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MSc Thesis in Finance

The Fama-French Five-Factor Asset Pricing Model for the Swedish Stock Market

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Abstract

The purpose of this thesis is to investigate how well does the five-factor Fama-French model perform in the Swedish stock market. Fama and French (2015) develop the five-factor model that augments the Fama and French (1993) three-factor model of market return, size and value with two new factors: operating profitability and investment. I examine whether the two main findings of their paper drawn from the US sample also holds true for the Swedish stock market. Namely, they find that the five-factor model describes excess stock returns better than the three-factor model. Also, they conclude that the value factor becomes redundant once profitability and investment factors are added to the model. After implementing a similar analysis on all stocks traded in the Swedish stock market from July 1991 to December 2014 I find that the five-factor model indeed performs better at explaining the variance in average stock returns. However, I do not find conclusive evidence that the value factor becomes redundant once profitability and investment factors are added to the three-factor model for the Swedish stock market.

Keywords: Fama French, Factor model, Asset pricing model, Profitability, Investment

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1 Introduction

1.1 The Capital Asset Pricing Model

The efforts to find the right factors that explain stock returns have provided us with numerous asset pricing models. Without a doubt the most popular asset pricing model, the Capital Asset Pricing Model (CAPM), originates from the works of Sharpe (1964), Lintner (1965), Black (1972) and others. The idea behind the CAPM stems out from Markowitz (1959) research on mean-variance efficient market portfolio. The CAPM is compelling as a theoretical model because it is easy to convey, derive and implement as it consists of only one factor. The single factor is excess market return, where a coefficient of which, beta, measures the extent to which stocks tend to move together with the market.

Although of its popularity, there are many empirical contradictions to the CAPM model. Many claim that the CAPM does not explain returns well enough. Namely, Banz (1981) provide evidence for the presence of size effect showing that average returns on small size stocks are underestimated and average returns on big size stocks are overestimated by the CAPM. Stattman (1980), Rosenberg, Reid and Lanstein (1985), Chan, Hamao and Lakonishok (1991) provide evidence for the presence of value effect showing that average returns are positively related to the ration of a firm's book value of equity to its market value of equity.

However, given such a poor track record of the CAPM, many are still using the model. Welch (2008) finds that around three quarters of professors recommend using the model to estimate the cost of capital. Furthermore, Graham and Harvey (2001) survey 392 CFOs and find out that three quarters of them are using CAPM in their work. Graham and Harvey (2001) also elaborate more on the idea by Fama and French (1992) that not only the CAPM does not seem to be a good model, but also it is unclear whether it is applied well in practise.

1.2 The Fama-French Three-Factor Model

Taking all critique towards the CAPM into account, Fama and French (1993) develop their famous three-factor model. The three-factor model augments the market return factor with size, based on market capitalization of a firm, and value, based on book-to-market value of equity ratio, risk factors. According to Fama and French (1993), the three-factor model explains over 90% of variance in returns, which is 20 percentage points more than the CAPM.

Nonetheless, the Fama and French (1993) three-factor model does not perform perfectly and also faces a fair share of critique. A controversy is raised over whether small stocks and value stocks generate higher returns because they are actually riskier, or because they allow investors to capture the risk adjusted return, the so called alpha. Anyways, evidence shows that stocks with higher ratio of book value of equity to market value of equity outperform stocks with the lower ratio. Similarly, firms with smaller market capitalization generate higher average returns than big sized firms. Regardless of the controversy, one thing is right – the three-factor model is better at explaining returns than the CAPM.

1.3 The Fama-French Five-Factor Model

Fama and French (2015) find another way to improve their three-factor model. In the recent study, they present the five-factor model that augments their former model with operating profitability and investment factors. Their decision to add these two factors is motivated by the dividend discount model, which says that the market value of a stock is the discounted value of expected dividends. By manipulating the dividend discount model together with Miller and Modigliani (1961) theory they come up with three statements about expected stock returns. First, higher book-to-market equity ratio implies a higher expected return – an observation already captured by the value factor in the Fama and French (1993) three-factor model. Second, higher expected earnings imply a higher expected return – the idea behind adding the operating profitability factor. And third, higher expected growth in book equity implies a lower expected return – motivation for adding the investment factor. Overall, they claim that value factor might appear to be a noisy proxy for expected returns due to the market capitalization variable being sensitive to forecasts of earnings and investment. In fact, one of the main findings of the Fama and French (2015) paper is that the value factor, *HML*, becomes redundant once they add the profitability and investment factors.

Moreover, the second statement is also supported by Novy-Marx (2013), who identifies the relation of expected profitability with average returns. While the third statement is supported by Aharoni, Grundy, and Zeng (2013) finding a relation between investment and average return. As it is evident that the three-factor model is not able to explain all of the variance in returns and that much of it might come from profitability and investment, Fama and French (2015) examine their five-factor model in further detail.

They come to conclusion that the five-factor model improves the descriptions of average returns compared to the three-factor model. The data they employ in their analysis comes solely from the US firms. Therefore, it is interesting to see whether the same conclusion holds true for other markets.

Also, they find striking evidence that the value factor, *HML*, becomes redundant once profitability and investment factors are introduced to the model. However, the authors note that this result might be specific to the sample of their paper and that the next step for their analysis would be to see whether the same is also true for different samples (Fama and French, 2015).

The motivation for my thesis stems out from these two main conclusions of Fama and French (2015) paper and the need to test these findings on different samples. Following from that I put forward the following research question:

How well does the five-factor Fama-French model perform in the Swedish stock market?

I also propose the two following hypotheses as my supposition to answer this research question:

H1: *The five-factor model improves the descriptions of average stock returns relative to the three-factor model for the Swedish stock market.*

H2: *The value factor becomes redundant in explaining average stock returns once profitability and investment factors are added to the model for the Swedish stock market.*

One might ask, after all, why explaining returns matters. First of all, it is important to understand what the sources of asset returns are as investors must identify the risks affecting their portfolios. By being able to identify the sources of returns, one can observe whether the portfolio of assets is performing well due to the skill of active management, or because it is loaded heavily on risk factors as the market beta, size, value, profitability or investment. Also, a better understanding of asset pricing might lead to healthier investments by firms due to their ability to evaluate the cost of capital more properly.

I choose to follow the similar methodology developed by Fama and French (2015) to derive results required to test my stated hypotheses and answer the research question. Fama and French (2015) start by constructing the factors and average returns on different types of stock portfolios. They then perform the GRS tests and find that the intercept values of different regressions are jointly indistinguishable from zero. This signals that the factors in their model explain most or all of the variance in expected returns. They compare the three-factor model with the five-factor model by checking the relative performance of these models with regards to the GRS test and the size of average absolute intercept values. They find that the five-factor model in all cases performs better than the three-factor model. However, they also observe that the four-factor model, which excludes the value factor, is performing equally well as the five-factor model, meaning that the value factor becomes redundant once the profitability and investment factors are introduced. I perform exactly same steps in my analysis to check whether the same holds true in Sweden also.

Fama and French (2015) take an extra step and also spend a large part of their paper investigating what type of sorts for constructing factors yields the best results. Fama and French (1993) conclude that 2 x 3 sort is the best approach to compute factor returns, where size of firms are sorted into 2 size groups using the median value of market capitalization, and book-to-market ratio is sorted into 3 groups using 30th and 70th percentiles as the breakpoints. The intersection of these 2 size groups and 3 value groups are used in forming the portfolios for computing small minus big (*SMB*) and high-minus-low (*HML*) factor spreads. Fama and French (2015) investigate whether this is the best approach also in the case of profitability and investment and try other sorting types like 2 x 2 or 2 x 2 x 2 x 2. However, they conclude that the results are independent of how the factors are constructed and stick to 2 x 3 sorting for the main part of their analysis. As a result, in this thesis I only work with factors constructed on 2 x 3 sorts.

The main findings of my thesis are that the five-factor Fama French model is indeed better at explaining the variance in average returns of Swedish stocks and that the value factor does not appear to become redundant after the addition of profitability and investment factors to the three-factor model.

