RADBOUD UNIVERSITY
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THE IMPACT OF THE GLOBAL FINANCIAL CRISIS ON THE EQUITY PREMIUM PUZZLE:

EVIDENCE FROM THE DUTCH EQUITY MARKET

Abstract This paper investigates the equity premium puzzle during the global financial crisis and how it is affected by investor sentiment, volatility and trade volume. We use the AEX as a proxy for the market portfolio over the years 2002 – 2016. We replicate the study of Fama and French to determine the theoretical benchmarks. We report an equity premium of 4.11% over the whole sample period. Using an AR(1) model, we find that investor sentiment has a significant negative impact on the equity premium puzzle. We find a significant positive relationship between volatility and the excess equity premium. We find hardly any evidence for a significant effect of trade volume within our data.

Keywords Equity Premium • Theoretical benchmark • Investor sentiment • Volatility • Trade volume

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1. Introduction

Many studies tried to explain the equity premium, which is defined as the excess return that a market portfolio of common stocks provides over the risk-free rate (typically a 3- or 6-month U.S. treasury bill). It is considered a premium "puzzle" because the percentage return is simply too high in order to speak of proper compensation for the risk one takes. In other words, the high average returns imply a level of risk aversion beyond reasoning. So far, academics proposed a decent number of explanations for this concept which was first formalized by Mehra and Prescott (1985).

Fama and French (2002) observe that the equity premium is not constant over time. Specifically, the evidence shows that between 1872 and 1950 the equity premium puzzle was non-existent. However, in the 50 years thereafter (until 2000), the equity premium becomes statistically significantly higher than benchmark returns (7.43). Given the fact that the excess premium – the difference of equity premium over benchmark returns – varies over time suggest that it may be subject to certain market conditions, such as changing interest rates, trading volume, volatility, or market sentiments. In this thesis, we focus on the impact of low probability events on the excess premium. After the Great Depression in the 1930's, we experienced another financial crisis during the time period 2007-2010. Barro (2006) and Gabaix (2008) provide additional evidence on how low-probability events may explain the high premium, building on the work of Rietz (1988). Given the evidence of the previous works, we can now use new data of the global financial crisis to test whether the equity premium has changed over the past 20 years and how it is affected by the crisis.

In this paper, we investigate how the equity premium puzzle is affected during the crisis. We first replicate the study of Fama and French and study key statistics to determine whether an equity premium puzzle exists. We use the dividend and earnings model to calculate the fair return. We use the short-term interest rate – or treasury bill rate – as a proxy for the risk-free rate. In the second part, we perform a regression analysis aiming to explain the excess equity premium using conditional return volatility, investor sentiment and trading volume in our AR(1) model. The study contains quarterly data on the Amsterdam Stock Exchange (AEX) as a proxy for the market portfolio over the period 2002 – 2016. Our priority is the global financial crisis, hence we split our data into three time periods: pre-crisis, crisis, and post-crisis. We follow the National Bureau of Economic Research in the determination of the starting and ending of the global financial crisis.

We complement the existing literature by finding that the average theoretical benchmark differs most from the actual equity premium during the crisis period. Over the whole sample period, the equity premium puzzle is significantly negatively affected by investor sentiment and positively affected by volatility. We fail to find statistically significant evidence of a negative effect of trade volume.

The remainder of the paper is structured as follows. We review the literature in the second section. In the third section, we present the methodology of the research and discuss the collected data. In the fourth section, we present the statistics along with the regression results. The fifth section includes a conclusion and recommendations for further research.

2. Literature review

2.1 Equity premium puzzle

In 1985, Rajnish Mehra and Edward C. Prescott published their paper "*The Equity Premium: A Puzzle*" conceptualizing the equity premium puzzle. This concept arises from two important pillars: the equity premium and the reason why it is a puzzle. The equity premium is what has been empirically observed over the past 100 years to be the difference between the return on a risky asset and a risk-free T-bill. What makes it a puzzle is the magnitude of the difference: the return one receives for investing in risky assets is significantly higher than justified by the risk premium (Mehra, 2003).

Evidence from the field suggest that the actual equity premium is simply too high to be justified. Fama and French (2002) collected data on the Standard & Poor 500 index from 1872 – 2000 to compare the actual equity premium with two theoretical equity premiums (see **table 1**). Specifically, one theoretical benchmark return is based on dividends (RXD_t), the other on earnings (RXY_t). Empirical results suggest that the actual equity premium $(RX_t = 7.43)$ is time-varying and significant different from its theoretical benchmarks over the last 50 years. We will discuss the theoretical premium calculations into more detail later (section 2.3).

Table 1. Equity Premium Fama and French (2002)

	R_f	R_t	RX_t	RXD_t	RXY_t
Mean of annual values of variables					
1872 – 1950	3.90	8.30	4.40	4.17	NA
1872 – 2000	3.24	8.81	5.57	3.54	NA
1951 – 2000	2.19	9.62	7.43	2.55	4.32

Mean values reported are expressed in percentages (value multiplied by 100).

Besides the evidence from the American stock market presented by Fame and French, studies show that there is global evidence for the existence of the equity premium. Dimson et al. (2003) report the equity premium for many European countries $(RX_t = 6.9\%)$ as well as for a world index $(RX_t = 5.7\%)$ for the period 1900 – 2002. For the Netherlands, the equity premium reported is 6.4%. Salomons and Grootveld (2003) investigate the existence of the equity premium in emerging– versus developed markets for the period 1971-2001. The authors find the equity premium to be significantly higher for emerging markets compared to developed countries.

