_{1t} + \mathbf{X}_{t-1} \boldsymbol{\Gamma}_{2t} + \boldsymbol{\varepsilon}_t, \qquad (6)$$

where $\mathbf{R}_t = (R_{1t}, \ldots R_{Nt})'$ is the vector of return in excess of the risk free rate for N assets, $\boldsymbol{\beta}_t = (\beta_{1t}, \ldots \beta_{Nt})'$ is the true market beta vector; $\mathbf{X}_{t-1}$ is a $N \times K$ matrix which includes K explanatory variables like size etc.; $\boldsymbol{\varepsilon}_t = (\varepsilon_{1t}, \ldots \varepsilon_{Nt})'$ is a vector of idiosyncratic errors with mean vector $\mathbf{0}$ and an intertemporally homoskedastic covariance matrix $\mathbf{V}_t$. CAPM implies that the price of beta risk, γ_{1t}, should be positive and significantly different from zero, while the other coefficients, γ_{0t} and $\boldsymbol{\Gamma}_{2t}$, should not be significantly different from zero. We estimate the risk premiums for each month starting in July 1980 and repeated each year up to 1990.

Since the variances of the returns at time t may differ across assets and the returns may also be correlated, the disturbance terms of the monthly cross-sectional model may be both heteroskedastic and correlated. Therefore, the OLS estimator of the parameters of the cross-sectional regression may be inefficient. A possible solution to this problem is to apply the GLS method. The GLS estimator of the cross-sectional regression model is

$$\hat{\boldsymbol{\Gamma}}_{t(GLS)} = \left(\mathbf{H}_t' \mathbf{V}_t^{-1} \mathbf{H}_t \right)^{-1} \mathbf{H}_t' \mathbf{V}_t^{-1} \mathbf{R}_t, \tag{7}$$

where

$$\mathbf{H}_t = \begin{bmatrix} 1 & \beta_{1t} & X_{1t} \\ . & . & . \\ . & . & . \\ 1 & \beta_{Nt} & X_{Nt} \end{bmatrix}$$

is the $(N \times (k+2))$ matrix of all the explanatory variables of the model. The matrix $\mathbf{V}_t$ is unknown and must be estimated. To simplify this estimation Litzenberger and Ramaswamy (1979), assumed the single index model as the return generating process. With this model the process that generates returns at the beginning of period t is assumed to be

$$R_{it} = \alpha_{it} + \beta_{i,t} R_{mt} + e_{it}, \qquad\qquad i = 1, 2, \ldots, N_t, \tag{8}$$

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[1] For simplicity, we use the notation β_i instead of β_{im}.

$$\text{cov}(e_{it}, e_{jt}) = 0 \qquad \text{for } i \neq j$$
$$= s_i^2 \qquad \text{for } i = j$$

With this specification the covariances among asset returns are

$$\text{cov}(R_{it}, R_{jt}) = \beta_{it}\beta_{jt} \, \text{var}(R_{mt}) \qquad \text{for } i \neq j$$
$$= \beta_{it}^2 \, \text{var}(R_{mt}) + s_i^2 \qquad \text{for } i = j \tag{9}$$

Litzenberger and Ramaswamy, using a portfolio approach, show that under the assumption of the single index model the estimation of the matrix $\mathbf{V}_t$ may be simplified to a diagonal matrix Ω_t, where

$$\Omega_t(i,j) = 0 \qquad \text{for } i \neq j$$
$$= s_i^2 \qquad \text{for } i = j \tag{10}$$
$$i, j = 1,2,\ldots\ldots\ldots N_t$$

Therefore, the GLS estimator is equivalent to the WLS estimator and can be obtained by deflating all the variables in equation (6) by the standard deviations of the residuals from the single index model for each firm and then estimating the transformed model with OLS.[2]

Another empirical problem in estimating equation (6) is the fact that the true $\boldsymbol{\beta_t}$ is unobservable and the estimated market beta, $\hat{\boldsymbol{\beta}}_t$, from historical data must be used as a proxy. The market beta vector, $\hat{\boldsymbol{\beta}}_t$, is the OLS estimate from the single index model for a period of at least 30 months and up to 36 months prior to t

$$R_{i\tau} = \alpha_{it} + \beta_{it} R_{m\tau} + e_{i\tau}, \qquad \tau = t\text{-}P_i, \ldots, t\text{-}1. \tag{11}$$

where P_i is an information set for return observations used to estimate $\hat{\beta}_{it}$, $R_{m\tau}$ is the return of the market portfolio at times $\tau < t$. The notation P_i shows that the set of return observations may differ across assets. $\hat{\beta}_{it}$ is an unbiased estimator of β_{it}. However, because of measurement error in $\hat{\beta}_{it}$, the estimated coefficients of the equation (6), due to error in

variables problem, will be inconsistent. Note, that the other explanatory variables are assumed to be measured without error.