The remainder of my thesis is organized as follows. In Section 2 I begin with a detailed description of Fama and French (2015) methodology and how do I adapt it for the Swedish sample. Section 3 presents the empirical findings of my analysis. I discuss these findings in Section 4 and draw conclusions of my thesis in Section 5.

2 Methodology

2.1 Data

I follow a similar methodology to the one implemented by Fama and French (2015) and try to deviate from it as little as possible in order to test their five-factor model on a different data sample. The data of Swedish listed companies is obtained from COMPUSTAT. I include every company listed in Sweden that has a SEDOL code. After removing the companies that have data available for less than 24 consecutive monthly observations (similar to approach Fama and French (1993)) I end up with a sample of 662 companies. Stock price and shares outstanding information for Swedish companies is available from 1982, but the accounting data required for this study is only available from 1987. Moreover, in order to compute some of the variables required for the study I need one year or two years of lagged values of some of accounting data. In addition, observations for the first two years have too few stocks to allow me construct well diversified portfolios. Therefore, I employ a data sample covering the period from January 1987 to April 2015. In comparison, Fama and French (2015) work with the US data covering the period from July 1963 to December 2013, which is 323 months longer than mine.

2.2 Variable Definitions

The aim of this paper is to perform empirical tests of the five-factor model and examine how well the factors explain average returns on diversified stock portfolios. I start with defining the variables that are being used in formation of stock portfolios and risk factors. All the below listed variables are computed independently for every stock and later combined together to form portfolio and factor data, the methodology of which is presented further in the paper.

Market Equity *(ME)* is closing share price times shares outstanding. It is computed at the end of every month as it used for value weighted return calculations. and the calculation of BE/ME ratio.

Book Equity *(BE)* is book value of common equity, plus deferred taxes and investment tax credit. It is essentially the same thing as in Fama and French studies (1993 and 2015), where they have the book equity computed as stockholders’ equity, plus deferred taxes and investment credit, minus book value of preferred stock (where stockholders' equity is defined as common equity, plus preferred stock). The variables used to calculate *BE* and all other accounting data used in my research is collected on an annual basis at the end of every fiscal year of their corresponding company.

Size is used to form portfolios in June of year t according to the size of the market capitalization of the involved companies. Therefore, the end of June value of *ME* for year t is used as a measure of Size of a company.

Book-to-Market Ratio *(BE/ME)* is used to form portfolios of companies in June of year t according to the ratio comparing the book value of equity to its market value. *BE/ME* value for June of year t is computed as *BE* for the fiscal year ending in year t – 1, divided by *ME* at the end of December of year t – 1.

Operating Profitability *(OP)* is used to form portfolios of companies in June of year t according to how robust of weak their operations are profitable in relation to the size of their book equity. *OP* for June of year t is measured as operating income after depreciation minus interest expenses and then divided by *BE*, all from the last fiscal year end in t-1. My approach slightly differs from Fama and French (2015), where they calculate the numerator of the ratio as annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses. Some of the data of these variables is not available for Swedish companies. However, the sum of their numerator roughly or, in most occasions, exactly corresponds to operating profit minus interest expenses, which I use for my analysis.

Investment *(INV)* is used to form portfolios of companies in June of year t according to how aggressive or conservative their growth in assets is. *INV* for June of year t is measured as change in total assets from the end of fiscal year t – 2 to the end of fiscal year t – 1, divided by total assets at the end of fiscal year t – 2.

2.3 Construction of Portfolios

Based on the variables described above, companies are sorted into 3 different sets of portfolios. I provide a summary of portfolio construction in Table 1.
One set is used for constructing size, book-to-market value, profitability and investment factors, where portfolios are formed as intersections of size, which is always divided into 2 sorts, with book-to-market value, profitability and investment respectively, which are divided into 3 sorts.

Second set is used to compute value weighted portfolio excess returns which are needed as dependent variables in analysis of the factor returns found from set in A and a market return factor. 3 subsets of 25 portfolios are formed as intersections of 5 sorts of size and 5 sorts of book-to-market value, 5 sorts of size and 5 sorts of profitability, and 5 sorts of size and 5 sorts of investment.

Third set is also used for the same purpose as set B, but is constructed using 3 intersections resulting in 3 subsets of 32 portfolios. Namely, one subset of 32 portfolios of 2 sorts of size with 4 sorts of book-to-market value and 4 sorts of profitability, second of 2 sorts of size with 4 sorts of book-to-market value and 4 sorts of investment and third of 2 sorts of size with 4 sorts of profitability and 4 sorts of investment.

Table 1

Construction of portfolios.

I assign stocks to portfolios based on the sorts of their size (*Size)*, book-to-market value ratio (*BE/ME)*, operating profitability (*OP)* and investment *(INV)*. Portfolios are formed in June of year t based on sorts that stocks are assigned to. The first sort is always on *Size* while second and third is on *BE/ME*, *OP* or *INV*. The interaction of either 2 or 3 sorts forms a diversified portfolio of stocks used for the analysis. Monthly value weighted excess returns are calculated for each portfolio based on what stocks have been assigned to it until the portfolios are reconstructed again at June of the next year. Median breakpoint means that stocks are divided into 2 groups, quartile – 4, quantile – 5.

Set	Sort	Breakpoints
2 x 3 sorts	6 portfolios on *Size* and *BE/ME*	*Size*: median
	6 portfolios on *Size* and *OP*	*BE/ME*: 30th and 70th percentile
	6 portfolios on *Size* and *INV*	*OP*: 30th and 70th percentile
		INV: 30th and 70th percentile
5 x 5 sorts	25 portfolios on *Size* and *BE/ME*	*Size*: quantiles
	25 portfolios on *Size* and *OP*	*BE/ME*: quantiles
	25 portfolios on *Size* and *INV*	*OP*: quantiles
		INV: quantiles
2 x 4 x 4 sorts	32 portfolios on *Size*, *BE/ME* and *OP*	*Size*: median
	32 portfolios on *Size*, *BE/ME* and *INV*	*BE/ME*: quartiles
	32 portfolios on *Size*, *OP* and *INV*	*OP*: quartiles
		INV: quartiles

At the end of each June, a company is assigned to its corresponding portfolio based on the computed variables. For example, a 2 x 3 sort portfolios on size and book-to-market value are constructed after all stocks for the year t are ranked in size, a median company size is found, and all companies with the size above of the median are marked as big stocks, while all companies below the median size are marked as small stocks. Similarly, all stocks for the same year t are ranked in their book-to-market value ratio: companies in the top 30th percentile are marked as high *BE/ME* stocks, middle 40th as neutral *BE/ME* stocks and bottom 30th as low *BE/ME* stocks. The intersections of 2 x 3 sorts on *Size* and *BE/ME* ratio produces 6 diversified portfolios for a year t.

Once the portfolio compositions are defined, I calculate value weighted monthly excess returns for every portfolio from July year t to June year t + 1 and reconstruct the portfolios again in June year t + 1 and so on. Returns are weighted with respect to the market capitalization *(ME)* of stocks. Similarly to Fama and French (2015), where they use 1 month US Treasury Bill rate as proxy for risk free rate, returns I calculate are in excess of the 1 month Swedish Treasury Bill rate.

2.4 Construction of Factors

Construction of factors follow from the portfolios formed on 2 x 3 sorts, where size is split into 2 groups and one of other 3 factors is divided into 3 groups. Fama and French (1993) introduces the three-factor model with excess market return factor $(R_M – R_F)$, small minus big size factor *(SMB)* and high minus low book-to-market value factor *(HML)* using 2 x 3 sort portfolios. Fama and French (2015) augment the three-factor model with robust minus week operating profitability *(RMW)* and conservative minus aggressive investment *(CMA)*. Table 2 describes the steps taken to derive these factors for the Swedish stock market.