The existing literature offers many explanations why "risky" asset investments offer a too high compensation relative to the risk-free asset. In the field of behavioral finance, influential researchers suggest concepts as myopic loss aversion (Benartzi & Thaler, 1995), disappointment aversion (Gul, 1991) and ambiguity aversion (Chen & Epstein, 2003) may explain the equity premium. Other studies suggest separating the risk-aversion coefficient from the elasticity of intertemporal substation in the utility function (Epstein & Zin, 1989; Weil, 1989) or including a habit formation in utility functions (Constantinides, 1990; Campbell & Cochrane, 1999).

In this paper, we are particularly interested in one explanation that is found in the literature: extraordinary – or low-likelihood – events. The hypothesis first stated by Rietz (1988) is clear and straight-forward: The possibility of a rare disaster, i.e. economic depressions or wars, can explain a significant deal of the asset risk premia. Barro (2006) and Gabaix (2008) find evidence that supports this hypothesis using the economic disasters that happened during the 20th century. We focus on the variation of excess equity premiun during the global financial crisis in 21st century. Bellelah et al. (2017) empirically study how the time-varying beta in the conditional CAPM is affected by the global financial crisis of 2008, finding that the high volatility just before – and during – the financial crisis increases the systematic risk coefficient for all major French industrial indices.

2.2 Theoretical Benchmarks of fair return

We need to compare the actual, observed stock market returns with a certain benchmark. The benchmark allows us to determine whether the actual (excess) return of the market is too high or too low. We follow the benchmark of Fama and French (2002), who use dividend and earnings model to estimate the rate of return an investor should ask in the market. Specifically, the authors make use of the dividend growth model, since its application is straight-forward and easily applicable. Investors and analysts worldwide use this model to assess whether the stock is under- or overvalued based on the difference between the actual market price and the price that is estimated by this model.

Let us recall that the average stock return consists out of two parts: the dividend yield and the capital gain, i.e. the increase in the asset's value. This is formalized as follows.

$$A(R_t) = A\left(\frac{D_t}{P_{t-1}}\right) + A(GP_t). \tag{1}$$

Where $A(\cdot)$ refers to an averaged value, R_t and D_t refer to the return and dividend for time t, respectively. P_{t-1} denotes the price of the previous period. GP_t indicates the rate of capital gain, which can be written out as $\frac{P_t - P_{t-1}}{P_{t-1}}$. Obviously, $\left(\frac{D_t}{P_{t-1}}\right)$ is thus the dividend yield. The authors find an alternative way to measure the returns based on the reasoning that the compound rate of dividend growth must roughly equal the compound rate of capital gain. We can show this mathematically by considering the Gordon Growth Model, which is formalized as follows:

$$P_t = \sum \delta^i (1+g)^i D_t = \frac{(1+g)D_t}{(k-g)} = \frac{D_{t+1}}{(k-g)}. \tag{2}$$

The model shows that the price at time t equals the dividend in the next period divided by the required rate of return adjusted for a constant growth rate. We can then confirm that the compound rate of capital gain equals the compound rate of dividend:

$$\log(P_t) = \log(1+g) + \log(D_t) - \log(k-g) \tag{3}$$

$$\log(P_{t-1}) = \log(1+g) + \log(D_{t-1}) - \log(k-g)$$

$$\log(P_t) - \log(P_{t-1}) = \log(D_{t-1}) - \log(D_t)$$

We can now replace the capital gain component, (GP_t) in formula (1), with a theoretical dividend growth component:

$$A(RD_t) = A\left(\frac{D_t}{P_{t-1}}\right) + A(GD_t). \tag{4}$$

GD_t represents the dividend growth rate, which can be written out as $\frac{D_t - D_{t-1}}{D_{t-1}}$. The authors make a valid note that for as far as theory concerned, the logic behind this can hold for any variable that cointegrates with the stock's price. Important, however, is that such a variable is stationary, i.e. reverting towards its mean or trend. Since earnings cointegrate with the asset's price and if the average growth in earnings is stationary, we can replicate model (2) to the earnings growth model (3):

$$A(RY_t) = A\left(\frac{D_t}{P_{t-1}}\right) + A(GY_t). \tag{5}$$

Dividends are replaced with earnings (Y_t), such that we get $\frac{Y_t - Y_{t-1}}{Y_{t-1}}$.

2.3 Factors affecting excess equity premium

To judge whether the realized equity premium is relatively strong or weak during the crisis we must include a theoretical benchmark estimated by using fundamentals. In the Fama and French (2002) growth models, the theoretical benchmark is based on a long perspective. Specifically, the authors used a 129-year timespan to estimate the sample period's benchmark. In earlier studies (Claus and Thomas, 2001; Gebhardt et al., 2001) shorter timespans were used as well, however, these studies tend to report upward biased growth rates. Fama and French's growth rates are claimed to be unbiased, by formally testing that the return on book equity exceeds the expected return based on fundamentals. We believe this needs clarification with a simple example. Assume we invest in a hypothetical asset at time t_{-1}. The investment generates earnings Y_t in the time to come at a constant expected value. Let the book value of the asset be denoted as B_{t-1} at the time of the investment, such that the average return on book equity is $A\left(\frac{Y_t}{B_{t-1}}\right)$. As the book-to-market ratio is typically below 1, i.e. the market value exceeds the book value, we should also see that the expected return exceeds the cost of capital. In other words, from an investor point of view we should expect a higher return than the minimum return required for providing capital to the firm. In order to show that the average growth rates are not upward biased, the average return on book equity should thus exceed the average estimated fair return by the benchmark. Fama and French, for one, indeed report an estimated return based on dividend (earnings) growth rate of 4.74% (6.51%) which is lower than the average return on book equity (7.60%). Concluding that growth rates are unbiased, we will perform a similar test to check for this bias.

