

STOCKHOLM SCHOOL OF ECONOMICS

Bachelor Thesis in Finance 2010

## **The New Swedish Beta: a Study of Single-Factor Domestic CAPM Mispricing by Swedish Industry**

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**Abstract:** This study investigates the implementation of the domestic and European single-factor capital asset pricing model in 8 of the largest industries in Sweden. The models are compared to the single-factor global CAPM model and the levels of mispricing are derived. It is found that the domestic model produces significant mispricing values in both the Basic Materials and Health Care sectors while the European model does not result in any significant mispricing values. The greater magnitude of mispricing within the domestic model in comparison to the European counter-part leads to the conclusion that the domestic model is not always efficient in capital cost computations in today's globalized economy.

**Keywords:** cost of capital; single-factor CAPM; globalization

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## **1. Introduction & Previous Literature**

Risk analysis and calculating the cost of capital is crucial in the performance valuation of firms and asset pricing in general. Since capital costs are a critical element in valuation models this has become a main topic of discussion since the earliest literature within the financial sector. The field was pioneered by Markowitz (1952) with “Portfolio Selection” and Sharpe (1964) with “Theory of Market Equilibrium” who presented the basic framework and assumptions imperative in the models applied by practitioners today. One of the most widespread and popular models applied today is the single-factor capital asset pricing model (CAPM) which was developed independently by Treynor (1961), Lintner (1965) and Mossin (1966). It is one of the earliest risk models developed within the field but is still utilized to a great extent due to its simplicity of application while still producing meaningful and applicable results.

The single-factor CAPM is a simple time-series regression model that regresses an assets or portfolios returns against a given market portfolio return. The  $\beta$ -value of the regression is a measure of the asset returns exposure to systematic, or market-wide risks. These risks include macroeconomic variables affecting the market as a whole such as interest rates, economic growth, taxes, etc. Since systematic risks cannot be diversified in an investor’s portfolio a risk premium is received to compensate for the exposure to such risks. In other words the CAPM separates these systematic risks from idiosyncratic, asset specific, risks and provides a framework for investors to calculate a realistic risk premium for all types of assets. This risk premium is then added to the market risk-free rate, to get a value of expected return, and used as either a hurdle rate for new projects or applied in the discounted cash flow framework to calculate present value of investments/assets.

The original CAPM model, as was adopted in the United States shortly after its development, makes use of a domestic market returns to represent systematic risks. This was natural at the time as the level of international financial integration was low, and also for the reason that the US economy, in the 60’s and 70’s made up a considerable portion of the global economy. Therefore, investors could make use of the domestic model that assumes that the domestic market is entirely isolated from foreign markets. According to Kaplan and Ruback (1995) this method of using a broad domestic market index as a proxy for market-returns is still applied by

practitioners. The situation however, has now changed and in the post-1980 era it is clear that the majority of world markets have become exceedingly integrated as restrictions to capital movement have become more liberal and communications technologies more efficient. This recent phenomenon is commonly referred to as globalization. Globalization advocates that cost of capital computations should be performed on a global basis, and a world market index should be used as a proxy for market returns. This however does not necessarily imply that a domestic version does not produce an accurate measure, but that the domestic market must contain all information needed to price assets on a global basis. If this information is not available in the domestic market the domestic model will give an inaccurate representation of the risks assumed, and thus prove to be inappropriate.

Existing literature on domestic CAPM miscalculation is relatively extensive, but generally focused on the largest most developed economies of the world such as the US and the European Union in its entirety. These studies include Koedijk et al (1999) who compare global and domestic single-factor models when applied in the case of single assets with the EU. They find that significant mispricing occurs in 7% of their investigated firms. Hau (2009) tests the case on global basis using a limited arbitrage model in an event study of a MSCI index revision and finds that MSCI stocks are all priced on a global basis. Studies focusing on mispricing in individual assets are also abundant such as Stulz (1995) study of mispricing in the firm Nestlé and Koedijk et al (1999) who also included an example of the firm Lafarge.

Smaller economies such as Sweden have very limited literature and therefore, notoriously take after the recommendations presented in the literature focused on studying larger economies. This practice of taking after leading economies can be problematic, as there exist many differences when comparing the Swedish market to the US or EU market with respect to global integration, existing institutions and most importantly systematic risks. Therefore it seems unreasonable to assume that the Swedish market contains the same level of information as, lets say, the European market in its entirety. The amount of existing literature and lack of studies conducted focusing on the Swedish market exclusively presents an opportunity to apply already developed theories and methods of study to draw relevant conclusions and insights relevant to Swedish practitioners. This brings us to the research question of this study: Does the Swedish domestic market contain enough information to value assets on a global basis? This will be answered by the question of; Does the application of the

domestic CAPM in Sweden result in significant risk miscalculation in comparison to the, what we today assume to be the correct in light of our integrated global economy, global model. I will further extend the study to incorporate a European CAPM model to emphasize the differences in mispricing between a model utilizing a relatively large integrated market as an indicator for systematic risks and one using a smaller market.

The studies focus will be on evaluating the single-factor domestic Swedish CAPM and European CAPM against their global counterpart. The focus on studying single-factor models is due to the popularity of these models in practice and that the global single-factor version could be used as a similar viable alternative. Even though more sophisticated models exist and may in certain cases produce a better result in valuation empirically, they have not been adopted to a broad extent due to their complexity. Graham and Campbell (1999) find that approximately 74% of firms apply the single-factor domestic CAPM. These results suggest that the common practitioner weighs the benefits of a better empirical result against the complications of the given risk/valuation model. Keck, Levengood and Longfield (1998) also reached this typical conclusion that there are substantial differences in what models are mainly used in practice and the models that are pioneering academic research. Thus, focus will lie on what is commonly applied in practice in order to draw conclusions relevant for active investors and firms today.