The estimated $\hat{\beta}_{it}$ is assumed to be equal to the true β_{it} plus a measurement error, u_{it}

$$\hat{\beta}_{it} = \beta_{it} + u_{it} \tag{12}$$

and

$$\mathrm{var}(u_{it}) = \mathrm{var}(\hat{\beta}_{it}). \tag{13}$$

From the single index model, the OLS estimation of the sampling variance of the $\hat{\beta}_{it}$ is

$$\mathrm{var}(\hat{\beta}_{it}) = \frac{\mathrm{var}(e_{i\tau})}{\sum_{\tau=t-P_i}^{t-1}\left(R_{m\tau} - \overline{R}_m\right)^2} = \frac{s_i}{\sum_{\tau=t-S_i}^{t-1}\left(R_{m\tau} - \overline{R}_m\right)^2}, \tag{14}$$

where $\overline{R}_m$ is the sample mean of $R_{m\tau}$. Therefore, the measurement error variance, $\mathrm{var}(u_{it})$, is proportional to s_i, and we can deflate all the variables by $\sqrt{\mathrm{var}(u_{it})}$ instead of s_i in our WLS estimation. By deflating all the variables in $\mathbf{H}_t$ by $\sqrt{\mathrm{var}(u_{it})}$ the variance of the deflated measurement error will be equal to one and the consistent estimator of the coefficients is given by

$$\hat{\Gamma}_{t(\mathrm{EIV-corrected})} = \left(\mathbf{H}_t^{*\prime}\mathbf{H}_t^* - \mathbf{M}\right)^{-1}\mathbf{H}_t^{*\prime}\mathbf{R}_t^* \tag{15}$$

where

$$\underset{Nx(k+2)}{\mathbf{H}_t^*} = \begin{bmatrix} \dfrac{1}{\sqrt{\mathrm{v\hat{a}r}(u_{1t})}} & \dfrac{\hat{\beta}_{1t}}{\sqrt{\mathrm{v\hat{a}r}(u_{1t})}} & \dfrac{X_{1t}}{\sqrt{\mathrm{v\hat{a}r}(u_{1t})}} \\ . & . & . \\ . & . & . \\ \dfrac{1}{\sqrt{\mathrm{v\hat{a}r}(u_{Nt})}} & \dfrac{\hat{\beta}_{Nt}}{\sqrt{\mathrm{v\hat{a}r}(u_{Nt})}} & \dfrac{X_{Nt}}{\sqrt{\mathrm{v\hat{a}r}(u_{Nt})}} \end{bmatrix},$$

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[2] See also Huang and Litzenberger "*Foundation for Financial Economics*", page 320-324.

$$\mathbf{R}_t^* = \begin{bmatrix} \dfrac{R_{1t}}{\sqrt{\text{vâr}(u_{1t})}} \\ . \\ . \\ \dfrac{R_{Nt}}{\sqrt{\text{vâr}(u_{Nt})}} \end{bmatrix}$$

$$\underset{Nx1}{}$$

and $\mathbf{M}$ is a $(k+2) \times (k+2)$ with N in the element $M_{2,2}$ and zero in all the other cells. Note that

the cell $M_{2,2}$ corresponds to the cell 2,2 of matrix $\mathbf{H}_t^{*'}\mathbf{H}_t^*$, which is the cross product of the

elements in the vector of deflated $\hat{\beta}_{it}$. The variance covariance matrix of the coefficients are

given by

$$\text{var}(\hat{\Gamma}_{t(\text{EIV}-\text{corrected})}) = (\sigma_{\varepsilon*}^2 + \hat{\gamma}_{1t,(\text{EIV}-\text{corrected})}^2) \left[\left(\mathbf{H}_t^{*'}\mathbf{H}_t^* - \mathbf{M}\right)^{-1} \mathbf{H}_t^{*'}\mathbf{H}_t^* \left(\mathbf{H}_t^{*'}\mathbf{H}_t^* - \mathbf{M}\right)^{-1} \right] \quad (16)$$

where $\sigma_{\varepsilon*}^2$ is the residual variance from the weighted regression model estimated by using the

EIV-corrected estimated coefficients.

The time-series of the monthly estimated coefficients are used to test for significance of the

risk premiums over all periods. We compute the following t-statistics to test whether the risk

premiums are significantly different from zero

$$t = \frac{\hat{\Gamma}}{\sigma(\hat{\Gamma})} \quad (17)$$

$\hat{\Gamma}$ and $\sigma(\hat{\Gamma})$ are estimated by two alternative methods:

Alternative 1. We estimate the average of the risk premiums over all periods T as the final

estimates of risk premiums and $\sigma(\hat{\Gamma})$ as the standard deviation of the sample mean of the risk

premiums

$$\hat{\Gamma} = \frac{\sum_t \hat{\Gamma}_t}{T} \qquad \text{and} \qquad \sigma(\hat{\Gamma}) = \sqrt{\frac{\sum_t \left(\hat{\Gamma}_t - \hat{\Gamma}\right)^2}{T(T-1)}} \quad (18)$$

Note that T is the number of months included in this study and is equal to 126. In this approach the risk premiums are assumed to be drawn from a stationary distribution (having the same mean and variance over time).