Excess returns of the portfolios from the first set from Table 1 are used in constructing the factor returns. The intersections of S*ize* with other 3 variables produce 3 sets of 6 value weighted portfolios. The *Size* factor, *SMB,* is the average of $SMB_{BE/ME}$, SMB_{OP} and SMB_{INV}, where each is calculated as the average of the 3 small stock portfolio returns minus the average of the 3 big stock portfolio returns (see Table 2). The value factor, *HML,* is the average of the 2 high *BE/ME* portfolio returns minus the average of the 2 low *BE/ME* portfolio returns. The profitability factor, *RMW,* is the average of the 2 robust *OP* portfolio returns minus the average of the 2 weak *OP* portfolio returns. The investment factor, *CMA*, is the average of the 2 conservative portfolio returns minus the average of the 2 aggressive portfolio returns.

Table 2
Construction of factors.

I assign stocks to 18 portfolios based on 2 x 3 sorts: 6 portfolios for each of 3 pairs of size *(Size)* paired with book-to-market value (*BE/ME)*, operating profitability (*OP)* and investment (*INV)*. Companies are split into 2 *Size* groups, small *(S)* and big *(B)*, according to the median *Size*. Companies are divided into 3 groups of book-to-market value (*BE/ME)*, high *(H)*, neutral *(N)*, and low *(L)*, operating profitability *(OP)*, robust *(R)*, neutral *(N)*, and weak *(W)*, and investment *(INV)*, conservative *(C)*, neutral *(N)*, and aggressive *(A)*. Portfolios are formed in June of year t and monthly value weighted returns in excess of risk free rate are calculated. The factors returns are *SMB* (small minus big *Size*), *HML* (high minus low *BE/ME*), *CMA* (conservative minus aggressive *Inv*).

Breakpoints	Factor components
Size: median	$SMB_{BE/ME} = (SH + SN + SL)/3 – (BH + BN + BL)/3$
BE/ME: 30th and 70th percentile	$SMB_{OP} = (SR + SN + SW)/3 – (BR + BN + BW)/3$
OP: 30th and 70th percentile	$SMB_{INV} = (SC + SN + SA)/3 – (BC + BN + BA)/3$
INV: 30th and 70th percentile	$SMB = (SMB_{BE/ME} + SMB_{OP} + SMB_{INV})/3$
	$HML = (SH + BH)/2 – (SL + BL)/2$
	$RMW = (SR + BR)/2 – (SW + BW)/2$
	$CMA = (SC + BC)/2 – (SA + BA)/2$

I calculate the market portfolio factor $(R_M – R_F)$ as a value weighted monthly return of all stocks in my sample minus the Swedish Treasury Bill rate with a maturity of 1 month as a proxy for the risk free rate. I use Datastream as a source for Swedish Treasury Bill rate data and calculate the monthly rate as an average of all observations within a given month. The same rate is also used for all excess return calculations. Monthly factors that I have derived for the Swedish stock market are given in Table A1 of the Appendix. One can regress excess monthly returns of a Swedish security or a portfolio of Swedish securities to find coefficients of how sensitive its excess returns are with respect to the computed risk factors for the Swedish stock market.

2.5 The five-factor model

All variables required for the analysis of the five-factor model in the Swedish stock market are now computed. The purpose of the model is to capture the relation between average returns and risk factors. Tests of the five-factor model are performed on the time series regression, which is depicted in the equation (1).

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (1)$$

In this equation R_{it} is the return on portfolio *i* for period *t* and R_{Ft} is the risk free return. Right hand side of the equation includes all five risk factors already described in the Construction of Factors section and e_{it} is a zero mean residual. If the factor exposures b_i, s_i, h_i, r_i and $c_i$capture all variation in returns of the left hand side variable, the intercept a_i must be zero for all securities and portfolios.

I perform GRS tests to see whether the intercepts are jointly equal to zero. The GRS statistic is the Gibbons, Ross and Shanken (1989) statistic that tests whether the estimated intercepts from a multiple regression model are jointly zero. Theoretically, a good factor model will have an intercept statistically indistinguishable from zero.

3 Empirical Results

3.1 Patterns of Average Returns

I start the analysis by observing the patterns of average portfolio returns made on intersections of 5 *Size* groups paired with 5 *BE/ME, OP*, or *INV* groups. Fama and French (1993) first make similar observations of how average returns are distributed with regards to *Size* and *BE/ME* of the companies. They conclude that value weighted average returns are increasing with *BE/ME* while holding *Size* roughly constant. On the other hand, returns in their sample are increasing with decreasing *Size* while holding *BE/ME* roughly constant. Namely, this means that on average value companies (as authors like to call companies with high *BE/ME* ratio) generate higher returns than growth (companies with low *BE/ME* ratio) stocks. Moreover, small companies are observed to generate higher returns than big companies. These patterns are later confirmed by Fama and French (2012) on international date, and many other research papers on samples different from Fama and French (1993).

Later, Fama and French (2015) introduce their five-factor model and investigate these patterns for two new variables, operating profitability and investment. They find that, for each size group of companies, average monthly returns are higher if operating profitability is higher. On the other hand, returns tend to fall for companies that are investing more aggressively. Size effect remains the same when portfolios are formed on intersections with *OP* or *INV* groups, as when they are formed with *BE/ME* groups.

In my sample of Swedish stocks, the patterns are rather similar, however, with some deviations. The findings are presented in Table 3. Panel A of the table shows that in 3 out of 5 different *BE/ME* columns average returns fall down when size of the portfolio companies gets larger. For example, stocks in the second largest size group (column 2 of Table 3) generate 0.47% average excess monthly returns while the number is increasing for the smaller companies up to 0.71% for the smallest company size group. However, the effect is ambiguous for the stocks with the lowest *BE/ME* ratio, and it even seems that the effect is reverse: the larger companies, the higher their average returns are. The same applies to the value group of the fourth largest *BE/ME* ratio, where no clear pattern of returns can be observed. In fact, average monthly returns are -0.14% for the smallest size group and 0.63% for the largest groups, when the evidence from other markets suggests the pattern to be opposite.

If I then focus on to the value effect and keep size roughly constant, I observe an overall pattern of returns increasing across rows when book value of equity of companies get higher relative to their market value of equity. However, this comes with some outlying values too. For example, for medium sized stocks, the average returns drop in third and fourth quantiles and then is higher again in the top quantile of *BE/ME*. Similarly to Fama and French (1993, 2012, and 2015) studies, the value effect is stronger for small companies, where average returns increase from -0.25% in the lowest value quantile to 1.43% in the highest value quantile, than for big companies where the returns only increase from 0.58% to 0.61% for the respective quantiles.

Table 3

Average monthly excess returns for portfolios formed on *Size* and *BE/BE*, *Size* and *OP*, *Size* and *INV*. July 1991 – December 2014, 283 months.

At the end of each June, companies are assigned to 5 *Size* groups (from Small to Big) using quantiles of market capitalization of all Swedish stocks within a year t. Similarly, companies are assigned to 5 *BE/ME*, *OP* and *INV* (from Low to High) groups using quantiles of their respective values. Intersections of each *Size* sort with *BE/ME*, *OP*, or *INV* form a value weight portfolio and average monthly returns in excess of the 1 month Swedish Treasury Bill rate are presented in the table. *Size* is market capitalization at the end of June of year t calculated as price times shares outstanding. *BE/ME* is book equity at the end of the fiscal year ending in year t – 1 divided by market capitalization at the end of December of year t – 1. *OP* is operating profitability calculated as operating income after depreciation minus interest expenses, divided by book equity, all from the end of fiscal year ending in year t – 1. *INV* is size of investments calculated as the change in total assets from the fiscal year ending in year t – 2 to the fiscal year ending in t – 1, divided by total assets from the fiscal year ending in year t – 2.