The methodologies applied are mainly adopted from Stulz (1995) study of mispricing of the firm Nestlé due to its popularity in financial literature, pedagogical framework and simplicity of application. I will further develop this method by applying the approach described by Koedijk et al (1999) to evaluate the significance of mispricing calculations. The lack of such calculations is a clear limitation in Stulz's study as he found evidence of mispricing but included no discussion of the significance of his figures. After the application of these methods my findings include strong evidence of mispricing in two of the eight examined industry portfolios when applying the Swedish model as opposed to finding no strong evidence of mispricing when applying the European model. The general magnitude of mispricing was also larger in the domestic model in comparison to the European. These results are in line with the main argument presented by Stulz (1995), that small economies should apply the global model in their cost of capital calculations. It is somewhat surprising that mispricing wasn't significant in more industries when using the domestic model, but may be a result of the limited dataset that could be applied. The results still suggest

that information needed to value assets on a global basis is not always abundant/efficient within domestic Swedish economy in general.

I will now commence this study by in, section 2, outlining the assumptions we are making in the study, explain the methodology involved in the analysis and justify the choice of data and proxy variables used in the models. In section 3 I will apply empirically the methodologies described in section 2. Continuing to section 4 we will present the results of applied models in section 3. Finally we will present and elaborate conclusions and the implications of found results in section 5.

## **2.1 Underlying Assumptions**

In order to be able to reach conclusions and enable us to analyze produced results in this study we need to first outline the general assumptions that are required in order for the CAPM to hold. In other words, the real world needs to be thought of using some simplifications in order for our model to fit correctly. The first two assumptions elaborated below are derived from the earlier stated works by Markowitz (1952) and Sharpe (1964) and are the foundations that the CAPM was built upon. The final assumption is typically made in similar studies to this and allows us to apply the global single-factor model.

(1) We begin by establishing the assumption of perfect markets/market efficiency. This entails that there is *perfect competition* within the market and no single investor or firm can affect asset prices. This assumption also states that there exist *no market frictions* such as taxes or any other form of transaction costs. This assumption also means that all *assets and information within the economy are freely available* to all investors and asset prices react to new information without delay and to the right degree.

(2) The second assumption we make is that all *investors within the economy are identical*. In other words they all have the same holding period, identical expectations and act in accordance with mean-variance optimization.

The lack of market frictions or the prevalence of market efficiency in the first assumption implies that investors can borrow and lend at the same risk-free rate, which is one of the most crucial assumptions for the CAPM to hold. The implications

of the combination of the first and the second assumption are that all investors hold the same efficient portfolio. Thus, the assumptions in their strict forms necessitate that all investor portfolios are scale replicas of the market portfolio and only differ with respect to size. If market frictions are assumed to exist then there would be deviations in investor portfolios from the market portfolio and borrowing and lending rates would diverge, this would quickly complicate the analytical process. Transaction costs in the real world vary to a very large extent and creating any reliable model including these would be very difficult. It is also important for the simplicity of the CAPM that all investors display the same behavior and solve for the same portfolio of assets and therefore value exposure to systematic risks similarly.

These first two assumptions are critical for the model itself to hold and are typically present in similar studies performed within the topic. In order to simplify our analysis and statistical strategy implemented I formulate one last assumption, associated with purchasing power parity (PPP), as stated below:

(3) The third assumption made is that PPP differences and changes do not exist or are not significant enough to cause significant changes in the general price level of assets.

The third assumption made regarding PPP allows us to neglect including the real world PPP differences and changes, or exchange rate premiums, in the global model. This is incorporated to keep the international equivalent of the CAPM at the same level of simplicity as the domestic model. In other words we can, via this assumption, apply the global single-factor model in our analysis.

## **2.2 Methodology**

The statistical methods applied in this paper are, as earlier acknowledged, focused around evaluating the basic single-factor CAPM models. This is now natural after the earlier stated assumptions and the implications of them. Investors will determine the amount of risk each asset adds to this portfolio solely by the securities beta values, when regressed against the market excess return. We will be investigating two extreme cases: when the market portfolio is defined as purely domestic basis and on a global basis and later evaluate what level of mispricing can be expected using the

different models. I will also include a form of middle ground model, which takes the EU portfolio as given market portfolio. It is reasonable to assume that Sweden is relatively well integrated with the rest of the European economy after the institutionalization of the EU, which greatly opened up the European economy.

### 2.2.1 The Domestic Swedish CAPM

The traditional case is that beta values are calculated off of the domestic market portfolio as explained in section 1. This model makes the assumption that Swedish investors only hold Swedish assets and that these assets cannot be held by anyone other than Swedish investors. In other words it makes the supposition that Swedish capital markets are entirely isolated from the global capital market and asset prices are decided purely on a domestic basis. The regression for this that we will perform in the study is:

$$(R_i - R_f) = \alpha_S + \beta_{iS}(R_S - R_f) + \varepsilon_S \quad (I)$$

- V  $R_i$ =return on individual asset i expressed in a specific currency
- V  $R_f$ =is the risk-free rate available in the specific currency
- V  $R_S$ =return of the Swedish market portfolio in a specific currency
- S  $\alpha_S$ =is the constant value present in domestic model
- S  $\beta_{iS} = \text{Cov}(R_i - R_f, R_S - R_f) / \text{Var}(R_S - R_f)$
- S  $\varepsilon_S$ =is a residual value

The statistical output of the model  $\alpha_S$ ,  $\beta_{iS}$  and  $\varepsilon_{iS}$  represent, respectively, a constant value which optimally takes on the value 0 when the model holds, the percentage of total domestic market variance explained by the covariance of asset return with respect to market return (showing asset exposure to domestic systematic risks) and a residual that cannot be explained by market-wide factors. The model can be split up into two parts, one representing systematic risks and another representing idiosyncratic risks.  $\beta(R_S - R_f)$  represents the systematic part of returns while  $\varepsilon_S$  represents the idiosyncratic risks.