Growth models replicated in this study are conditional on time, meaning returns, dividends, and earnings vary per moment. Many investors prefer to generate a relative stable income by earning dividends as dividend movements tend to be less volatile than price movements. Typically, price volatility can show extremes during the crisis. Thus, when the dividend model remains rather stable during the crisis but capital gains fluctuate heavily simultaneously, we should expect higher discrepancies between models during the crisis. In other words, we would expect to see rather stable estimations by the dividend growth model based over the whole sample. Hence, we hypothesize (**H_1**) that the theoretical benchmark premium based on the dividend growth model deviate most from the realized equity premium during the crisis.

We empirically observe the returns on any given financial instrument such as a stock, index and bond. However, we do not observe the equity premium directly, it is calculated by subtracting the risk-free rate of return from actual stock return. The difference between the actual premium and the theoretical models must be statistically significant different from zero, otherwise there would be no puzzle. Therefore, we will investigate whether the non-fundamental factors investor sentiment, volatility and trading volume could potentially explain the difference between the actual equity premium and the theoretical benchmark.

2.3.1 Investor sentiment

Generally, investor sentiment represents the market participants' thoughts regarding an equity's future. Sehgal et al. (2009) define the investor sentiment as the (lack of) confidence of an investor which serves as a proxy for investor behaviour influencing the equity market. Financial economic literature has been occupied on how to measure the market sentiment. Besides the use of the NCF of mutual funds (Randall et al., 2003), the Put-Call ratio (Dennis et al., 2002) and Barron's Confidence Index (Lashgari, 2000), there is another approach as to what represents investor sentiment: the investor fear gauge known as the VIX. The index estimates the implied volatility for over the next 30 days of a particular index. In Whaley's study (Whaley, 2000), he describes how the VIX is derived from the price inputs of the S&P 500 index options. Although international stock markets tend to interact with one another and thus the VIX could also be used as a proxy for investor sentiment for the AEX, there is a specific fear gauge index called the VAEX. The latter is in its set-up identical to the VIX with a minor difference that it is derived from price inputs of the AEX options.

Rietz (1988) offered an explanation of traders emotionally worrying about the minor chance of a financial crisis occurring. When emotion drives financial markets' movements, the fundamental value of an asset does not necessarily equal the price set by market sentiment. Shiller (1981) argued that volatility is much higher than changes in dividends can justify, which causes periods of strong deviations of stock market price from its fundamental value. This leaves a potential opportunity to make a profit. One condition for this to investigate is a theoretical model based on fundamentals to determine the true value of the asset. When this condition is met, we can estimate the proportion that cannot be explained by the theoretical model. In terms of sentiment, we typically distinguish two concepts: bearish and bullish markets. Bearish markets are usually seen during a recession or crisis where prices plunge at least 20% and sentiment is really negative. Bullish markets are the exact opposite of the bear markets with rising prices by at least 20%. Kirchler (2009) observes that sentiment leads to overvaluation in bearish markets and undervaluation in bullish markets. We must note that, considering the VAEX as our proxy for the sentiment level, a high VAEX implies higher levels of fear and therefore a negative sentiment. Thus, when the VAEX is low It means there is not too much fear in the market. Investors typically invest more when fear is low, leading the actual price to deviate more from its fundamental value. Translating this mechanism into our expectations, we hypothesize (**H_2**) that investor sentiment has a negative effect on the existence of the equity premium.

2.3.2 Return volatility

We speak of volatile markets when the respective prices move sharply up- or downwards. Being a statistical measure of dispersion in financial markets, volatility functions as an indicator for the risk a security yield. The more volatile an asset is, the less precise we are able to estimate its future price. Investors take into account this uncertainty when trading. Typically, more volatile assets require higher rewards by investors compared to less volatile, "safer" assets. Many studies document a positive relationship between return volatility and the equity premium (Engle et al., 1988; Harvey, 1989; Kim et al. 2004). We find that many studies apply the GARCH (1,1) model to determine the conditional volatility. Based on previous findings, we hypothesize (**H_3**) that volatility has a positive effect on the existence of the equity premium. In line with the theory, we will use the GARCH model to estimate the volatility conditional on time.

2.3.3 Volume of trade

Trade volume equals the number of shares traded and can be measured for any type of asset. Basically, it provides the investor with information about the activities on stock markets and its liquidity. When many investors trade on a trading day, demand and liquidity increase. A shifting demand and stable supply causes market prices to rise. Especially with the low interest rates nowadays, stock markets are more attractive as savings only result in value reduction due to inflation. Based on that logic, we would expect to see that investors would want a higher premium for less liquid stocks and a lower premium when stocks are traded a lot and therefore more liquid. Thus, low liquidity suggest higher premium, which would indicate negative correlation. Amihud & Mendelson (1986) indeed find evidence of a negative relation between trade volume and the risk premium. Chordia et al. (2001) documented similar results. Based on the seemingly logical explanation and the results found by previous studies, we hypothesize (**H_4**) that trade volume has a negative effect on the existence of the equity premium.