	Low	2	3	4	High
Panel A: Size - BE/ME portfolios					
Small	-0.25%	0.71%	1.01%	-0.14%	1.43%
2	0.36%	0.76%	0.11%	0.58%	0.95%
3	0.29%	0.74%	0.21%	0.10%	0.37%
4	0.37%	0.64%	0.67%	0.13%	0.64%
Big	0.58%	0.47%	0.60%	0.63%	0.61%
Panel B: Size – OP portfolios					
Small	0.09%	0.58%	0.95%	1.16%	1.24%
2	1.13%	0.18%	0.64%	0.75%	0.66%
3	-0.34%	0.27%	0.99%	0.11%	0.54%
4	-0.63%	0.00%	0.45%	0.93%	0.82%
Big	0.27%	0.50%	0.55%	0.21%	0.83%
Panel C: Size – INV portfolios					
Small	0.61%	1.05%	0.34%	0.54%	0.00%
2	0.63%	0.77%	0.96%	0.05%	0.45%
3	0.75%	1.12%	0.95%	0.56%	-0.37%
4	0.11%	0.78%	0.65%	0.41%	0.22%
Big	1.09%	0.75%	0.71%	-0.22%	0.77%

In Panel B of Table 3 I check for these patterns in intersections of size and operating profitability. Here the size effect is more evident across the portfolios with medium to high operating profitability, while the pattern is inconclusive for first two quantiles of *OP*.

By looking at how average returns develop across different size rows, I see evidence that more profitable firms are generating higher average returns. The profit effect holds true for all size groups but the second size quantile, where, in fact, average returns decrease from 1.13% for low profitability firms to 0.66% to high profitability firms. However, other four quantiles show that with increasing the operating profitability average returns increase from a range of -0.63% to 0.27% to a range of 0.54% to 1.24%.

Panel C of Table 3 shows inconclusive evidence for the size effect once it is paired with investment variable. Some of the groups of *INV* have returns increasing with size, while for some they are decreasing. The size effect in this case is probably distorted because of the fact that investment variable, i.e. growth in total assets, is correlated to the book value of book of equity, which is used in computing the *Size* variable.

There is an overall pattern of average returns of portfolios being higher for stocks that have more conservative investment activities. However, in four out of five occasions returns are lower in the lowest quantile of *INV* as compared to the second lowest quantile.

All in all, one can observe that the patterns of average returns are rather similar to the ones discussed in Fama and French (2015). Small sized companies appear to generate higher returns than their larger peers. Value companies with high *BE/ME* ratio have higher returns than growth companies with low *BE/ME* ratio. Moreover, companies with robust operating profitability also have stronger returns than the ones with weak *OP*. Lastly, companies that invest less turn out to yield higher average returns than the ones with more aggressive investment. However, as I show, exceptions to these patterns appear more often than one might see on studies made on the US samples. Deviations might occur due to the fact that the period I investigate is 283 months long, while the sample in Fama and French (2015) consists of 606 months. Also, some portfolios for some of the periods might not be as diversified as they are in the US sample, due to the reason that Swedish stock market is significantly smaller and has too few companies available in some of the intersections of variables used to form the portfolios.

3.2 Summary Statistics for Factor Returns

Table A1 in the appendix shows monthly factor returns for the Swedish stock market. Here I present Table 4 which describes summary statistics of these factor returns. Average monthly value weighted excess market return for the Swedish stock market from July 1991 to December 2014 amounts to 0.65%. It is slightly larger than the one estimated in the US by Fama and French (2015), where they investigate the period from July 1963 to December 2013 and find the excess market return to be 0.50%. However, all four other factors are much smaller in the Swedish case. In fact, they are statistically indistinguishable from zero as mean value is close to zero and standard deviation is relatively large. Therefore, p-values are way above the 5% threshold, not allowing me to reject the hypothesis that factors are not equal to zero. Nevertheless, on average, factors have positive signs, giving some more evidence that stocks of small size, high value with robust operating profitability and conservative investment generate larger returns than big sized, low value, weakly profitable and aggressively investing companies.

Table 4
Summary statistics for monthly factor returns. July 1991 – December 2014, 283 months.

I calculate market portfolio factor *($R_M - R_F$)* as a value weighted monthly return of all stocks the sample minus the Swedish Treasury Bill rate with a maturity of 1 month. At the end of each June, companies are assigned to 2 *Size* groups (Small and Big) using median market capitalization of all Swedish stocks within a year t. Similarly, companies are assigned to 3 *BE/ME*, *OP* and *INV* groups using 30th and 70th percentiles as breakpoints. Intersections of each *Size* group with *BE/ME*, *OP*, or *INV* form value weighted portfolios. The *Size* factor, *SMB*, is the average of small stock portfolio returns minus the average of big stock portfolio returns (see Table 2). The value factor, *HML*, is the average of the 2 high *BE/ME* portfolio returns minus the average of the 2 low *BE/ME* portfolio returns. The profitability factor, *RMW*, is the average of the 2 robust *OP* portfolio returns minus the average of the 2 weak *OP* portfolio returns. The investment factor, *CMA*, is the average of the 2 conservative portfolio returns minus the average of the 2 aggressive portfolio returns.

	$R_M - R_F$	SMB	HML	RMW	CMA
Panel A: Descriptive statistics					
Mean	0.65%	0.08%	0.02%	0.12%	0.25%
Std. dev.	6.27%	4.08%	4.77%	5.31%	4.72%
t-Statistic	1.74	0.33	0.08	0.39	0.89
p-Value	0.08	0.74	0.94	0.70	0.38
Panel B: Correlations					
$R_M - R_F$	1	-0.18	-0.32	-0.21	-0.13
SML	-0.18	1	-0.04	-0.24	0.08
HML	-0.32	-0.05	1	-0.13	0.37
RMW	-0.21	-0.24	-0.13	1	-0.37
CMA	-0.13	0.08	0.37	-0.37	1

3.3 Performance of Asset Pricing Models

In this section I focus on the main part of my research, where I describe the regression results of average portfolio returns regressed on risk factors. This allows me to see whether the intercept values of the regressions are indistinguishable from zero and how well the models capture variance in average returns. The findings are presented in Table 5. I use GRS tests to tell whether the estimated intercepts from a multiple regression model are jointly indistinguishable from zero. P-values for the GRS test statistic are also given in the table. 25 or 32 regressions are run for different sets of portfolio using 5 different sets of factors: where one of which is the three-factor model and another is the five-factor model. In theory, a model which has factors that capture all variance in left hand side returns will have an intercept of zero. A p-value for a GRS test of 0.05 or smaller would indicate that I cannot reject the hypothesis of intercepts for all the regressions jointly being equal to zero. Moreover, I look at the average of absolute intercept values and average R-squared to compare the relative performance of each model.

The results indicate that all factor models have regression intercepts jointly equal to zero for all sets of portfolios, because p-Values of GRS tests are below the 0.05% threshold. Furthermore, average absolute intercept value is lower for all sets of portfolios for the five-factor model than the three-factor model. This gives evidence that the five-factor model performs better in capturing variance in the left hand side returns than the three-factor alternative.

Panel A of Table 5 shows that average absolute intercept value is 2 basis points smaller for the five-factor model than the one for the three-factor model, when tests are made for the 25 portfolios of *Size* and *BE/ME*. However, it is important to note that the four-factor model without the investment (*CMA*) factor is equally good as the five-factor model, meaning that in this case adding the *CMA* factor to the four factors already included in the model does not improve its explanatory power. This is also supported by the R-squared value as it remains at 0.58 for both the five-factor model and the model without the *CMA.*

Panel B of Table 5 depicts results for similar tests for the 25 *Size – OP* portfolios. The five-factor model records the lowest average absolute intercept value among the tested models (7 basis points smaller than the three-factor model). However, two four-factor models which include *RMW* factor in the regressions also perform relatively well. This is coming from the fact that the *OP* variable used in constructing these portfolios is also targeted by the *RMW* factor.

Panel C describes model performance on 25 *Size – INV* portfolios. As the name already suggests, the models that incorporate the investment factor, CMA, exhibit the smallest average absolute intercept values. The model including all factors has the intercept value 3 basis points smaller than the three-factor model. The model which does not include the value factor, *HML*, has the same intercept value as the five-factor model, though its R-squared is 2 percentage points smaller.