### 2.2.2 The Global CAPM

In the earlier stated model we are making what we might consider, in modern times, an unreasonable assumption that the Swedish market is entirely separate/isolated from all other markets. To test this empirically I will need a model that makes a reverse assumption and compare the resulting risk measures, this assumption is that world capital markets are entirely open and Swedish investors hold the entire global market portfolio to scale. This model is performed by a similar regression to the domestic model, due to implications of earlier outlined assumption 3, but replacing the domestic market excess return ( $R_S - R_f$ ) with the global market excess return ( $R_W - R_f$ ) resulting in the global CAPM model:

$$(R_i - R_f) = \alpha_w + \beta_{iW}(R_W - R_f) + \varepsilon_w \quad (\text{II})$$

- V  $R_i$ =return on individual asset i expressed in a specific currency
- V  $R_f$ =is the risk-free rate available in the standard currency
- V  $R_W$ =return of the global market portfolio in a standard currency
- S  $\alpha_w$ =is the constant value present in domestic model
- S  $\beta_{iW} = \text{Cov}(R_i - R_f, R_W - R_f) / \text{Var}(R_W - R_f)$
- S  $\varepsilon_w$ =is a residual value

The statistical output of this model is very similar to domestic model but  $\beta_{iW}$  here represents the percentage of total global market variance explained by the covariance of asset return with respect to global market return (showing asset exposure to global systematic risks). Similar to the domestic model, the model can be split into two parts;  $\beta_{iW}(R_W - R_f)$  which represents asset risk associated with global systematic risks and  $\varepsilon_{iS}$  which represents idiosyncratic asset risks on a global basis. It is important to note here that global and domestic systematic risks are not necessarily the same and this is the issue that leads to mispricing.

### 2.2.3 The European Union CAPM

As I have now included two extreme cases in our methodology we add a final model to test a form of "middle ground". This model will be based on calculating risk on an EU basis and thus making the assumption that EU markets are entirely open and that investors within the EU hold scale replicas of the EU market portfolio, but also that the EU is isolated from the rest of world markets. This may be closer to reality

than assuming that Sweden is entirely integrated into the world economy. This EU CAPM model is as follows:

$$(R_i - R_f) = \alpha_E + \beta_{iE}(R_E - R_f) + \varepsilon_E \quad (\text{III})$$

- V  $R_i$ =return on individual asset i expressed in a specific currency
- V  $R_f$ =is the risk-free rate available in the standard currency
- V  $R_E$ =return of the EU market portfolio in a standard currency
- S  $\alpha_E$ =is the constant value present in domestic model
- S  $\beta_{iE}$ =Cov( $R_i - R_f$ ,  $R_E - R_f$ )/Var( $R_E - R_f$ )
- S  $\varepsilon_E$ =is a residual value

This model is identical to the previous two models with the sole difference being that the market excess return is here the EU market excess return and systematic and idiosyncratic risks represented in the model are now on an EU basis.

### 2.3 Analyzing Empirical Fit: Methodology

I have now outlined the three competing models of this study. What remains is how to analyze the empirical fit of each of the models. Which model understates/overstates the risk? This is where the methodologies introduced by Stulz (1995) are applied. In light of the recent globalization phenomenon I take the global model as given and compare the domestic and EU versions respectively against this benchmark to find mispricing values. The method of calculating domestic mispricing is summarized below, while the method of finding EU mispricing is identical but replacing the domestic model/output with EU model counterparts.

I begin my statistical analysis of when the domestic CAPM is suitable and when it leads to substantial mispricing by first conducting a global CAPM on the Swedish market as whole:

$$(R_S - R_f) = \alpha + \beta_{SW}(R_W - R_f) + \varepsilon_{SW} \quad (\text{IV})$$

This model makes the assumption that the Swedish market is entirely incorporated into the global market. Here  $\beta_{SW}$  shows us the exposure of the Swedish market as a whole to global systematic risks. I can then insert the beta value from the domestic CAPM into this model to result in a model for individual asset return calculated using

domestic CAPM. This model will be in turn assuming markets are perfectly integrated globally. The model looks as follows:

$$(R_i - R_f) = \alpha + \beta_{iS}\beta_{SW}(R_W - R_f) + \varepsilon_{iSSW} \quad (\text{V})$$

This model and the global CAPM model calculate the same asset risk exposures but the latter model assumes markets are entirely integrated but CAPM is still performed domestically, thus it can be stated that the domestic and global CAPM compute identical risk measures when:

$$\beta_W = \beta_S\beta_{SW} \quad (\text{VI})$$

When these are equal the domestic market contains enough information to price assets on a global basis. If these measures are not equal, the domestic CAPM has mispriced the riskiness of the asset and there exist discrepancies between risks that can be diversified on a domestic basis but not globally or vice versa. The degree of beta miscalculation can then be seen by:

$$\beta_W - \beta_S\beta_{SW} = x \quad (\text{VII})$$

where x in the above equations represents the amount of miscalculation. When x is negative the domestic CAPM has overestimated the risk of the asset and when positive it has underestimated risk.