3. Research methodology

We discuss the research methodology in this section. In general, the study is empirical of nature and includes a quantitative analysis. We use one economic entity, the AEX, for the time period 2002 – 2016. Therefore, we deal with a time series dataset. We continue in this section as follows. First, we will discuss the research problem. Then, we motivate the way we investigate the problem in terms of included variables, the dataset and regression method.

3.1 Problem statement

The main interest of this paper is to investigate the equity premium puzzle during the global financial crisis and how it is affected by investor sentiment, volatility and trade volume. More specifically, we translate the problem into the following research question: "What is the impact of investor sentiment, volatility, and trade volume on the equity premium puzzle during 2002 – 2016?". To answer this question, we first perform a similar statistical analysis as has been done by Fama and French (2002). Instead of using the U.S. stock market as in the bulk of the literature, we use the Amsterdam Stock Exchange. Moreover, we investigate a time period that has not been included in the paper of Fama and French. The statistical analysis is important for our regression analysis that we perform thereafter. We will now discuss the variables that are included in both analyses, how we obtain the data and the regression method.

3.2 Methodology

In the first part, we perform the statistical analysis. We start by paying attention to the risk-free rate of return as it is an important factor in the equity premium. We then replicate the tables constructed by Fama and French to compare it with other studies. Specifically, the tables present the estimated returns and equity premia by utilizing the models discussed in the literature review. We end the statistical part by calculating the difference between the actual equity premium and the equity premium estimated by the theoretical models. When the difference over time is statistically significant from zero, we conclude there is an equity premium puzzle. The latter is then used into the regression in the second part.

The second part consists of an autoregressive (AR) regression analysis. An AR(1) model is used to include a lagged version of the dependent variable, which is difference between the actual equity premium and the theoretical benchmark. We decided to include this lagged version as the previous difference may contain lots of information on the current difference. We also include three other explanatory variables in the regression, namely investor sentiment, volatility, and trade volume. As done frequently in the literature, we estimate the conditional volatility by using the GARCH (1,1) model (Generalized Autoregressive Conditional Heteroskedastic model).

3.3 Research Variables

We list our variables in this sub-section and discuss for each variable separately how it is either retrieved from a database or calculated.

3.3.1 Risk-free – and inflation rate

A risk-free rate of return must stem from an investment where (almost) no risk is involved, such as treasury bills and commercial papers. A rather practical notion between the lines is that no investment actually has absolute zero risk, even government bonds do carry some risk. However, the chances on a government to default are slim. We obtain the quarterly risk-free rate from the OECD[1] database without further adjustments. We obtain the quarterly inflation rate from the OECD database as well. The inflation rate is also known as the Consumer Price Index (CPI). We should note that Fama and French found evidence that the nominal values support the same inferences as for the real values. Therefore, it would not be necessary to incorporate the inflation rate. Nevertheless, for comparison reasons we decided to have the price deflator remaining in our study.

3.3.2 Dividends (Dividend Yield) and earnings (P/E)

We obtain the dividend yield from the FactSet database. The dividend yield is constructed by dividing the dividends of the time period divided by the closing price of the previous period. Let us illustrate this with an example. Suppose the AEX's dividend yield DY_t obtained from the database for time t equals 4.00%. This means that the dividend paid for that particular period divided by the ending price of the AEX last period equals 0.04. When the closing price of the AEX at time t_{-1} equals (€440), we can obtain the dividend at time t, which is $D_t = DY_t * P_{t-1} = 0.04 * 440$. We perform a similar act to compute the earnings per period. Specifically, we infer the earnings from the P/E ratio. We can illustrate this with an example as well, again, looking at time t. From the FactSet database, we obtain a P/E_t ratio of 16. The AEX's price is the one we reported earlier (€440). Therefore, we can calculate the earnings at time t, which then is $Y_t = \frac{P_{t-1}}{P/E_t} = \frac{440}{16}$.

3.3.3 Growth rates and growth models

Estimating return with the models discussed earlier, we need the growth components. Specifically, we have the capital gains in the actual return denoted as $\left(\frac{P_t - P_{t-1}}{P_{t-1}}\right)$. Furthermore, we need the dividend growth component $\left(\frac{D_t - D_{t-1}}{D_{t-1}}\right)$ and the earnings growth component $\left(\frac{Y_t - Y_{t-1}}{Y_{t-1}}\right)$. Using these growth calculations, we only need the prices, dividends and earnings over time. We retrieve the prices directly from the FactSet database and we calculate the dividends and earnings as discussed above. When adding the dividend yield to the growth rates we end up with the returns estimated by the models.

3.3.4 Equity premium

Once we have estimated the earnings by using the growth models, we can subtract the risk-free rate of return to calculate the equity premium. This results in the actual equity premium ($RX_t = R_t - R_f$), the theoretical benchmark premium based on dividends $\left(RXD_t = RD_t - R_f\right)$ and the theoretical benchmark premium based on earnings $\left(RXY_t = RY_t - R_f\right)$. We report all premiums in the statistical part of our analysis. In the regression part, we subtract the theoretical benchmark based on dividends from the actual equity premium ($RX_t - RXD_t$). If the latter is significant different from zero, there is an equity premium puzzle.