The three panels described above show the results of regressions that have been run on 25 portfolios made on 5 x 5 sorts. The remaining three panels are on 32 portfolios that combine three variables with 2 x 4 x 4 sorts. Panel D investigates the model performance on such portfolios on *Size*, *BE/ME* and *OP* sorts. Once again, the five factor model is better at explaining the returns than the three-factor model (average absolute intercept down to 0.46 from 0.51). However, a model that excludes *HML* from the regression records an even lower average absolute intercept value (2 basis points lower than the five factor model).

Panel E of Table 5 shows that both the five-factor model and the four-factor model excluding the *HML* factor perform equally well in terms of the absolute average intercept, though R-squared is 4 percentage points smaller for the four-factor model.

Lastly, Panel F shows that 3 models are explaining left hand side returns equally well: the five-factor model, the four factor model excluding *CMA*, and the four factor model that excludes the *HML* factor. All 3 of them have average absolute intercept values 5 basis points smaller than the three-factor model. As usual, the five-factor model exhibits the largest R-squared value, though just 1 percentage point higher than for the other two models.

Overall, this evidence allows me to answer the research question of my thesis. I show proof to my first hypothesis stating that the five-factor model explains the variability in average returns better for the Swedish stock market than the three-factor model. It is evident from results in Table 5 that the five-factor model that augments the three-factor model with profitability and investment factors records lower values for average absolute intercept. Not only that, but also the five-factor model regressions on average exhibit higher R-squared.

Furthermore, I reject my second hypothesis stating that the *HML* factor becomes redundant once profitability and investment are added to the model. I find that adding the *HML* to other four factors does not decrease the average absolute intercept value in 3 out 6 sets of portfolio returns. Moreover, in 1 out of 6 sets excluding the *HML* results in even lower average absolute intercept value. However, still in 2 out of 6 sets of portfolio returns that I

Table 5

Summary statistics for tests of asset pricing models. July 1991 – December 2014, 283 months.

I test how well factors are able to explain monthly excess returns on 25 *Size – BE/ME* portfolios (Panel A), 25 *Size – OP* portfolios (Panel B), 25 *Size – INV* portfolios (Panel C), 32 *Size – BE/ME – OP* portfolios (Panel D), 32 *Size – BE/ME – INV* portfolios (Panel E), and 32 *Size – OP – INV* portfolios. 25 portfolios are constructed on 5 x 5 sorts and 32 portfolios on 2 x 4 x 4 sorts. For each set or portfolios , I run tests with 3, 4 or 5 factors. Namely, first model is the three-factor Fama-French model and fourth is the five-factor Fama-French model. Others are different combinations of the four-factor model. GRS statistics test whether the expected values of all 25 or 32 intercept estimates are zero, p-Value shows the significance of the GRS test, $A|a_i|$ is average absolute intercept values from 25 or 32 regressions and $A(R^2)$ is their average adjusted R-squared.

	GRS	p-Value	$A\|a_i\|$	$A(R^2)$
Panel A: 25 Size – BE/ME portfolios				
$R_M – R_F$ SMB HML	2.36	0.00	0.31	0.57
$R_M – R_F$ SMB HML RMW	2.37	0.00	0.29	0.58
$R_M – R_F$ SMB HML CMA	2.49	0.00	0.33	0.58
$R_M – R_F$ SMB RMW CMA	2.33	0.00	0.31	0.55
$R_M – R_F$ SMB HML RMW CMA	2.31	0.00	0.29	0.58
Panel B: 25 Size – OP portfolios				
$R_M – R_F$ SMB HML	2.11	0.00	0.42	0.54
$R_M – R_F$ SMB HML RMW	2.38	0.00	0.36	0.58
$R_M – R_F$ SMB HML CMA	2.25	0.00	0.43	0.55
$R_M – R_F$ SMB RMW CMA	2.40	0.00	0.36	0.57
$R_M – R_F$ SMB HML RMW CMA	2.43	0.00	0.35	0.58
Panel C: 25 Size – INV portfolios				
$R_M – R_F$ SMB HML	3.60	0.00	0.31	0.52
$R_M – R_F$ SMB HML RMW	2.81	0.00	0.31	0.53
$R_M – R_F$ SMB HML CMA	3.29	0.00	0.30	0.54
$R_M – R_F$ SMB RMW CMA	2.35	0.00	0.28	0.53
$R_M – R_F$ SMB HML RMW CMA	2.25	0.00	0.28	0.55
Panel D: 32 Size – BE/ME – OP portfolios				
$R_M – R_F$ SMB HML	3.50	0.00	0.51	0.48
$R_M – R_F$ SMB HML RMW	3.73	0.00	0.46	0.50
$R_M – R_F$ SMB HML CMA	3.41	0.00	0.53	0.48
$R_M – R_F$ SMB RMW CMA	3.41	0.00	0.44	0.47
$R_M – R_F$ SMB HML RMW CMA	3.44	0.00	0.46	0.50
Panel E: 32 Size – BE/ME – INV portfolios				
$R_M – R_F$ SMB HML	2.93	0.00	0.43	0.48
$R_M – R_F$ SMB HML RMW	2.65	0.00	0.42	0.49
$R_M – R_F$ SMB HML CMA	3.01	0.00	0.42	0.51
$R_M – R_F$ SMB RMW CMA	2.55	0.00	0.39	0.47
$R_M – R_F$ SMB HML RMW CMA	2.62	0.00	0.39	0.51
Panel E: 32 Size – OP – INV portfolios				
$R_M – R_F$ SMB HML	8.64	0.00	0.44	0.43
$R_M – R_F$ SMB HML RMW	7.06	0.00	0.39	0.46
$R_M – R_F$ SMB HML CMA	8.42	0.00	0.46	0.45
$R_M – R_F$ SMB RMW CMA	4.20	0.00	0.39	0.46
$R_M – R_F$ SMB HML RMW CMA	6.08	0.00	0.39	0.47

seek to explain with the five risk factors, the full five-factor model with the *HML* factor performs better. Therefore, I find inconclusive evidence for its redundancy and must reject the hypothesis. The rejection of the hypothesis is also supported by the fact that the adjusted R-squared values are always larger when there five factors rather than just four.

Table 6
Regression results of each factor being regressed on four other factors. July 1991 – December 2014, 283 months.

I calculate market portfolio factor $(R_M - R_F)$ as a value weighted monthly return of all stocks the sample minus the Swedish Treasury Bill rate with a maturity of 1 month. At the end of each June, companies are assigned to 2 *Size* groups (Small and Big) using median market capitalization of all Swedish stocks within a year t. Similarly, companies are assigned to 3 *BE/ME, OP* and *INV* groups using 30th and 70th percentiles as breakpoints. Intersections of each *Size* group with *BE/ME*, *OP*, or *INV* form value weighted portfolios. The *Size* factor, *SMB,* is the average of small stock portfolio returns minus the average of big stock portfolio returns (see Table 2). The value factor, *HML,* is the average of the 2 high *BE/ME* portfolio returns minus the average of the 2 low *BE/ME* portfolio returns. The profitability factor, *RMW*, is the average of the 2 robust *OP* portfolio returns minus the average of the 2 weak *OP* portfolio returns. The investment factor, *CMA*, is the average of the 2 conservative portfolio returns minus the average of the 2 aggressive portfolio returns.

	Int	$R_M - R_F$	SMB	HML	RMW	CMA	R^2
$R_M - R_F$							
Coef.	0.0079		-0.43	-0.45	-0.44	-0.16	0.25
t-Statistic	2.42		-5..18	-6.11	-6.46	-2.00	
p-Value	0.02		0.00	0.00	0.00	0.05	
SMB							
Coef	0.0026	-0.21		-0.16	-0.26	-0.02	0.13
t-Statistic	1.12	-5.18		-2.97	-5.44	-0.32	
p-Value	0.27	0.00		0.00	0.00	0.75	
HML							
Coef.	0.0015	-0.26	0.19		-0.13	0.29	0.23
t-Statistic	0.61	-6.11	-2.97		-2.32	4.96	
p-Value	0.54	0.00	0.00		0.02	0.00	
RMW							
Coef.	0.0045	-0.30	-0.37	-0.15		-0.38	0.28
t-Statistic	1.64	-6.46	-5.44	-2.32		-6.23	
p-Value	0.10	0.00	0.00	0.02		0.00	
CMA							
Coef.	0.0034	-0.09	-0.02	0.28	-0.32		0.24
t-Statistic	1.38	-2.00	-0.32	4.96	-6.23		
p-Value	0.17	0.05	0.75	0.00	0.00		

To make sure that the *HML* factor is not redundant I compile Table 6, which is similar to what Fama and French (2015) use to prove the redundancy of their *HML* factor. Here I regress each factor return on other four factors. A statistically insignificant intercept would indicate that a large part of the left hand side factor return variance is explained by the factors on the right hand side of the regression. In fact, the intercept for *HML* turns out to be insignificant, but so does the intercepts for *SMB*, *RMW* and *CMA* factors. Therefore, I cannot conclude that any of the variables is redundant as all of them seem to be highly related and are complementing each other.