The intuition behind what causes the local and global CAPM to result in different measures of risk can be seen through the following equation<sup>2</sup>:

$$\beta_W = \beta_S\beta_{SW} + [Cov(\varepsilon_{iS}, (R_W - R_f)) / Var(R_W - R_f)] \quad (\text{VIII})$$

Which shows that the two models calculate the same level of risk only when the residual of the domestic CAPM,  $\varepsilon_S$ , is uncorrelated with global market excess returns. In other words risks that are diversifiable domestically must also be diversifiable globally otherwise the models will result in different measures of risk. If these risks are not diversifiable globally then the domestic CAPM will understate the risk exposure, as it disregards these risks. On the other hand if there are risks that are diversifiable globally but not on a domestic basis the domestic model will overstate the systematic risk exposure.

The method then employed to calculate the significance of the mispricing figures comes down to testing the relationship between domestic idiosyncratic risks and global systematic risks. This can be performed by regressing the residual from the

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<sup>2</sup> Appendix I: Derivation of equation (VIII)

domestic model (representing domestic idiosyncratic risk), against global excess returns (representing global systematic risk). This regression looks as follows:

$$\varepsilon_{iS} = \alpha_{\varepsilon} + \beta_{i\varepsilon}(R_W - R_f) + \varepsilon_{\varepsilon} \quad (\text{IX})$$

The significance of  $\beta_{i\varepsilon}$  corresponds to the significance of the mispricing term. This can be seen via the expression for the calculated  $\beta_{i\varepsilon}$  in equation IX:

$$\beta_{i\varepsilon} = [\text{Cov}(\varepsilon_{iS}, (R_W - R_f)) / \text{Var}(R_W - R_f)] \quad (\text{X})$$

This is the same as the second part of equation (VIII) and therefore we can draw the conclusions if we receive a statistically significant beta in regression (IX) we will have significant mispricing. A negative beta will correspond with under-pricing and positive with over-pricing. This effect can be clearly seen in equation (XI) below. The amount of mispricing of returns can be finally condensed to an expression in terms of the beta value in equation (X) by simply multiplying this beta with the global market expected return and, thus:

$$E(R_{Asset}^{Global}) - E(R_{Asset}^{Domestic}) = \beta_{i\varepsilon}(R_W - R_f) \quad (\text{XI})$$

This equation also helps us understand the methodology of calculating statistical significance. It makes it clearly seen that if  $\beta_{i\varepsilon}$  is statistically significant there will be a significant difference in returns calculated using global method and those calculated using the domestic method.

## 2.4 Dividend Discount Model

The found expected returns in the above described CAPM can then be applied in a discounted cash-flow framework in order to value the given asset. The framework that will be implemented in this study was presented by Gordon (1962) and is commonly referred to as the dividend discount model:

$$\text{Stock Value} = \frac{\text{Dividend}}{r - g} \quad (\text{XII})$$

V  $r$ =cost of capital (as calculated by the CAPM)

V  $g$ =dividend growth rate

The model assumes that dividends grow at a constant rate and that the firm will continue indefinitely. It also assumes that the cost of capital is constant throughout the firms existence. The actual dividend is not vital when it comes to evaluating

percentage change in stock value and therefore a standard 1\$ dividend is commonly used and will also be applied in this study.

### **3. Data and Proxy variables**

The Return Database that I have compiled<sup>3</sup> to perform this study includes monthly return data from the 8 largest Swedish industries, using Datastream value-weighted Swedish industry index returns as a proxy, including the years Jan1990-Dec2007. I will be using similar corresponding value-weighted indices as a proxy for market returns, these returns have been compiled from MSCI Swedish, Euro-Wide and Global index values. As a proxy for the risk-free rate I have chosen to make use of the Swedish 1 month t-bill rate, which is during our period of study on average about 4.5%. All market price index values are expressed in one common currency; Swedish Kronor (SEK).

I will focus the study to find a general pricing error per industry in Sweden for the 8 largest industries. It has been found that grouping assets into portfolios leads to better measures of betas as a portfolio of assets has lower idiosyncratic risks due to the effects of diversification, this allows us to find a better value for exposure towards systematic risks. The practice of grouping assets into portfolios when implementing the CAPM was first introduced Black, Jensen and Scholes (1972). Some issues that arise when studying individual assets include; the high level of volatility of assets usually results in inconclusive significance testing, asset betas vary over time (due to changes in firm size, financing and risks) and high average measurement error. Asset portfolios improve each of these issues by diversification and produce clearer results at least to a certain extent.

The choice of using MSCI indexes for domestic, EU and global returns is due to that these indexes are used in most similar studies and are often applied by practitioners. Keeping our analysis as close to the methods used by practitioners is crucial to get a realistic representation of the actual mispricing that practitioners will incur when implementing the domestic instead of global approach. The choice of Datastream global equity indices for the industry returns is due to its broad stock coverage in their calculated price index, with a coverage of over 80% of entire industry capitalization. Thus, the Datastream indices provide a better coverage of the

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<sup>3</sup> Appendix II: Summary statistics of the compiled database used in the study

industries as a whole including a larger amount of both small and large cap stocks thus are better to apply when evaluating the aspects of an industry than an MSCI counterpart, which is limited to mostly large cap stocks.