1 https://data.oecd.org/interest/short-term-interest-rates.htm#indicator-chart

3.3.5 *Investor sentiment, volatility and trade volume*

Our explanatory variables of interest for the regression are investor sentiment, return volatility and trading volume. Investor sentiment is measured in different ways in the literature. Some studies use surveys among individual investors, alternatives use the net cashflow of mutual funds. We use the volatility index for the AEX (VAEX) that gauges fear among investors. The index is derived from the AEX options and is widely used by investors before making actual investment decisions. This index as a proxy for investor's sentiment should not be confused with our second regression variable, namely historical volatility. As the VAEX is implied volatility and based on option prices, historical volatility is measured by performing statistical calculations on previous returns. Assets characterized with high historical volatility, or the average deviation from the mean, is typically only interesting for less risk-averse investors as prices may substantially deviate. Finally, trade volume is defined as the number of contracts or shares traded on the market. Some assets are being traded more than others which in general indicates the liquidity of the traded asset. For this study, it is particularly interesting to keep in mind that price movements are significantly more interesting when trade volume increases.

We retrieve the data on the VAEX and trade volume from investing.com, a reliable source regarding technical data and financial tools on the global financial markets. The time-varying volatility is estimated by the GARCH (1,1) model. In this model, h_t represent the variance at time t. It is a function of the long-run average (δ), the weighted squared return ($\alpha_1 e_{t-1}^2$) and the weighted variance of the previous period ($\beta_1 h_{t-1}$).

$$h_t = \delta + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1}. \tag{6}$$

3.4 Regression model

For the second part of the paper, we study the effects of investor sentiment, volatility, and trading volume on the equity premium puzzle. We denote the excess equity premium, or the equity premium puzzle as EP_t (EP_{t-1} refers to the previous period, called the lagged version). The term S_t represents investor sentiment, return volatility is represented by h_t and trade volume is denoted as π_t. Finally, ϵ_t shows the error term of the model. Associated with our hypotheses, we formalize the model as follows:

$$EP_t = \beta_0 + \beta_1 EP_{t-1} - \beta_2 S_t + \beta_3 h_t - \beta_4 \pi_t + \epsilon_t. \tag{7}$$

EP_t – the excess equity premium – is calculated by subtracting the benchmark from the actual equity premium. We can thus write $EP_t = RX_t - RXD_t$, where RX_t refers to the actual equity premium and RXD_t is the premium based on the theoretical model using dividends. Therefore, EP_{t-1} simply equals the exact variables of the previous period, denoted as $RX_{t-1} - RXD_{t-1}$. For example, the actual equity premium of period 1 and period 2 is 5% and 6%, respectively. The theoretical premium in period 1 and 2 is 3% and 1%. Calculating the excess premium, we find that EP_t equals 5% – 3% = 2% and EP_{t-1} equals 6% – 1% = 5%. Referring back to the model, we thus expect that $EP_{t-1} = 5\%$ contains information on the value of the excess premium at period thereafter; $EP_t = 2\%$.

4. Results

We first assess the results of the first part of the paper. **Table 2** provides the estimates of the equity premia from January 2002 until December 2016 with AEX as a proxy for market portfolio. First of all, we should note that all the calculations are provided in the methodological part, therefore we will not discuss these here once again. As Nobel prize winner Harry Markowitz defined in his paper on Modern Portfolio Theory (1952), the third assumption states that investment eventually has consumption as its goals. To actually argue on this level, we must correct the nominal key financials for inflation, which we reported below.

4.1 Equity premium versus theoretical benchmark

We first test an important assumption in order for these calculations to have statistical meaning. Specifically, we must test whether the dividend-price and earnings-price ratios are stationary. Although less formal, it can be seen from **figure 7** in **appendix II** that $\left(\frac{D_t}{P_t}\right)$ and $\left(\frac{Y_t}{P_t}\right)$ are reverting to a constant. We perform a Dickey Fuller test for both ratios to formally test for non-stationarity. We find a test-statistic of –5.654 for the dividend-price ratio, which is smaller than all critical values (–3.430, –2.860, –2.570 for the 1%, 5% and 10% critical value, respectively). We observe the same result for the earnings-price ratio only now with a test statistic of –3.925. The coefficients from the Dickey Fuller test are negative for both ratios as well, which confirms the ratios eventually return towards the constant. From a theoretical perspective it is very reasonable to have such results as such ratios simply do not climb to infinite.

In line with the study of Fama and French, we find that the average market value of equity exceeds the book value over the whole sample period $\left(\frac{B_t}{P_t} = 0.57\right)$. This result implies that the cost of capital is below the expected return on the AEX. To test whether the growth rates are not upward biased, we compute an average income to book ratio. This ratio should exceed the returns estimated by the growth models based on fundamentals as explained in section 2.2. Our data suggests that our growth models are not upward biased, since the estimated returns by dividends and earnings are both lower than the average income to book ratio.

An important aspect of the equity premium is the risk-free rate of return. We notice a steep increase in the run up to the crisis period, where the T-bill rate hits its highest point 5.11%. Typically, demand for liquidity increases and supply for credit decreases simultaneously during a crisis. A central bank comes into play with monetary policy aiming to find balance by decreasing interest rates. As can be seen from figure 1, the risk-free rate drops significantly amid the crisis (1). National central banks in Europe lower interest rates from above 5% to below 1% to stimulate the economy. Although the post-crisis period experiences a minor increase in 2014, the risk-free rate decreases at a gradually thereafter until it becomes negative (– 0.26%) in 2016. The economic implication of a negative rate (2) is that investors yield no return once investing in the risk-free asset. In fact, they must pay to stall their money in such a safe investment.