Alternative 2. We relax the assumption of constant variance over time and estimate $\hat{\Gamma}$ as the weighted average of the monthly estimated coefficients, where the weights are inversely proportional to variance of the coefficients from monthly regressions

$$\hat{\Gamma} = \sum_t Z_t \hat{\Gamma}_t \quad \text{and} \quad \sigma(\hat{\Gamma}) = \sqrt{\sum_t Z_t^2 \, \text{var}(\hat{\Gamma}_t)}, \quad (19)$$

where,

$$Z_t = \frac{\left[\text{var}(\hat{\Gamma}_t)\right]^{-1}}{\sum_t \left[\text{var}(\hat{\Gamma}_t)\right]^{-1}}$$

and $\text{var}(\hat{\Gamma}_t)$ is the estimated variance of $\hat{\Gamma}_t$ from the cross-section regressions at time t.

To consider the fact that realised returns are noisy estimators of expected return, we will also test the hypothesis of a positive relation between realised stock return and beta, conditional on excess market return being positive and vice versa. We divide the estimates from the monthly regressions, $\hat{\Gamma}_t$ into two periods and the test is performed separately for each period using the t-statistics as in equation (17), while $\hat{\Gamma}$ and $\sigma(\hat{\Gamma})$ are computed separately for each period using two alternative methods:

Alternative 1.

$$\hat{\Gamma}^+ = \frac{\sum_t \left(\hat{\Gamma}_t \middle| R_{mt} \geq 0\right)}{T^+} \quad \text{and} \quad \sigma(\hat{\Gamma}^+) = \sqrt{\frac{\sum_t \left(\left[\hat{\Gamma}_t \middle| R_{mt} \geq 0\right] - \hat{\Gamma}^+\right)^2}{T^+(T^+ - 1)}} \quad (20)$$

Alternative 2.

$$\hat{\Gamma}^{+} = \sum_{t} Z_{t}\left(\hat{\Gamma}_{t} \middle| R_{mt} \geq 0\right) \qquad \text{and} \quad \sigma\left(\hat{\Gamma}^{+}\right) = \sqrt{\sum_{t} Z_{t}^{2} \ \text{var}\left(\hat{\Gamma}_{t}\right) \middle| R_{mt} \geq 0} \ , \tag{21}$$

where

$$Z_{t} = \frac{\left[\text{var}(\hat{\Gamma}_{t} \middle| R_{mt} \geq 0)\right]^{-1}}{\sum_{t}\left[\text{var}(\hat{\Gamma}_{t} \middle| R_{mt} \geq 0)\right]^{-1}}$$

T^{+} is the number of periods with positive excess market returns. The estimates for the negative periods, $\hat{\Gamma}^{-1}$ and $\sigma\left(\hat{\Gamma}^{-1}\right)$ are derived in an analogous manner. When excess market return is negative we expect an inverse relationship between beta and returns.

Finally we use a pooled regression model: we stack all observations for all firms and years into one regression. This regression uses simultaneously firm information from different points of time in estimating the coefficients, and the regression has a higher degree of freedom and it is more efficient. The pooled regression model can be written as:

$$\tilde{R}_{it} = \gamma_{0} + \gamma_{1} \ \beta_{it} + \mathbf{\Gamma}_{2} \ \mathbf{X}_{i,t\text{-}1} + \varepsilon_{it}$$

$$t = 1,\ldots\ldots, T_{i}^{*} \qquad \text{and} \quad i = 1,\ldots, N,$$

where $\tilde{R}_{it}$ is the annual average of the monthly returns. T_{i}^{*} is the number of the years included in the study for firm i. Therefore the total number of observations in the pooled model is:

$$n = \sum_{i=1}^{N} T_{i}^{*} \ .$$

We now use annual average of the monthly returns when running the pooled regression instead of the monthly returns as in our cross-sectional regressions. Since we use the same observations for all explanatory variables in the monthly regressions during one year, the estimates from one single regression for average return in each year are the same as the

average estimates of the monthly coefficients in that year. Stacking the observations on a monthly basis will result in too large increase in degree of freedom, which makes the results highly significant without using any further information. The pooled regression model is estimated in the same manner as the CRS regressions and $\mathbf{V}$ is assumed to be block diagonal with $\mathbf{V}_t$ along the diagonal.

We use the Extreme Bound Analysis (EBA) as suggested by Leamer (1983) to examine the sensitivity of the estimated coefficients to changes in the number of the explanatory variables included in the model. EBA involves the following steps:

i) defining prior specifications: CAPM defines which explanatory variables should be included in the model. It means that beta is defined as an important variable and it is included in the model, and the other variables are considered as doubtful and they may be included or omitted.

ii) estimating the coefficients: we estimate all the regression models, which may result from inclusion of the important variable and all the possible combinations of the doubtful variables. There are 2^k possible combinations, where k is the number of doubtful variables.

iii) defining the extreme bounds for each coefficient: we define the extreme bounds for each coefficient, β, as the lowest and highest estimated values resulting from 2^k different regressions.

iv) verifying the sensitivity of the coefficients: we define a coefficient as sensitive if it changes signs or becomes insignificant at the extreme bounds.