Limiting the dataset to monthly prices post 1990 is due to Swedish institutional changes that occurred during the 1980's that liberalized capital flow regulation. The result of this is that Sweden has gone through a quick internationalization of capital markets and became well integrated with the rest of the developed world after 1990. The Swedish capital market was highly secluded from foreign markets in earlier decades making these decades uninteresting in this study as we assume globally integrated markets. These dates are also appropriate with respect to that European markets were integrated with the institutionalization of the EU during the time, which is beneficial when implementing the EU model. I will also limit the data to dates before the recent financial crisis which would, if included, add a lot of noise to the data making it more difficult to draw relevant conclusions. Most fluctuations during this period were purely governed by the volatile and shifting speculation of investors due to crisis. This leaves a total of 215 return values between these dates, which should be enough to draw conclusions but may prove to be a little low with respect to drawing conclusive/tight confidence intervals.

#### 4. Results

I now present the main results obtained when applying the outlined methodologies, in section 2, to the dataset presented in the previous section. I begin by applying the three different CAPM to the dataset and obtain estimates of beta for the eight different industries included in the study with respect to the Swedish, EU and World market indices<sup>4</sup>. The models are represented by equations (I), (II) and (III) in section 2. The beta estimates found after performing the regressions are presented in the table below:

Table 1: Industry (represented by Datastream industry indices) Beta values with respect to MSCI Sweden, Europe and World market indices

$\beta_{\text{INDUSTRY}}$	MSCI Sweden	MSCI Europe	MSCI World
<b>Consumer Goods</b>	0.760	1.081	1.100
<b>Basic Materials</b>	0.824	1.224	1.295
<b>Industry</b>	0.910	1.242	1.350
<b>Health Care</b>	0.538	0.870	0.934
<b>Consumer Services</b>	0.737	0.917	1.007

<sup>4</sup> Appendix III: The regression output obtained when implementing the Swedish, European and Global CAPM models

<b>Telecom</b>	0.907	1.137	1.199
<b>Finance</b>	0.981	1.339	1.421
<b>Technology</b>	1.343	1.403	1.642

It is clear that the found beta values increase for every sector as the market proxy utilized broadens. This tells us that the Swedish and European coefficient of exposure towards global systematic risks must be greater than average exposure (average market coefficient of exposure towards global systematic risks is 1, therefore Sweden and EU must have a beta-value greater than 1). After performing regressions on the Swedish and EU markets as whole, as shown in equation (IV), we find that this conclusion is true. It is also evident, as one would expect, that the EU market exposure coefficient is lower than the Swedish coefficient. This is natural due to the much larger size of the EU portfolio, as it includes a much larger portion of the global portfolio in comparison to the Swedish portfolio its beta estimate is closer to the average country beta, 1.

Table 2: Swedish and European market global beta (MSCI)

$\beta_{\text{MARKET}}$	<b>MSCI World</b>
<b>MSCI Sweden</b>	1.349
<b>MSCI Europe</b>	1.057

I then continue my statistical strategy by applying equation (VII) to find values for beta miscalculation<sup>5</sup>. Note that there is a difference in beta miscalculation and asset mispricing, beta miscalculation is the difference in the global beta implied by the domestic model and the actual global beta, while mispricing is the difference in implied returns of the two models. The beta miscalculation term can be applied in equation (XI) to find return mispricing. Before this is done it is important to derive if the calculated values are statistically significant or not. The resulting beta deviations, with respect to the global CAPM, and the results of the significance tests<sup>6</sup> (performed using a standard 95% confidence interval) are presented below:

Table 3: Swedish and European model Beta deviation in comparison to Global model as calculated by equation (VII) (significant values are marked by \*)

$\beta$ Deviation	<b>MSCI Sweden</b>	<b>MSCI Europe</b>
<b>Consumer Goods</b>	0.075	-0.043
<b>Basic Materials</b>	0.183*	0.001
<b>Industry</b>	0.122	0.037
<b>Health Care</b>	0.208*	0.014
<b>Consumer Services</b>	0.013	0.038
<b>Telecom</b>	-0.105	-0.003
<b>Finance</b>	0.098	0.006
<b>Technology</b>	-0.17	0.159

<sup>6</sup> Appendix IV: Output from significance testing of the mispricing figures

Equation (VII) shows that positive miscalculations mean that the domestic model has under-estimated risk while negative values entail over-estimation. When observing the results of beta miscalculation it is clear that Sweden's degree of miscalculation is higher than that of the EU. The industries Basic Materials and Health Care both display significant pricing errors when using the Swedish model, but when the European model is applied these values are very close to zero and are far from significant. The resulting p-values<sup>7</sup>, associated with betas in significance testing, were substantially lower for tests involving domestic model than those found for the European model. This also suggests a better empirical fit of the European model as it shows that mispricing values deviate stronger from 0 in the domestic model.

I can now use these values found above to obtain values for how much the models misprice cost of capital, in terms of basis points. This is done by inserting values from the table above into equation (XI) from our methodology (I here use the average global excess return<sup>8</sup> over the period 4.836% and average risk-free rate of 4.5%). The resulting mispricing values are:

Table 4: Swedish and European model expected return deviation in comparison to Global model as calculated by equation (XI) (significant values are marked by *)		
$E(R_i)^{ICAPM} - E(R_i)^{CAPM}$	MSCI Sweden	MSCI Europe
<b>Consumer Goods</b>	0.36	-0.21
<b>Basic Materials</b>	0.88*	0.00
<b>Industry</b>	0.59	0.18
<b>Health Care</b>	1.01*	0.07
<b>Consumer Services</b>	0.06	0.18
<b>Telecom</b>	-0.51	-0.01
<b>Finance</b>	0.47	0.03
<b>Technology</b>	-0.82	0.77