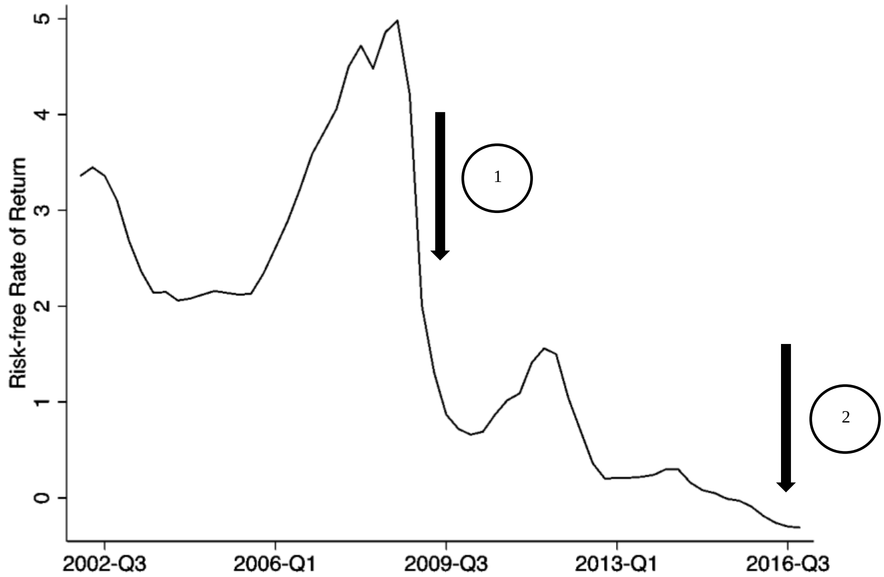

Figure 1 - Risk-free rate of return over time

4.1.1 Actual return and theoretical benchmarks

The results show that for the whole sample period, the dividend growth model estimates a return that is 1.83% higher than the actual return of 5.85%. The earnings model on the contrary, estimates a return that is 1.63% lower than the actual return. The benchmark based on dividends would suggest that the actual return thus is relatively low while the benchmark based on earnings signals the opposite of almost identical magnitude. In terms of what model is closest to reality, we must take into account several other factors. For instance, we observe a significantly higher standard deviation for the earnings model (27.34) compared to the dividends model (18.27). We would also want to investigate the pattern over the other separate periods and even over some individual years. We will touch upon the most interesting results in the following paragraph(s).

Noteworthy is how the growth rates and, respectively, the estimated return based on dividends seems to be closer to actual returns independent of the time period. Although this holds for the crisis-period, we should comment that the benchmark return in that particular period is still significantly off. Specifically, we report an actual return of -5.52% while the benchmark return based on dividend (earnings) is 8.70% (9.98%). Obviously 2007 – 2009 are the big years in this study. Stock markets crashed as prices kept plunging, resulting in an extraordinary capital loss. Interestingly, dividend and earnings growth rates experienced only minor drops during the time period.

Table 2. Equity premium table statistics

	Inf_t	R_f	$\left(\frac{D_t}{P_{t-1}}\right)$	GP_t	GD_t	GY_t	R_t	RD_t	RY_t	RX_t	RXD_t	RXY_t
Means of quarterly values of variable												
01/2002 – 11/2007	1.84	2.80	3.27	3.51	5.86	7.06	6.78	9.13	10.33	3.98	6.32	7.52
12/2007 – 06/2009	2.19	3.79	4.35	-9.88	4.34	5.64	-5.52	8.70	9.98	-9.32	4.90	6.19
07/2009 – 12/2016	1.44	.44	3.57	4.22	2.76	-5.38	7.79	6.33	-1.81	7.35	5.89	-2.25
01/2002 – 12/2016	1.68	1.73	3.55	2.30	4.13	.68	5.85	7.68	4.22	4.11	5.94	2.48
Standard deviations of quarterly variables												
01/2002 – 11/2007	.78	.74	.45	11.27	12.92	22.20	11.16	12.72	22.50	11.21	12.43	22.90
12/2007 – 06/2009	.51	1.49	1.19	8.86	6.14	13.88	8.08	6.29	12.91	7.57	7.10	11.56
07/2009 – 12/2016	.94	.54	.55	8.32	23.08	32.23	8.36	23.33	32.06	8.38	23.60	31.76
01/2002 – 12/2016	.87	1.54	.69	10.46	18.17	27.41	10.25	18.27	27.34	10.68	18.35	26.98
Bias check												
	$\left(\frac{B_t}{P_t}\right)$	R_t	RD_t	RY_t	$\left(\frac{Y_t}{B_{t-1}}\right)$							
01/2002 – 12/2016	0.57	5.85	7.68	4.22	8.39							

Mean values reported are expressed in percentages (value multiplied by 100).

We find no reason to favor the dividend model over the average return during the pre-crisis period. We roughly find equally standard errors and the estimated return by the dividend model is about 2% lower. In the crisis period, we find that the dividend model estimates the most precise returns of all three. Precision however disappears in the post-crisis time period. Regarding the earnings model, estimates are most precise during the crisis as well but are still less precise than the dividend model. We find that the earnings model has really high standard deviations in most of the years and returns estimated by the model are also significantly different from the average return. Taking into consideration the higher precision of the capital gains over most of the years we find it reasonable to favor the return estimated under R_t.