3   *Data*

The data covers the period 1978 to 1990 and consists of stock returns which are corrected for dividends and capital changes like splits etc. The sample includes all share on the so-called "A1-listan" which means that the OTC shares are excluded. Our sample represents more than 95% of the market value of all shares. All information on book values is taken from the annual statements by the firms. The size variable is measured each year by the market value of the firm at the end of June. The leverage is the book value of total capital divided by the book value of equity: total capital is measured at the end of the fiscal year, which is in December for over 90% of the cases, and equity is measured at the end of December. The earnings/price factor is measured at the end of the fiscal year: the earnings are from the annual statement and the price is the market value of the firm at end of December. All information from the annual reports has been collected by us.

4   *Analysis*

First the results are presented from a one-factor model with beta as the only explanatory variable in the second pass regression. We also analyse the role of beta for driving return in states where the excess market return is positive and negative respectively. Finally, other explanatory variables will be included and we look at the effects of correcting for errors in variables and the use of a pooled regression.

A   One-factor equilibrium model

In this model CAPM is tested by estimating the price of beta-risk and the intercept using the method of Fama and MacBeth (1973) and correcting for errors in variables using Litzenberger and Ramaswamy (1979). CAPM is not rejected if the price of beta-risk is positive and

significant and the intercept is not significantly different from zero. We estimate for each month the following regression correcting for error in variables:

$$\mathbf{R}_t = \mathbf{I}_N\, \gamma_{0t} + \boldsymbol{\beta}_t\, \gamma_{1t} + \boldsymbol{\varepsilon}.$$

In Table 1 the estimates of the price of market risk is insignificant but it is positive except for the OLS-estimates. The intercept is positive but it is only significantly different from zero in the simplest model. The positive constant may be a sign that there are other factors taking care of market risk and/or there are other sources of risk besides the market risk; this hypothesis is analysed below in the multi-factor model. The insignificant beta may be due the fact that beta does not reflect market risk or the realised price of market risk, the realised excess market return, is non-positive.

B   Conditional factor model

We have seen above that beta captures some part of the market risk and its estimated price, γ_1, moves together with realised excess market return. However, we have found that the average price of beta over the whole period is not significantly different from zero. In this part we study if beta is priced differently in periods with positive versus periods with negative realised market return. Table 2 shows the result from the cross-sectional regressions. Beta has significant coefficients in both states: positive in good states and negative in bad states. The constant is significantly positive in good states and significantly negative (alt. 2) in bad states which implies that other factors may also drive returns in these states. Thus, beta is a very important variable for explaining cross-sectional differences among asset returns and its price is conditional on the sign of realised excess market returns.

C   Multi-factor equilibrium model

We now analyse if there are other explanatory variables besides beta that can explain cross-sectional variation in average stock returns. If stocks are priced rationally, systematic differences in average returns are due to differences in risk. As a result explanatory variables with significant coefficient should be proxies for sensitivities to common risk sources in returns. The variables are: firm size, book-to-market, leverage, positive earnings-price ratio and a dummy if the earnings-price ratio is negative.

The averages of the estimated coefficients from monthly OLS regressions and their *t*-values are reported in Table 3. Beta is never significant but it is positive except for the OLS-estimate that is still negative. Only the coefficient for the dummy variable E/P negative has a *p*-value below 0.10 for all methods. Variables like Size and Book-to-Market have a significant influence on return for some methods. But the Size variable has the "wrong" price.

The results from the pooled regression of annual data in Table 4 show that several variables are now significant and size and book-to-market has the same sign as in studies on U.S. data. The coefficient for beta is always positive but it is still not significantly different from zero. The coefficient for firm size is generally considered as a price of risk connected with small firms. The positive coefficient for book-to-market may, according to Fama and French (1992), be due to a leverage effect. But the contrarian camp explains the positive coefficient as a sign of market inefficiency: naive investors may be more willing to invest in low book to market firms because these firms performed well in the past and this behaviour will push up their prices and lower their expected returns. The same explanation might be given for the significantly negative coefficient for the earnings-price ratio.

An extreme bound analysis of the pooled regressions leads to very interesting results, see Table 5. On their own, neither the coefficient for the constant nor the coefficient for beta are significantly different from zero. However, they are both related to the size variable, if size is included the coefficient for the constant is always positive and significant and the coefficient for beta is positive but not significant. The coefficient for the size variable is always significantly negative.[3] The coefficients for book-to-market and earnings-price ratio are always significant if both variables are included, but on their own they are never significant. Notice that the significance of the coefficient for beta invariably drops when book-to-market and earnings-price ratio are included.[4] The correlation between the book-to-market factor and the earnings-price ratio is as high as 0.97, see Table 6, and the correlation between the coefficients is -0.98, see Table 7. This result is very different from Fama and French (1992) where the coefficient for earnings-price-ratio is positive and significant if book-to-market is left out, but together only the coefficient for book-to-market is significant. The coefficient for the leverage factor is never significant if the size variable is included. Finally, the coefficient for negative earnings-price ratio is never significant. All in all, it seems safe to say that, under all circumstances, the size variable plays an important role for explaining the cross sectional differences among asset returns.