4 Discussion

To sum up the empirical analysis, it is clear from my evidence that the five-factor model performs better than the three-factor model for the Swedish stock market. Therefore, I prove my first hypothesis.

On the other hand, I reject the second hypothesis saying that the value factor becomes redundant after the addition of profitability and investment factors. Even though in some occasions *HML* indeed shows up to be irrelevant, in the same share of cases an opposite can be said. Therefore, I find inconclusive evidence for the second hypothesis and have to reject it.

In addition to these two main findings, my results also show the presence of size, value, profitability and investment effects for the Swedish stocks as SML, HML, RMW and CMA exhibit marginal, but, most importantly, positive spreads.

It is important to turn attention to the possible uses for the Table A1 in Appendix. It is a Swedish alternative of factor returns to the US factor returns available in Kenneth R. French website. Anyone interested in evaluating the returns of any Swedish asset or performance of a diversified portfolio consisting of Swedish securities, should regress the returns in question as the left hand side variable on the factor returns given in the Table A1. For example, it is possible to investigate whether active management of a Swedish pension fund create value for the stakeholders or is simply exposed to any of the risk factors as a way to generate higher returns. People who evaluate performance of a fund using the CAPM model only might overestimate manager's ability to generate abnormal returns. While a more precise investigation involving more factors might show that in fact s the manager is not generating abnormal returns, but, for example, loading on more small stocks and trying to capture the size effect.

Of course there remain many ways for further investigation of the topic which are out of scope of this thesis. The Swedish case shows some evidence that Fama and French (2015) findings are not just sample specific with regards to my first hypothesis. However, it is important to test the model on different samples of both developed and developing financial markets to gain even more evidence. On the other hand, I find evidence that their findings with regards to my second hypothesis were in fact US sample specific. Similarly, it would be highly interesting to investigate different markets and see whether HML or any other factor becomes redundant.

An interesting addition to my thesis would be to add the momentum factor in order to get the so called four-factor model introduced by Carhart (1997) and compare its relative performance to other models. However, after trying to include momentum as an additional factor in my regressions seeking to explain the portfolio returns, I observe that its estimates are statistically insignificant and distort the estimates of other factors. Therefore, I choose not to investigate the Carhart's model further and focus on the models proposed by Fama and French (1993 and 2015) studies.

5 Conclusion

The aim of my thesis is to answer the following research question: *How well does the five-factor Fama-French model perform in the Swedish stock market?*

In order to answer the question I must set up five factor returns for the Swedish stock market using the methodology described in Fama and French (1993 and 2015). I start my analysis by constructing the variables required for the research. I employ the data on 662 Swedish companies for the period from July 1991 to December 2014. Using this data I form three sets of each 25 (5 x 5 sorts) or 32 (2 x 4 x 4 sorts) value weighted diversified portfolios that are used as left hand side variables in the regressions. Moreover, I also construct 2 x 3 sort portfolios in order to combine the four risk factors: size as the average return of small size firms minus the average return of big size firms (*SMB*), value as the average return of high book-to-market equity ratio firms minus the low ratio firm return (*HML*), profitability as the average return of firms with robust profitability minus the average return of firms of weak profitability (*RMW*) and investment as the average return of firms with conservative investment minus the average return of firms with aggressive investment (*CMA*). Additionally, I also compute the market risk factor, as value weighted average of market excess returns.

I also propose the two following hypotheses that I seek to prove with my research:

H1: *The five-factor model improves the descriptions of average stock returns relative to the three-factor model for the Swedish stock market.*

H2: *The value factor becomes redundant in explaining average stock returns once profitability and investment factors are added to the model for the Swedish stock market.*

In this thesis I show evidence for the support of the first hypothesis, but find inconclusive evidence for the second. All in all, I can conclude that the five-factor model is a better asset pricing model than the three-factor model for the Swedish stock market. This conclusion comes from the results that average absolute intercept for the regressions with five factors are closer to zero, showing that more variance in average returns is captured by the model. Thus, practitioners working with Swedish data should use the asset pricing model with factors as described in Fama and French (2015) as it seems to be the best model among the ones investigated in my study. In fact, in this thesis I calculate and add the time series of the five factor returns in the Appendix, which can be used in investigated the performance of asset managers running the portfolios consisting of Swedish assets.

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Appendix

Table A1

The Fama-French 5 factors for the Swedish stock market. July 1991 – December 2014, 283 months.

I calculate market portfolio factor *($R_M - R_F$)* as a value weighted monthly return of all stocks the sample minus the Swedish Treasury Bill rate with a maturity of 1 month. At the end of each June, companies are assigned to 2 *Size* groups (Small and Big) using median market capitalization of all Swedish stocks within a year t. Similarly, companies are assigned to 3 *BE/ME*, *OP* and *INV* groups using 30th and 70th percentiles as breakpoints. Intersections of each *Size* group with *BE/ME*, *OP*, or *INV* form value weighted portfolios. The *Size* factor, *SMB*, is the average of small stock portfolio returns minus the average of big stock portfolio returns (see Table 2). The value factor, *HML*, is the average of the 2 high *BE/ME* portfolio returns minus the average of the 2 low *BE/ME* portfolio returns. The profitability factor, *RMW*, is the average of the 2 robust *OP* portfolio returns minus the average of the 2 weak *OP* portfolio returns. The investment factor, *CMA*, is the average of the 2 conservative portfolio returns minus the average of the 2 aggressive portfolio returns.

Year/Month	$R_M - R_F$	SML	HML	RMW	CMA
199107	-2.09	-5.42	-0.99	0.03	0.30
199108	-4.35	5.72	-3.18	8.58	7.68
199109	-6.71	3.29	-4.41	3.16	-1.79
199110	-1.41	-3.14	-9.40	7.51	-3.87
199111	-9.25	8.38	4.30	-10.01	-10.75
199112	-4.73	0.16	-9.89	10.96	2.16
199201	2.50	6.61	14.54	-3.11	4.63
199202	-3.84	0.58	-0.26	5.77	12.35
199203	5.37	6.04	-3.02	4.16	-11.32
199204	-3.39	1.08	3.65	-6.12	0.62
199205	1.31	1.99	-3.24	14.47	2.30
199206	-10.76	-2.27	6.12	6.45	-2.04
199207	-5.34	-2.24	-7.60	8.84	-3.59
199208	-11.05	-1.79	-5.28	13.34	7.25
199209	-12.94	-11.95	-6.24	10.12	-1.20
199210	0.76	-8.45	-2.69	6.86	-21.68
199211	27.34	-2.00	-1.99	-7.36	-2.49
199212	1.32	-5.43	4.49	9.88	0.09
199301	-2.77	7.13	-5.83	-9.95	-11.09
199302	11.96	1.78	4.39	-4.22	2.81
199303	-0.89	3.78	0.42	-1.84	9.14
199304	3.73	-5.60	-5.57	1.93	-7.10
199305	8.31	-0.50	-5.09	-1.89	-1.46
199306	-1.89	-0.63	-0.80	-3.74	-0.57
199307	12.05	1.53	2.84	-24.88	9.80
199308	6.63	0.28	-2.31	4.35	3.82
199309	0.52	0.83	-5.52	10.38	-6.61
199310	10.40	0.74	12.21	-15.77	5.49
199311	-10.37	2.38	4.91	2.06	7.96
199312	6.45	-2.33	1.98	2.24	3.03
199401	13.89	2.84	9.38	-11.05	10.78
199402	-4.94	4.53	-4.00	4.99	-1.75