Table 3. Equity premium table statistics over time

	Inf_t	R_f	$\left(\frac{D_t}{P_{t-1}}\right)$	GP_t	GD_t	GY_t	R_t	RD_t	RY_t	RX_t	RXD_t	RXY_t
Means of quarterly values of variable												
2002	3.29	3.32	2.76	-3.67	6.50	-34.80	-.90	9.26	-32.03	-4.22	5.94	-35.35
2003	2.09	2.33	3.98	3.68	-2.05	26.02	7.67	1.93	30.01	5.34	-.39	27.68
2004	1.34	2.11	3.36	3.69	-10.00	11.58	7.06	-6.63	14.94	4.95	-8.74	12.83
2005	1.55	2.30	3.18	7.49	16.90	23.72	10.67	20.07	26.90	8.37	17.77	24.60
2006	1.09	3.23	3.06	4.82	21.66	11.73	7.89	24.73	14.79	4.66	21.49	11.56
2007	1.61	4.27	3.13	4.75	10.55	5.55	7.89	13.68	8.68	3.62	9.41	4.41
2008	2.49	4.63	3.87	-9.16	2.82	13.57	-5.28	6.70	17.45	-9.92	2.07	12.82
2009	1.19	1.22	5.33	.75	3.67	-34.87	6.08	9.00	-29.54	4.85	7.77	-30.77
2010	1.39	.86	3.33	4.77	-23.08	14.92	8.11	-19.74	18.25	7.24	-20.61	17.38
2011	2.49	1.37	3.57	-.01	1.57	31.57	3.55	5.15	35.15	2.18	3.77	33.77
2012	2.44	.42	3.87	4.19	5.96	-2.12	8.06	9.83	1.73	7.64	9.41	1.31
2013	2.51	.22	3.40	6.26	13.80	-13.47	9.67	17.20	-10.06	9.45	16.98	-10.28
2014	.97	.21	2.90	3.52	-16.47	-8.87	6.42	-13.57	-5.97	6.21	-13.78	-6.18
2015	.60	-0.02	3.26	1.25	10.775	-11.27	4.52	14.04	-8.00	4.54	14.06	-7.98
2016	.31	-0.26	4.17	2.30	34.52	-27.35	6.48	38.70	-23.17	6.74	38.96	-22.90

Mean values reported are expressed in percentages (value multiplied by 100).

4.1.2 Equity premium

We report an overall equity premium of 4.11%, which is lower than the premium found in previous studies. Fama and French report an equity premium of 7.43% for the U.S. stock markets during 1950 – 2000, while Salomons and Grootveld (2003) report a premium for the Dutch stock market of 6.4%. Our slightly lower premium can possibly be explained by **table 3.** The table shows the actual equity premium experiences a significant drop during the crisis. We should note that by examining 15 years of data the effect of the crisis is more palpable in comparison to when we had decided to include 40 years of data. Time horizon thus may bias our overall equity premium. We could check whether this bias is present by including more years. Unfortunately, due to access restrictions, we could only add up data to the beginning of 2000 which may have only a minor influence. We therefore argue it is reasonable to continue by keeping in mind that extending the time horizon may lead to a slightly different premium.

In spite of the fact that the risk-free rate plunges by the end of 2008, the average 'riskless' rate of return is still 3.79% in the crisis period. This obviously has a large impact on the equity premium. As actual returns were already negative for the time period, subtracting the risk-free rate produces an even more negative actual equity premium of –9.32%. This result is highly interesting, since it would imply that investors yield a higher return on risk-free asset compared to the risky, though diversified market portfolio. Voss (2011) argues that a negative premium may function as an indicator of overvaluation of stocks. The author finds that a negative premium is typically present just before and during a crisis. He finds evidence of a correlation between turning points in the premium and historical economic events.

Of the theoretical benchmark premia, we find the average theoretical equity premium based on the dividend growth model to be the most stable over time. We observe a stunning decrease in the premium based on the earnings growth model that needs further explanation. Thus, we would seek for an explanation as to why this premium drop so significantly while the other two do not. We propose that this enormous drop is due to extremely decreasing earnings of one of the major listed firms on the AEX: Royal Dutch Shell. In fact, we went through the listings and find that Shell's earnings in the third quarter of 2016 halved compared to the previous year's earnings. We find similar patterns for more firms, for example ArcelorMittal (decreased earnings by 20%). Since we observe recovering patterns over the years to come, we expect further research on this topic to report slightly different results. Especially taking into account that due to the corona crisis patterns seem to change once again.

We hypothesized that the dividend growth model estimations deviate most from the realized equity premium during the crisis. We find an averaged difference between both premiums of 2.34%, 14.22%, and 1.46% for pre-crisis, crisis, and post-ciris, respectively. The difference is indeed greatest during the crisis as expected. We find a similar pattern for the earnings benchmark. However, when we examine the individual years reported in **table 3**, we find the greatest difference of an individual year in 2016. Therefore, we would want to make a conclusion with serious caution. Specifically, the year 2016 is averaged out with more years than are included in the crisis period, hence the difference given a particular date during the crisis has a greater weight when averaged. Nevertheless, due to the impact of the negative actual equity premium that is not found after the crisis, we accept our hypothesis that the benchmark premium based on the dividend model deviates most from the actual premium during the crisis.

We document the existence of an equity premium puzzle when the difference between the actual equity premium and the benchmark is significantly different from zero. **Figure 2** enables us to graphically see the range of the premia estimated in this paper. From the graph we infer that the range of the actual equity premium is significantly smaller compared to the benchmarks.