5 Conclusion

In this paper we analyse the ability of beta and other factors to explain cross-sectional variation in average stock returns on the Swedish stock market for the period 1980-1990. We correct for errors in variables problem of the estimated market beta by using the method of Litzenberger and Ramaswamy (1979). In the second-pass regression we use a pooled

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[3] We have also performed the extreme bound analysis when first the constant is left out and secondly when beta

regression model besides OLS to estimate the risk premiums of the different factors, the pooled model gives more efficient estimates than to use separate cross-sectional regressions. The pooled regression is also used for an extreme bound analysis.

In the test of the simple one-factor equilibrium model beta is not priced but it still captures a lot of the market risk. The result may just be due to the fact that excess market return is not often positive enough in our sample. We share this problem with a lot of other investigations.

We find that beta is priced differently in periods with positive versus periods with negative realised market return. Beta has significant coefficients in both states and it is particularly influential in bad states. Thus, beta is a very important variable for explaining cross-sectional differences among asset returns and its price is conditional on the sign of realised excess market returns.

In the multi-factor equilibrium model we analyse if there are other explanatory variables besides beta that can explain cross-sectional variation in average stock returns. The variables are: firm size, book-to-market, leverage, earnings-price ratio and a dummy if the last variable is negative. In general, few variables are significant whether beta is corrected for errors in variables or not. The picture is different for the pooled regression on annual data: several variables are now significantly prized and size and book-to-market has the same sign as in studies on U.S. data. The coefficient for beta is positive but it is still not significantly different from zero.

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is left out. The coefficient of the size variable is robust even to these specifications.
[4] In fact, if the size factor is left out the coefficient of beta is negative.

In an extreme bound analysis of the pooled regressions we examine the sensitivity of the estimated coefficients to changes in the number of the explanatory variables. On its own the coefficient for beta is not significantly different from zero. But it is related to the size variable, if size is included the coefficient for beta is positive but not significant. The coefficient for the size variable is always significantly negative. The coefficients for book-to-market and earnings-price ratio are always significant if both variables are included. But these variables are highly positively correlated and their coefficients are highly negatively correlated. We conclude that the size variable seems to be most important for explaining the cross sectional differences among asset returns.

References

Chan, L .K. C. And J. Lakonishok, 1993, Are the reports of beta's death premature? *Journal of Portfolio Management*, Summer 1993, 51-62.

Fama, E. F. and K. R. French, 1992, The cross-section of expected stock returns*, Journal of Finance* 47, 427-465.

Heston, S. L., K. G. Rouwenhorst, and R. E. Wessels, 1997, The role of beta and size in the cross-section of internationa stock returns, *Working paper*, Washington University.

Huang, C and R. Litzenberger, 1998, *Foundation for financial economics*, North-Holland.

Isakov, D., 1997, Is beta still alive? Conclusive evidence from Swiss stock market*, Working paper*, HEC-Université de Genève.

Jagannathan, R. and Z. Wang, 1996, The conditional CAPM and the cross-section of expected returns, *Journal of Finance* 51, 3-53.

Kothari, S. P., J. Shanken, and R. G. Sloan, 1995, The CAPM: "Reports of my death have been greatly exaggerated", *Working paper*, Bradley Policy Research Center.

Lakonishok, J., A. Shleifer, and R. W. Vishny, 1994, Contrarian investment, extrapolation, and risk, *Journal of Finance* 49, 1541-1578.

Leamer, E., 1983, Lets take the con out of econometric, *American Economics Review* 73, 31-43.

Litzenberger, R. And K. Ramaswamy, 1979, The effect of personal taxes and dividends on capital asset prices, *Journal of Financial Economics* 7, 163-195.

Merton, R. C., 1980, On estimating the expected return on the market, *Journal of Financial Economics*, 323-361.

Pettengill, N. G., S. Sundaram, and I. Mathur, 1995, The conditional relationship between beta and returns, *Journal of Financial and Quantitative Analysis* 30, 101-117.

Table 1. One factor equilibrium model

The table reports the results of the one factor equilibrium model; when beta is used as the only measure of risk. The first rows in the table report the averages, standard errors, t-values, and the significance level of the estimated coefficients from the one factor cross-sectional model:

$$\mathbf{R}_t = \mathbf{I}_N \gamma_{0t} + \boldsymbol{\beta}_t \gamma_{1t} + \boldsymbol{\varepsilon}.$$

The cross-sectional model is estimated for 126 months, correcting the errors in variables problem. The t-statistics are computed as $t = \dfrac{\hat{\Gamma}}{\sigma(\hat{\Gamma})}$, where $\hat{\Gamma} = [\hat{\gamma}_0, \hat{\gamma}_1]$. $\hat{\Gamma}$ and $\sigma(\hat{\Gamma})$ are estimated by two alternative methods.