199403	-10.35	-2.21	4.59	-0.80	1.35
199404	4.65	1.75	-1.89	3.50	3.82
199405	-0.25	-2.39	2.73	0.22	5.44
199406	-8.14	-0.01	-0.88	-0.90	0.01
199407	6.26	-3.79	2.52	0.03	-1.67
199408	-1.70	-2.79	-0.04	2.90	-0.70
199409	-3.07	-1.30	-0.74	4.00	-1.17
199410	5.07	-2.54	1.58	-0.51	0.29
199411	1.15	3.04	0.83	-2.23	3.74
199412	-3.37	3.62	-1.04	0.96	-0.24
199501	1.10	1.50	1.13	1.48	0.16
199502	-0.73	-0.15	-0.03	-0.85	-1.27
199503	-3.93	-5.48	-5.86	9.94	-6.82
199504	6.74	-4.78	1.64	1.10	-1.87
199505	0.69	-2.70	-1.42	1.94	1.44
199506	3.21	0.61	-2.42	2.80	-4.46
199507	3.10	0.00	1.71	-3.17	1.75
199508	-0.52	0.51	-7.83	5.26	-4.22
199509	6.98	-2.48	-0.83	-2.77	7.31
199510	-8.90	4.52	0.25	-4.45	4.24
199511	1.64	-0.68	-1.23	-7.54	1.98
199512	-1.42	-0.70	0.99	-3.25	2.57
199601	0.96	3.58	-3.22	4.76	-1.83
199602	5.51	-2.61	3.13	7.76	-5.45
199603	0.62	0.12	2.37	2.51	1.10
199604	1.60	-0.71	3.82	-1.67	6.36
199605	1.12	5.85	-6.53	-0.30	-5.08
199606	-0.42	-3.41	0.59	1.88	-5.40
199607	-4.66	0.90	3.09	-3.07	2.45
199608	5.27	-4.01	-2.19	-1.39	-0.49
199609	4.37	-3.58	-4.01	-6.95	-2.30
199610	2.44	-2.19	-1.56	-2.11	-1.07
199611	8.27	-4.31	-5.49	-1.43	1.68
199612	3.79	0.71	-1.97	-0.87	-0.35
199701	6.23	2.59	3.52	2.08	4.64
199702	4.71	-4.23	1.89	-8.53	-0.64
199703	3.45	-4.64	-3.13	-0.19	-1.18
199704	-4.90	1.84	5.42	0.81	1.64
199705	5.19	-4.70	0.86	0.50	8.32
199706	6.95	-9.33	-2.42	-0.10	-3.34
199707	6.52	-2.63	-3.59	1.89	3.57
199708	-6.09	10.13	1.18	2.48	3.26
199709	7.02	1.37	-1.26	1.24	0.64
199710	-10.76	2.90	-0.77	-0.97	-0.34
199711	4.86	-3.32	0.68	-3.01	-0.43
199712	-1.14	-1.65	3.11	-0.03	2.41
199801	3.56	-3.04	0.21	-0.97	-5.55
199802	7.84	-3.92	-4.33	-0.31	-6.03
199803	5.47	-4.29	0.60	-0.46	-1.08

199804	0.70	-1.84	-2.40	0.97	3.07
199805	3.94	-0.99	-2.18	-0.20	-2.06
199806	1.77	-2.33	-5.38	3.14	-8.40
199807	-0.48	0.60	-5.43	1.98	-4.29
199808	-15.56	-2.68	0.90	2.99	6.36
199809	-11.37	1.95	3.99	3.67	1.01
199810	4.34	-5.00	-4.42	-1.23	-6.36
199811	12.21	0.96	-13.42	7.55	-9.10
199812	-1.61	1.72	-1.18	0.98	3.52
199901	2.62	-7.00	1.26	3.81	-3.05
199902	1.74	-0.61	4.66	-5.43	9.14
199903	-1.35	-0.77	5.67	-8.55	6.25
199904	7.47	-0.76	-0.81	2.49	-2.13
199905	0.17	4.20	-2.25	2.52	1.93
199906	5.90	-7.52	0.60	8.31	-3.49
199907	-0.26	-3.03	2.68	-1.71	-1.39
199908	0.83	0.20	-1.14	-0.13	3.98
199909	-1.25	1.68	-2.65	-2.40	-1.82
199910	9.80	-1.86	-10.76	6.93	-2.10
199911	12.12	1.57	-13.40	8.68	-6.52
199912	17.10	3.93	-11.97	12.46	-8.13
200001	3.83	8.84	-11.85	8.35	-5.26
200002	19.30	4.59	-20.28	11.81	-13.69
200003	-5.53	1.02	9.44	-6.42	2.14
200004	1.76	0.12	-7.53	-2.04	-5.28
200005	-3.65	-3.93	4.04	-0.90	0.29
200006	-3.94	-6.90	4.43	3.14	5.61
200007	0.64	-3.36	4.02	-1.31	1.40
200008	1.31	3.66	-2.70	-6.29	-0.88
200009	-9.44	5.42	12.92	-6.63	12.89
200010	-3.49	-5.48	16.25	0.64	9.52
200011	-9.32	5.33	8.45	-0.64	9.60
200012	-2.54	-2.49	9.23	1.85	3.98
200101	7.77	-1.08	-9.17	-8.73	0.26
200102	-12.22	5.59	17.45	-3.84	13.97
200103	-16.83	13.98	8.96	-8.46	10.45
200104	11.11	-6.12	-2.17	2.65	-0.58
200105	-0.58	2.01	-0.13	-0.50	3.34
200106	-5.22	-6.87	10.42	3.20	4.66
200107	-2.37	-3.45	5.75	5.03	3.52
200108	-8.43	-1.40	5.68	-0.41	4.57
200109	-13.46	-0.77	7.09	5.00	5.65
200110	6.55	5.85	-4.16	-3.99	4.76
200111	12.87	1.19	-11.13	-2.97	-8.96
200112	1.12	-2.68	6.57	3.86	0.71
200201	-6.87	2.95	7.64	-1.04	6.30
200202	0.13	-2.07	5.10	6.04	3.37
200203	2.77	0.31	1.42	2.02	-0.11
200204	-8.87	0.52	14.08	1.92	9.24

200205	-6.45	3.54	1.70	-0.29	4.08
200206	-7.03	-3.08	7.68	11.12	-8.70
200207	-11.33	7.10	3.86	5.55	-2.11
200208	-1.43	-5.86	1.39	1.18	-8.16
200209	-17.03	-0.50	10.31	16.20	-9.56
200210	13.90	-2.65	-11.33	-21.78	9.70
200211	12.34	3.95	-7.29	-11.39	8.59
200212	-12.61	-0.38	11.00	15.57	-13.36
200301	-3.63	4.20	-2.32	-8.37	-0.72
200302	-1.21	-0.54	1.56	7.81	-2.52
200303	-3.44	-3.08	4.05	2.38	-1.43
200304	12.05	-4.22	-1.94	-11.32	-2.59
200305	-0.55	4.97	-3.94	-4.15	9.24
200306	3.84	0.26	3.09	-3.96	4.78
200307	7.21	-1.08	2.99	-9.93	5.82
200308	3.32	4.67	0.67	-5.73	2.10
200309	-2.80	8.79	-4.53	-0.92	0.74
200310	8.15	-1.19	3.23	-4.44	3.29
200311	0.85	5.69	-1.79	2.37	0.02
200312	3.63	-0.60	-0.66	-1.23	-5.70
200401	5.95	12.97	-1.64	-14.77	6.87
200402	4.37	0.99	-3.80	-7.02	2.28
200403	-1.51	-0.70	0.12	4.01	-2.87
200404	-0.44	-0.23	4.56	3.01	-1.73
200405	-1.55	-3.41	0.65	1.27	-0.16
200406	3.36	-3.23	0.98	-1.46	1.60
200407	-2.23	-2.96	6.26	4.29	-1.02
200408	-0.16	-0.92	0.09	0.49	-2.28
200409	4.07	3.07	-3.31	-3.60	3.14
200410	0.03	0.78	3.63	5.57	-4.17
200411	6.67	-0.18	-1.30	-0.30	0.86
200412	1.12	4.03	0.53	3.25	-2.94
200501	0.05	3.95	3.07	2.46	-0.05
200502	4.41	4.10	2.63	5.55	-3.74
200503	0.15	4.10	-3.46	0.10	1.95
200504	-3.79	0.95	-4.48	1.70	1.62
200505	4.83	-4.19	-1.67	-1.35	3.84
200506	3.91	1.19	-2.75	-0.54	-0.08
200507	4.82	-0.65	0.43	0.72	-2.23
200508	-1.10	6.16	-2.44	2.34	-3.29
200509	5.29	1.99	-3.89	-0.93	0.50
200510	-1.87	-2.23	3.80	-1.34	0.05
200511	3.33	1.61	1.24	-0.67	-0.68
200512	5.66	3.08	1.65	-2.51	-2.27
200601	1.42	2.14	1.55	-8.63	-4.52
200602	3.70	-0.57	-0.08	4.08	-1.06
200603	6.41	0.61	-0.27	-0.48	-0.68
200604	-1.72	1.36	0.62	1.90	-3.38
200605	-8.98	-1.35	2.42	2.27	-0.74