*Negative values entail over-pricing and positive values entail under-pricing.*

The result that is somewhat surprising is that the Swedish model only significantly misprices 2 of the 8 investigated industries. This can either be explained by the clear abundance of information that is available in the Swedish economy pertaining to valuing certain industries on a global basis and not others, or by the fact that not enough return observations were included to create tight enough confidence bands and thus draw relevant conclusions. The explanation is most likely a mixture of both. The issue of large confidence bands would have been even worse if I were to focus the study on individual assets, the reasoning behind this having already been

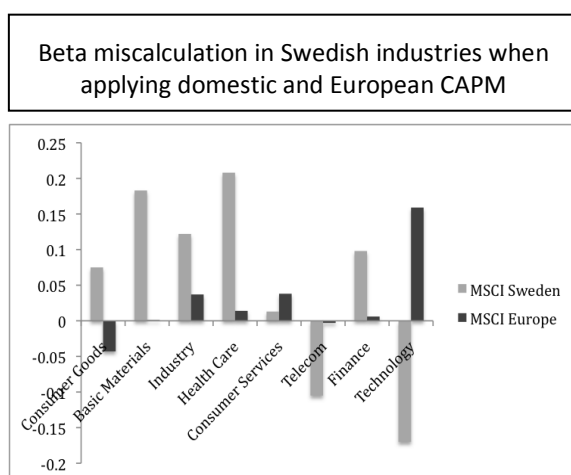
<sup>7</sup> P-values can be seen in regression output of significance tests in Appendix IV

<sup>8</sup> Appendix V : Expected return mispricing values when applying a variety of global market returns

explained in the earlier Data section. I found it not possible to broaden the time scope of data to get more values as this would lead to inclusion of the financial crisis which would not necessarily address the issue as it would add a lot of noise to our dataset. Alternatively, return data pre-1990 could have been included but inclusion of dates when Sweden was relatively economically secluded from the rest of the world would deviate a lot from our beliefs of a globalized economy. This period is thus not relevant to the study.

## 5. Implications and Conclusions

When analyzing our results it is clear that the domestic model causes substantially greater miscalculations in comparison to the EU counterpart even if only two of the industry miscalculations were found to be statistically significant when applying the



domestic model. This is in line with conclusions drawn by Stulz (1995) that investors in smaller countries need to be more cautious when deciding upon a model used for measuring risk as the amount of information available to value assets on a global basis becomes more limited in a smaller economy.

The optimal model for practitioners given the assumption of globally integrated markets is the global model although these findings suggest that the European model produces a sufficient risk measure that is not statistically different from the measure presented by the Global model.

The results also show that for 6 of the 8 industries (consumer goods, basic materials, industry, health care, consumer services and finance) domestic idiosyncratic risks are positively correlated with global systematic risks. This in turn leads to that the domestic model under-prices risk. The intuition behind this is that there exist risks within the Swedish economy, affecting these 6 specific industries, that can be diversified on a domestic basis but are not diversifiable on a global basis. The results for the remaining 2 industries (telecom and technology) show opposite conclusions. There are risks within these industries that are not diversifiable on a domestic basis but are diversifiable on a global basis and thus the domestic model results in over-pricing these assets.

All conclusions go to suggest that the EU model provides a better foundation for pricing assets on a global basis than the domestic version. None of the EU models results are statistically significant from the results of the global version and the magnitude of mispricing is clearly lower in the EU CAPM than the domestic counterpart. This study could in future literature be further developed by testing these models against a range of other asset pricing models applied in Sweden. It is crucial for investors in general to be clear what magnitude of mispricing a given model commonly results in and literature within the Swedish market is very limited.

To illustrate the implications that beta miscalculation can have on a firms equity value I will use the examples of the 2 industries that showed significant mispricing when applying the domestic model<sup>9</sup>, to do this I will apply the dividend discount framework. The mispricing of Basic Materials was an under-pricing of 88 basis points while that of Health Care is calculated to 101 basis points. We can then apply the dividend discount formula to calculate the present value of \$1 in dividends, carefully assuming a low 2% growth rate. First using the correct global measure of expected returns 10.76% and 9.01% respectively leads to \$1 in dividends per year being worth \$11.42 and \$14.27. When using the domestic model calculated expected returns of 9.88% and 8% respectively leads to the \$1 being worth \$12.69 and \$16.67. These are quite grave implications and as an investor you would not be satisfied to receive the 10% or 15% less due to the deviations in your risk calculation method.

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<sup>9</sup> Appendix VI : Implied equity values of all 8 industries and 3 models

**Appendix I:** Derivation of expression for Global asset beta in terms of domestic asset beta and domestic market beta.

When presented the domestic CAPM and a Global CAPM for domestic market:

$$(R_i - R_f) = \alpha_S + \beta_{iS}(R_S - R_f) + \varepsilon_{iS} \quad (\text{I})$$

$$(R_S - R_f) = \alpha + \beta_{SW}(R_W - R_f) + \varepsilon_{SW} \quad (\text{II})$$

Equation (II), a CAPM valuing Swedish market as a whole with respect to global market returns, can be substituted in for domestic market returns in equation (I), a CAPM valuing an individual asset with respect to Swedish market returns, this leads:

$$(R_i - R_f) = \alpha_S + \beta_{iS}(\alpha_{SW} + \beta_{SW}(R_W - R_f) + \varepsilon_{SW}) + \varepsilon_{iS}$$

$$\beta_{iW} = \text{Cov}(R_i - R_f, R_W - R_f) / \text{Var}(R_W - R_f)$$

$$\beta_{iW} = \text{Cov}(\alpha_S + \beta_{iS}(\alpha_{SW} + \beta_{SW}(R_W - R_f) + \varepsilon_{SW}) + \varepsilon_{iS}, R_W - R_f) / \text{Var}(R_W - R_f)$$

$$\beta_{iW} = [\text{Cov}(\beta_{iS}\beta_{SW}\text{Var}(R_W) + \text{Cov}(\varepsilon_{iS}, R_W - R_f))] / \text{Var}(R_W - R_f)$$

$$\beta_{iW} = \beta_{iS}\beta_{SW} + \text{Cov}(\varepsilon_{iS}, R_W - R_f) / \text{Var}(R_W - R_f)$$