Alt. 1➡ $\qquad \hat{\Gamma} = \dfrac{\sum_t \hat{\Gamma}_t}{T} \qquad$ and $\qquad \sigma(\hat{\Gamma}) = \sqrt{\dfrac{\sum_t (\hat{\Gamma}_t - \hat{\Gamma})^2}{T(T-1)}}$

Alt. 2➡ $\qquad \hat{\Gamma} = \sum_t Z_t \hat{\Gamma}_t \qquad$ and $\qquad \sigma(\hat{\Gamma}) = \sqrt{\sum_t Z_t^2 \operatorname{var}(\hat{\Gamma}_t)},$

$\qquad$ where $Z_t = \dfrac{[\operatorname{var}(\hat{\Gamma}_t)]^{-1}}{\sum_t [\operatorname{var}(\hat{\Gamma}_t)]^{-1}}$ and $\operatorname{var}(\hat{\Gamma}_t)$ is the estimated variance for the $\hat{\Gamma}_t$

$\qquad$ from the cross-section regressions at time t.

		OLS		WLS		EIV-corrected	
		Constant	**Beta**	**Constant**	**Beta**	**Constant**	**Beta**
Alt. 1	Coeff.	0.873	-0.232	0.66	0.10	0.58	0.17
	Std	0.476	0.364	0.52	0.40	0.70	0.77
	t-value	1.833	-0.637	1.27	0.21	0.84	0.22
	p-value	0.07	0.52	0.25	0.80	0.40	0.83
Alt. 2	Coeff.	0.82	-0.13	0.49	0.24	0.29	0.48
	Std	0.21	0.20	0.21	0.21	0.38	0.38
	t-value	3.82	-0.66	2.30	1.15	0.76	1.27
	p-value	0.00	0.51	0.02	0.25	0.45	0.21

Table 2. Monthly cross-sectional regressions for periods with positive and negative excess market returns

The table reports the averages for the estimated coefficients from the one factor cross-sectional model for periods with positive and negative realised market return respectively. The estimates from the monthly regressions, $\hat{\gamma}_{0t}$ and $\hat{\gamma}_{1t}$, are divided into two periods and the test is performed separately for each period. The *t*-statistics for each period are computed as

$$t = \frac{\hat{\Gamma}}{\sigma(\hat{\Gamma})}, \text{ where } \hat{\Gamma} = [\hat{\gamma}_0, \hat{\gamma}_1]. \ \hat{\Gamma} \text{ and } \sigma(\hat{\Gamma}) \text{ are estimated by two alternative methods.}$$

Alt. 1➔
$$\hat{\Gamma}^+ = \frac{\sum_t (\hat{\Gamma}_t | R_{mt} \geq 0)}{T^+} \quad \text{and} \quad \sigma(\hat{\Gamma}^+) = \sqrt{\frac{\sum_t ([\hat{\Gamma}_t | R_{mt} \geq 0] - \hat{\Gamma}^+)^2}{T^+(T^+ - 1)}}$$

Alt. 2➔
$$\hat{\Gamma}^+ = \sum_t Z_t (\hat{\Gamma}_t | R_{mt} \geq 0) \quad \text{and} \quad \sigma(\hat{\Gamma}^+) = \sqrt{\sum_t Z_t^2 \ \text{var}(\hat{\Gamma}_t) | R_{mt} \geq 0},$$

$$\text{where } Z_t = \frac{[\text{var}(\hat{\Gamma}_t | R_{mt} \geq 0)]^{-1}}{\sum_t [\text{var}(\hat{\Gamma}_t | R_{mt} \geq 0)]^{-1}} \quad \text{and} \ \text{var}(\hat{\Gamma}_t) \text{ is the estimated variance for}$$

the $\hat{\Gamma}_t$ from the cross-section regressions at time *t*. T^+ is the number of periods with positive excess market returns.

The estimates for the negative periods, $\hat{\Gamma}^{-1}$ and $\sigma(\hat{\Gamma}^{-1})$ are derived in an analogous manner.

		Positive		Negative	
		Constant	**Beta**	**Constant**	**Beta**
Alt. 1	Coeff.	2.11	2.67	-1.52	-3.28
	Std	0.82	0.84	1.16	1.29
	t-value	2.58	3.18	-1.32	-2.54
	p-value	0.01	0.00	0.19	0.01
Alt. 2	Coeff.	1.67	2.01	-1.77	-1.82
(Weighted)	Std	0.49	0.49	0.60	0.60
	t-value	3.39	4.10	-2.94	-3.03
	p-value	0.00	0.00	0.00	0.00

Table 3 Monthly cross-sectional regressions for the multi-factor model

The table reports the averages for the estimated coefficients from the multi-factor cross-sectional model.

$$\mathbf{R}_t = \mathbf{I}_N \gamma_{0t} + \boldsymbol{\beta}_t \gamma_{1t} + \mathbf{X}_{t-1} \boldsymbol{\Gamma}_{2t} + \boldsymbol{\varepsilon}_t,$$

where $\mathbf{R}_t = (R_{1t},\dots R_{Nt})'$ is the vector of return in excess of the risk free rate for N assets, $\boldsymbol{\beta}_t = (\beta_{1t},\dots \beta_{Nt})'$ is the true market beta vector; $\mathbf{X}_{t-1}$ is a $N \times K$ matrix which includes K explanatory variables.

The cross-sectional model is estimated for 126 months. The t-statistics are computed as $t = \dfrac{\hat{\Gamma}}{\sigma(\hat{\Gamma})}$, where $\hat{\Gamma} = [\hat{\gamma}_0, \hat{\gamma}_1, \hat{\Gamma}_2]$. $\hat{\Gamma}$ and $\sigma(\hat{\Gamma})$ are estimated by two alternative methods.