200606	-0.85	-1.34	-0.64	5.30	-2.30
200607	-1.31	-0.88	0.32	-2.39	2.14
200608	4.04	-0.22	-0.44	-1.89	4.77
200609	4.82	-0.78	-0.15	-2.11	0.79
200610	4.57	-4.12	3.14	1.22	3.46
200611	-0.53	2.66	-2.84	-1.63	0.90
200612	8.42	4.46	-4.05	0.43	-3.71
200701	2.78	2.03	1.04	-5.43	-1.00
200702	-2.57	0.08	3.31	1.06	5.35
200703	5.08	2.05	-1.92	0.00	-0.32
200704	3.72	1.28	1.76	-3.65	-3.09
200705	-0.04	1.05	0.90	4.12	-3.42
200706	-2.69	0.35	0.18	0.31	-0.36
200707	-1.49	-2.03	-1.08	0.65	-0.25
200708	-2.94	-1.36	-1.74	-2.75	3.32
200709	-0.27	2.01	-6.92	-6.80	4.94
200710	-2.34	-1.39	0.95	0.16	-2.97
200711	-7.08	-1.42	-1.39	-0.97	2.97
200712	-2.27	0.04	-2.97	1.75	2.12
200801	-13.25	8.42	0.80	-3.45	4.12
200802	3.28	1.54	-0.77	3.06	-4.46
200803	-1.52	-1.00	-2.69	2.48	0.32
200804	1.16	2.38	-1.46	1.15	-1.74
200805	1.27	-1.09	-0.15	-0.24	-1.07
200806	-15.32	2.78	0.12	1.40	1.76
200807	-0.44	0.32	-2.79	1.85	1.42
200808	1.07	-1.41	-1.63	3.06	1.92
200809	-13.50	1.25	-2.13	1.57	3.55
200810	-19.00	-0.81	-2.88	2.17	7.48
200811	-1.58	-1.09	-3.65	4.23	1.20
200812	3.09	-11.36	5.48	4.03	1.74
200901	-4.30	17.57	-5.36	-4.54	-1.39
200902	3.47	-3.86	-4.82	-0.70	1.39
200903	2.18	0.79	1.18	-7.75	-0.54
200904	18.54	-8.08	-0.39	-2.97	7.48
200905	2.31	3.56	0.64	1.28	-3.40
200906	1.15	-2.17	-4.95	4.17	-2.72
200907	10.40	-9.82	-0.01	-0.49	2.40
200908	3.84	3.34	1.38	-5.15	9.61
200909	0.85	3.72	0.19	-1.22	-1.75
200910	5.16	-6.03	-1.27	2.37	-1.54
200911	0.19	2.72	5.02	-1.30	-8.17
200912	1.79	-1.50	-0.15	-0.54	-0.87
201001	1.05	9.19	-5.21	-1.65	-0.86
201002	-0.66	-0.54	-0.79	2.58	0.89
201003	7.91	3.69	7.33	-4.88	5.43
201004	2.87	-3.60	0.43	0.49	-5.11
201005	-7.84	-1.36	-4.42	4.26	-3.04
201006	1.22	-5.75	0.35	-0.41	1.87

201007	4.56	-5.52	0.69	-0.23	-1.09
201008	-3.31	-1.93	0.53	1.36	-1.31
201009	8.70	-6.05	2.24	-0.45	1.45
201010	0.42	0.58	2.99	2.19	-1.91
201011	1.39	-2.30	-1.15	-2.65	3.64
201012	5.78	-3.09	2.88	-4.85	5.08
201101	-0.80	7.52	3.17	4.12	-3.65
201102	-1.98	-0.61	3.31	1.76	1.04
201103	1.65	-0.14	-1.41	-0.63	3.65
201104	1.84	1.35	-2.81	1.78	-0.08
201105	-1.61	-1.11	-0.28	6.52	-4.65
201106	-3.88	-0.04	-1.28	3.36	0.01
201107	-4.61	1.61	0.15	-4.93	3.99
201108	-11.14	2.42	-3.13	-2.35	-3.84
201109	-5.50	-0.18	-4.34	-1.02	3.25
201110	8.64	-5.06	4.83	7.56	-3.01
201111	-1.54	-4.23	-0.57	4.80	1.28
201112	1.11	-3.13	-0.47	-4.22	0.49
201201	5.52	4.10	1.98	4.25	-4.27
201202	6.33	-0.90	1.85	3.33	-1.34
201203	-2.26	1.73	-1.50	-0.69	-4.49
201204	-1.12	-1.85	1.81	-2.63	3.14
201205	-8.01	5.91	7.08	-10.18	-1.26
201206	3.19	-7.42	2.19	1.52	1.69
201207	4.30	-3.04	-2.17	-1.05	-3.46
201208	-2.14	2.43	0.09	-3.75	3.10
201209	2.79	-2.66	1.56	1.84	0.62
201210	-1.46	-2.97	0.89	2.94	5.35
201211	2.84	-3.92	-0.37	-0.37	3.93
201212	1.97	5.68	-5.31	2.70	-6.80
201301	5.98	6.79	-5.22	-10.11	-4.18
201302	3.69	1.85	2.28	2.47	-1.56
201303	-0.17	6.88	0.98	-2.84	2.44
201304	0.05	-0.80	3.61	-2.54	-1.22
201305	1.25	5.26	3.79	-8.11	3.43
201306	-5.09	0.15	-6.28	-3.33	-4.79
201307	7.34	-6.19	-1.43	4.98	1.36
201308	-1.20	5.59	2.32	-7.23	2.73
201309	4.01	5.23	-1.41	-6.88	-1.06
201310	2.04	1.71	0.63	1.11	-1.32
201311	2.16	-0.88	-1.01	-0.21	5.30
201312	2.21	-2.88	2.06	2.12	0.10
201401	-1.73	11.60	-1.76	-1.52	-2.87
201402	5.84	-1.05	3.47	-2.19	-3.12
201403	-0.59	-2.97	-0.38	1.38	-1.01
201404	0.20	-1.67	0.14	0.58	-2.63
201405	3.28	-1.63	1.87	2.02	4.44
201406	-1.37	0.49	-1.44	-1.60	-2.03
201407	-0.54	7.99	5.20	-7.82	7.76

201408	0.57	-0.51	-2.71	-0.54	-5.53
201409	0.37	0.75	-0.89	4.39	-1.03
201410	1.49	-1.51	-1.35	6.61	-0.20
201411	3.31	-2.73	0.33	-4.42	0.06
201412	0.91	-0.69	0.08	4.53	0.24