## Appendix II: Summary Statistics of Database (Monthly Returns)

<b>Index</b>	<b>Mean</b>	<b><math>\sigma</math></b>	<b>Minimum</b>	<b>Maximum</b>
World	0.778%	3.998%	-11.440%	14.276%
Europe	0.973%	4.327%	-11.357%	15.047%
Sweden	1.292%	6.886%	-24.617%	17.020%

<b>Industry</b>	<b>Mean</b>	<b><math>\sigma</math></b>	<b>Minimum</b>	<b>Maximum</b>
Basic Materials	1.331%	6.502%	-17.412%	25.559%
Industry	1.414%	6.530%	-19.869%	16.052%
Consumer Goods	2.054%	8.102%	-21.330%	24.619%
Health Care	1.414%	7.018%	-18.000%	28.188%
Consumer Services	2.054%	7.140%	-20.269%	19.995%
Telecom	2.057%	10.396%	-25.726%	32.416%
Finance	1.621%	7.087%	-22.711%	22.525%
Technology	1.614%	15.278%	-42.368%	70.090%

### Appendix III: Regression Output for Domestic, Eu and Global single-factor CAPM

#### Regression Output for the Domestic CAPM

Industry	$\beta$	$\sigma$	t	P	CI Low	CI High	$\alpha$	CI Low	CI High	R <sup>2</sup>
Consumer Goods	0.760	0.060	12.71	0	0.642	0.878	0.003	-0.006	0.013	0.476
Basic Materials	0.824	0.054	15.25	0	0.717	0.930	0.002	-0.007	0.010	0.567
Industry	0.910	0.040	22.58	0	0.830	0.989	0.002	-0.005	0.008	0.741
Health Care	0.538	0.621	8.66	0	0.415	0.660	0.006	-0.004	0.016	0.296
Consumer Services	0.737	0.045	16.41	0	0.648	0.825	0.009	0.002	0.017	0.602
Telecom	0.907	0.075	12.13	0	0.759	1.054	0.007	-0.005	0.019	0.453
Finance	0.981	0.043	22.72	0	0.896	1.066	0.003	-0.004	0.010	0.744
Technology	1.343	0.094	14.29	0	1.158	1.528	-0.001	-0.016	0.014	0.534

#### Regression Output for the European CAPM

Industry	$\beta$	$\sigma$	t	P	CI Low	CI High	$\alpha$	CI Low	CI High	R <sup>2</sup>
Consumer Goods	1.018	0.087	11.64	0	0.846	1.191	0.005	-0.005	0.015	0.432
Basic Materials	1.224	0.070	17.51	0	1.086	1.362	0.003	-0.005	0.011	0.633
Industry	1.242	0.061	20.36	0	1.122	1.363	0.004	-0.003	0.010	0.700
Health Care	0.870	0.081	10.71	0	0.709	1.030	0.007	-0.002	0.016	0.392
Consumer Services	0.917	0.073	12.60	0	0.773	1.060	0.012	0.003	0.020	0.472
Telecom	1.137	0.114	10.00	0	0.912	1.361	0.009	-0.003	0.022	0.360
Finance	1.339	0.066	20.43	0	1.210	1.469	0.005	-0.002	0.012	0.701
Technology	1.403	0.163	8.63	0	1.082	1.723	0.004	-0.014	0.022	0.295

#### Regression Output for the Global CAPM

Industry	$\beta$	$\sigma$	t	P	CI Low	CI High	$\alpha$	CI Low	CI High	R <sup>2</sup>
Consumer Goods	1.1	0.1	11.04	0	0.904	1.297	0.006	-0.004	0.016	0.407
Basic Materials	1.295	0.084	15.4	0	1.129	1.461	0.004	-0.005	0.012	0.571
Industry	1.35	0.072	18.83	0	1.209	1.492	0.004	-0.003	0.011	0.666
Health Care	0.934	0.092	10.1	0	0.752	1.117	0.007	-0.002	0.016	0.364
Consumer Services	1.007	0.082	12.27	0	0.845	1.169	0.012	0.004	0.02	0.458
Telecom	1.199	0.13	9.2	0	0.942	1.456	0.01	-0.003	0.023	0.322
Finance	1.421	0.081	17.63	0	1.262	1.58	0.006	-0.002	0.014	0.636
Technology	1.642	0.177	9.27	0	1.292	1.991	0.004	-0.013	0.022	0.326

#### Appendix IV: Regression output for significance testing

Significance testing for pricing error of the domestic model when the global counterpart should be used; a significant  $\beta$ -value implies significant pricing error.