Alt. 1➔ $\qquad \hat{\Gamma} = \dfrac{\sum_t \hat{\Gamma}_t}{T}$ $\qquad$ and $\qquad \sigma(\hat{\Gamma}) = \sqrt{\dfrac{\sum_t (\hat{\Gamma}_t - \hat{\Gamma})^2}{T(T-1)}}$

Alt. 2➔ $\qquad \hat{\Gamma} = \sum_t Z_t \hat{\Gamma}_t$ $\qquad$ and $\qquad \sigma(\hat{\Gamma}) = \sqrt{\sum_t Z_t^2 \, \mathrm{var}(\hat{\Gamma}_t)},$

$\qquad$ where $Z_t = \dfrac{[\mathrm{var}(\hat{\Gamma}_t)]^{-1}}{\sum_t [\mathrm{var}(\hat{\Gamma}_t)]^{-1}}$ and $\mathrm{var}(\hat{\Gamma}_t)$ is the estimated variance for the $\hat{\Gamma}_t$ from the cross-section regressions at time t.

		Constant	Beta	Size	Book To Market	Leverage	E/P Positive	E/P Negative Dummy
OLS	Coeff.	0.10	-0.32	0.07	0.51	-0.02	1.30	-1.16
	Std	9.24	3.69	1.13	3.61	0.52	13.78	6.23
	t-value	0.13	-0.97	0.70	1.60	-0.36	1.06	-2.09
	p-value	0.90	0.33	0.48	0.11	0.72	0.29	0.04
WLS	Coeff.	0.02	0.08	0.04	0.61	-0.01	0.63	-0.98
	Std	0.90	0.37	0.11	0.32	0.05	1.19	0.54
	t-value	0.02	0.22	0.32	1.89	-0.18	0.53	-1.82
	p-value	0.98	0.83	0.75	0.06	0.86	0.60	0.07
WLS Weighted	Coeff.	-0.43	0.12	0.06	0.19	0.00	-0.08	-0.70
	Std	0.44	0.23	0.06	0.10	0.01	0.22	0.41
	t-value	-0.98	0.50	1.13	1.88	0.30	-0.36	-1.70
	p-value	0.33	0.62	0.26	0.06	0.77	0.72	0.09
EIV-Corrected	Coeff.	0.50	1.94	-0.22	0.24	-0.04	0.77	-1.28
	Std	0.98	1.64	0.22	0.41	0.05	1.22	0.57
	t-value	0.51	1.18	-0.99	0.59	-0.91	0.63	-2.24
	p-value	0.61	0.24	0.32	0.55	0.36	0.53	0.03
EIV-Corrected Weighted	Coeff.	-0.63	0.22	0.18	0.20	0.00	-0.22	-0.95
	Std	0.51	0.58	0.08	0.15	0.01	0.30	0.49
	t-value	-1.23	0.38	2.29	1.37	0.16	-0.73	-1.94
	p-value	0.22	0.70	0.02	0.17	0.88	0.47	0.05

Table 4 Multi-factor pooled regressions

The table reports the coefficients estimated by the multi-factor pooled regression model, with and without correcting for errors in variables.

$$\widetilde{R}_{it} = \gamma_0 + \gamma_1\,\beta_{it} + \mathbf{\Gamma}_2\,\mathbf{X}_{i,t-1} + \varepsilon_{it},$$

where $\widetilde{R}_{it}$ is the annual average of the monthly returns.

$$t = 1,\ldots,T_i^* \qquad \text{and} \qquad i = 1,\ldots,N.$$

T_i^* is the number of the years included in the study, which is equal to 11.

		Constant	Beta	Size	Book To Market	Leverage	E/P Positive	E/P Negative Dummy
OLS	Coeff.	2.98	0.14	-0.47	0.41	0.00	-0.75	-0.55
	Std	0.80	0.41	0.10	0.14	0.01	0.27	0.62
	t-value	3.71	0.33	-4.53	2.89	-0.17	-2.84	-0.90
	p-value	0.00	0.74	0.00	0.00	0.86	0.00	0.37
WLS	Coeff.	3.94	0.50	-0.66	0.64	0.00	-1.18	-1.10
	Std	0.83	0.47	0.11	0.19	0.02	0.35	0.78
	t-value	4.73	1.07	-6.13	3.43	0.24	-3.34	-1.41
	p-value	0.00	0.29	0.00	0.00	0.81	0.00	0.16
EIV-Corrected	Coeff.	3.00	1.05	-0.65	0.71	0.01	-1.27	-1.46
	Std	1.00	1.03	0.13	0.24	0.02	0.45	0.89
	t-value	3.01	1.02	-5.06	2.94	0.47	-2.81	-1.65
	p-value	0.00	0.31	0.00	0.00	0.64	0.01	0.10

Table 5. Sensitivity analysis

The table reports the coefficients and their *t*-values resulted from the extreme bounds analysis of the multi-factor pooled regression model, correcting for errors in variables.

Constant		Beta		Size		Book To Market		Leverage		E/P Positive		E/P Negative Dummy	
Coeff	*t*-value	Coeff	*t*-value	Coeff	*t*-value	Coeff	*t*-value	Coeff	*t*-value	Coeff	*t*-value	Coeff	*t*-value
3.00	3.01	1.05	1.02	-0.65	-5.06	0.71	2.94	0.01	0.47	-1.27	-2.81	-1.46	-1.65
2.80	2.83	1.05	1.01	-0.62	-4.90	0.64	2.71	0.01	0.34	-1.14	-2.56		
3.41	3.38	1.66	1.71	-0.74	-6.10	0.05	0.95	0.01	0.30			-1.01	-1.15
3.06	3.10	1.04	1.01	-0.65	-5.07	0.70	2.92			-1.26	-2.78	-1.43	-1.62
3.51	3.47	1.71	1.75	-0.75	-6.24			0.00	0.29	0.02	0.23	-1.00	-1.13
-0.58	-0.65	-0.53	-0.58			1.08	4.75	0.01	0.56	-1.91	-4.46	-0.83	-0.94
3.24	3.24	1.62	1.66	-0.72	-6.01	0.05	0.94	0.00	0.22				
3.45	3.45	1.65	1.70	-0.74	-6.10	0.05	0.95					-0.99	-1.13
2.85	2.91	1.04	1.01	-0.62	-4.91	0.64	2.69			-1.14	-2.55		
-0.61	-0.69	-0.50	-0.55			1.03	4.67	0.01	0.49	-1.82	-4.37		
-0.76	-0.85	0.09	0.10			0.10	1.76	0.01	0.30			0.05	0.06
-0.51	-0.58	-0.55	-0.60			1.07	4.73			-1.90	-4.43	-0.79	-0.90
-0.73	-0.81	0.13	0.14					0.00	0.28	0.06	0.58	0.11	0.13
3.33	3.33	1.66	1.71	-0.73	-6.17			0.00	0.21	0.03	0.27		
3.52	3.50	1.71	1.75	-0.76	-6.27			0.00	0.29			-1.00	-1.14
3.54	3.54	1.70	1.74	-0.75	-6.25					0.02	0.23	-0.98	-1.11
3.27	3.30	1.61	1.66	-0.72	-6.02	0.05	0.94						
-0.76	-0.85	0.09	0.10			0.10	1.76	0.01	0.31				
3.35	3.36	1.66	1.71	-0.73	-6.19			0.00	0.21				
-0.56	-0.63	-0.52	-0.57			1.02	4.66			-1.82	-4.35		
3.36	3.39	1.65	1.71	-0.73	-6.17					0.03	0.27		
-0.72	-0.80	0.13	0.14					0.00	0.29	0.06	0.58		
-0.70	-0.78	0.11	0.13					0.00	0.28			0.10	0.12
-0.72	-0.82	0.08	0.09			0.10	1.75					0.07	0.08
3.56	3.57	1.69	1.74	-0.76	-6.27							-0.99	-1.12
-0.69	-0.78	0.11	0.13							0.06	0.58	0.13	0.15
3.38	3.42	1.65	1.71	-0.73	-6.19								
-0.72	-0.82	0.08	0.09			0.10	1.76						
-0.70	-0.78	0.11	0.13					0.01	0.29				
-0.69	-0.78	0.11	0.13							0.06	0.58		
-0.67	-0.75	0.10	0.11									0.12	0.14
-0.66	-0.75	0.10	0.11										
Min. -0.76	-0.85	-0.55	-0.60	-0.76	-6.27	0.05	0.94	0.00	0.21	-1.91	-4.46	-1.46	-1.65
Max. 3.56	3.57	1.71	1.75	-0.62	-4.90	1.08	4.75	0.01	0.56	0.06	0.58	0.13	0.15

Table 6. Correlation matrix of the explanatory variables

The table reports the correlation matrix of the explanatory variables based on the total number of observations.

	Beta	Size	Book To Market	Leverage	E/P Positive	E/P Negative Dummy
Beta	1.00					
Size	0.14	1.00				
Book To Market	-0.01	-0.13	1.00			
Leverage	-0.03	-0.06	-0.01	1.00		
E/P Positive	-0.05	-0.07	0.97	0.00	1.00	
E/P Negative Dummy	0.06	-0.23	0.03	0.14	-0.03	1.00

Table 7. Correlation matrix of the coefficients estimated by the pooled regression

The table reports the correlation matrix of the estimated coefficients estimated by the multi-factor pooled regression model, correcting for errors in variables.

	Constant	Beta	Size	Book To Market	Leverage	E/P Positive	E/P Negative Dummy
Constant	1.00						
Beta	-0.29	1.00					
Size	-0.86	-0.20	1.00				
Book To Market	-0.23	-0.20	0.25	1.00			
Leverage	-0.09	0.02	0.03	0.07	1.00		
E/P Positive	0.20	0.20	-0.23	-0.98	-0.07	1.00	
E/P Negative Dummy	-0.17	-0.06	0.19	-0.18	-0.14	0.19	1.00