	$\beta$	$\sigma$	t	P-value	CI Low	CI High	$\alpha$
Consumer Goods	0.075	0.093	0.8	0.425	-0.11	0.259	0.004
Basic Materials*	0.184	0.083	2.2	0.029	0.019	0.349	0.027
Industry	0.123	0.062	1.97	0.051	-0.001	0.246	0.021
Health Care*	0.209	0.096	2.17	0.031	0.019	0.398	0.026
Consumer Services	0.013	0.07	0.18	0.854	-0.126	0.152	0.0002
Telecom	-0.025	0.117	-0.21	0.831	-0.256	0.206	0.0003
Finance	0.097	0.067	1.44	0.15	-0.036	0.23	0.011
Technology	-0.17	0.147	-1.66	0.248	-0.459	0.119	0.008

\*Statistically significant  $\beta$ -value

Significance testing for pricing error of the European Union model when the global counterpart should be used.

Industry	$\beta$	$\sigma$	t	P-value	CI Low	CI High	$\alpha$
Consumer Goods	0.024	0.097	0.24	0.808	-0.169	0.216	0
Basic Materials	0.001	0.078	0.02	0.985	-0.152	0.155	0
Industry	0.037	0.068	0.54	0.59	-0.097	0.171	0.002
Health Care	0.015	0.09	0.16	0.87	-0.164	0.193	0
Consumer Services	0.038	0.081	0.47	0.641	-0.122	0.198	0.001
Telecom	-0.003	0.127	-0.02	0.98	-0.253	0.247	0
Finance	0.005	0.073	0.07	0.946	-0.139	0.149	0
Technology	0.159	0.181	0.88	0.38	-0.198	0.515	0.004

**Appendix V:** Amount of expected return mispricing (in percentages) calculated with various global excess market returns values found with equation (XI).

Domestic Model	Global Excess Return								
	<b>3.00</b>	<b>3.50</b>	<b>4.00</b>	<b>4.50</b>	<b>4.84</b>	<b>5.00</b>	<b>5.50</b>	<b>6.00</b>	<b>6.50</b>
<b>Consumer Goods</b>	0.23	0.26	0.30	0.34	0.36	0.38	0.41	0.45	0.49
<b>Basic Materials</b>	0.55	0.64	0.73	0.82	0.88	0.92	1.01	1.10	1.19
<b>Industry</b>	0.37	0.43	0.49	0.55	0.59	0.61	0.67	0.73	0.79
<b>Health Care</b>	0.62	0.73	0.83	0.94	1.01	1.04	1.14	1.25	1.35
<b>Consumer Services</b>	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08
<b>Telecom</b>	-0.32	-0.37	-0.42	-0.47	-0.51	-0.53	-0.58	-0.63	-0.68
<b>Finance</b>	0.29	0.34	0.39	0.44	0.47	0.49	0.54	0.59	0.64
<b>Technology</b>	-0.51	-0.60	-0.68	-0.77	-0.82	-0.85	-0.94	-1.02	-1.11

European Model	Global Excess Return								
	<b>3.00</b>	<b>3.50</b>	<b>4.00</b>	<b>4.50</b>	<b>4.84</b>	<b>5.00</b>	<b>5.50</b>	<b>6.00</b>	<b>6.50</b>
<b>Consumer Goods</b>	-0.13	-0.15	-0.17	-0.19	-0.21	-0.22	-0.24	-0.26	-0.28
<b>Basic Materials</b>	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
<b>Industry</b>	0.11	0.13	0.15	0.17	0.18	0.19	0.20	0.22	0.24
<b>Health Care</b>	0.04	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09
<b>Consumer Services</b>	0.11	0.13	0.15	0.17	0.18	0.19	0.21	0.23	0.25
<b>Telecom</b>	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
<b>Finance</b>	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04
<b>Technology</b>	0.48	0.56	0.64	0.72	0.77	0.80	0.87	0.95	1.03

**Appendix VI:** Calculations using the discounted dividend framework to receive equity value implications of beta miscalculation.

Implied expected returns by the three models:

	<b>Global Model</b>	<b>Domestic Model</b>	<b>European Model</b>
<b>Consumer Goods</b>	9.82%	9.46%	10.03%
<b>Basic Materials</b>	10.76%	9.88%	10.76%
<b>Industry</b>	11.03%	10.44%	10.85%
<b>Health Care</b>	9.02%	8.01%	8.95%
<b>Consumer Services</b>	9.37%	9.31%	9.19%
<b>Telecom</b>	10.30%	10.81%	10.31%
<b>Finance</b>	11.37%	10.90%	11.34%
<b>Technology</b>	12.44%	13.26%	11.67%

Implied equity value of 1 dollar in dividends with an expected growth rate of 2%, values calculated using equation (XII):

	<b>Global Model</b>	<b>Domestic Model</b>	<b>European Model</b>
<b>Consumer Goods</b>	\$12.79	\$13.41	\$12.45
<b>Basic Materials</b>	\$11.41	\$12.69	\$11.41
<b>Industry</b>	\$11.08	\$11.85	\$11.30
<b>Health Care</b>	\$14.25	\$16.65	\$14.40
<b>Consumer Services</b>	\$13.57	\$13.68	\$13.91
<b>Telecom</b>	\$12.05	\$11.35	\$12.04
<b>Finance</b>	\$10.67	\$11.23	\$10.70
<b>Technology</b>	\$9.58	\$8.88	\$10.34

Percentage difference in equity value implied by European and the Domestic CAPM in relation to the Global CAPM:

	<b>Domestic Model</b>	<b>European Model</b>
<b>Consumer Goods</b>	4.83%	-2.62%
<b>Basic Materials</b>	11.16%	0.00%
<b>Industry</b>	6.99%	2.03%
<b>Health Care</b>	16.81%	1.01%
<b>Consumer Services</b>	0.82%	2.50%
<b>Telecom</b>	-5.79%	-0.12%
<b>Finance</b>	5.28%	0.32%
<b>Technology</b>	-7.28%	7.96%

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