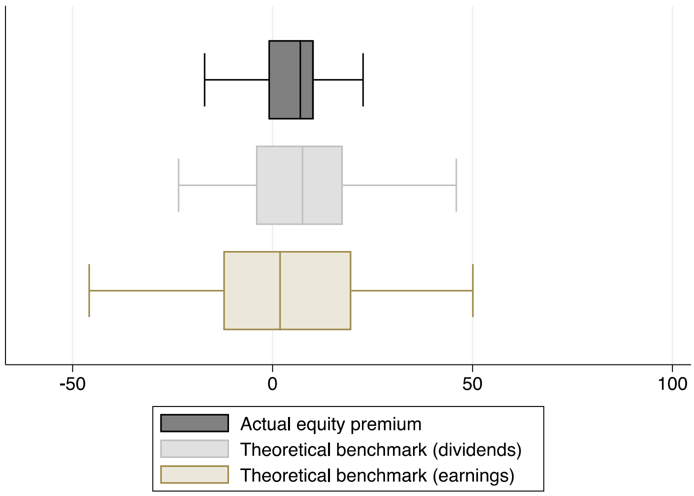

Figure 2 - Box plot of premia

The whiskers – the vertical lines at the left and right endings – essentially provide us with the lowest and highest datapoint, respectively. For clarification purposes, we thus can infer that the highest theoretical benchmark premium based on earnings is as high as 50. The line in the boxes represents the median, i.e. half of the observation is left of the line (lower) and half is right of the line (higher). The box plot ends at the median for the lower and higher 50% of the observations. Greater variability in the theoretical benchmarks is a good lead for the existence of a puzzle. The greater the variability, the stronger the puzzle may be. Although the graph helps us to immediately spot the variability differences, we are ought to formally test this per datapoint by calculating the exact difference as part of the regression in the next section.

4.2 Regression analysis

Prior to analyzing the data, we must make sure that heteroskedasticity, autocorrelation, and non-stationarity do not play a role in our analysis. First, we graph the residuals as can be seen in **figure 1** of **appendix III**. We formally test for heteroskedasticity by performing a Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, concluding we cannot reject the null-hypothesis of a constant variance (P>|t|= .3014). This means heteroskedasticity is not a problem in our data. Moreover, we diagnose autocorrelation by performing a Durbin Watson test. Based on our test statistic ($DW = 2.0213$) we report that we do not find evidence of autocorrelation. Finally, non-stationarity is first screened by graphing the variables over time, which we included in **appendix IV**. The figures show that our dependent variable returns to zero over time and our independent variables return to a constant over time. As all of our variables return to either a constant or zero, we already have an indication that non-stationarity is not a problem in our study. We formally prove it by running Dickey Fuller tests, of which we report the statistics in the appendix.

We must also test whether the equity premium puzzle is statistically significant from zero. We perform a one-sample t-test under the null-hypothesis that the equity premium puzzle equals zero. We report a two-sided test statistic of .5028, meaning we fail to reject the null hypothesis that the difference is statistically significant from zero. However, this does not imply that the difference is equal to zero, we simply have not enough evidence to argue a significant difference from zero. In fact, we argue that **figure 3** does indicate an equity premium puzzle considering the outcome range. **Figure 12** in **appendix IV** shows the development of the puzzle's magnitude over time. Based on the graphs, we find it reductive to conclude there is no puzzle by taking into account only the sample's mean test statistic.

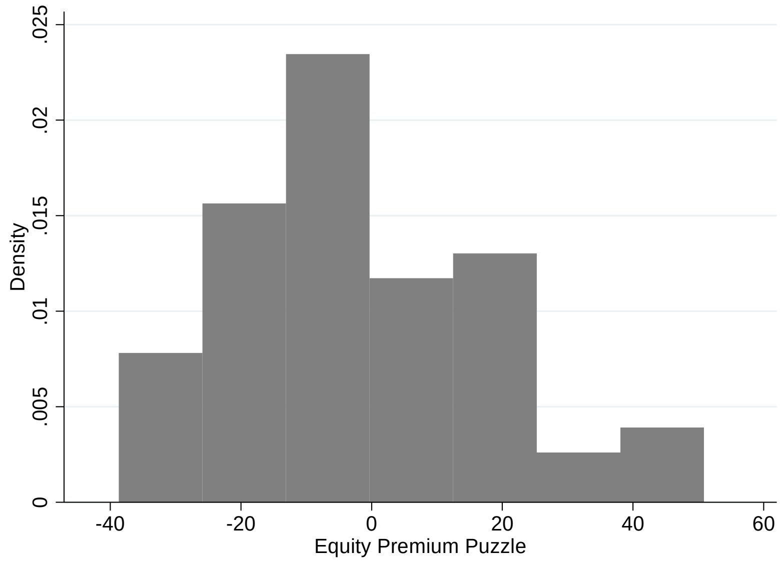

Figure 3 - Histogram of the outcome variable

We included the lagged version of the difference in equity premia (EP_{t-1}) as it potentially contains important information on the current difference in equity premia. Specifically, we may not have to explain the absolute value of the equity premium puzzle but rather we explain the difference between moments in time. We report the results in **table 4**. For the whole sample period, we find a significant beta coefficient for the lagged equity premium, as well as for investor sentiment and for volatility at the 1%-significance level. All signs confirm the theory as discussed in the literature review. We include a robustness check and analysis of the regression excluding the lagged excess equity premium (EP_{t-1}) in **appendix V**.

Table 4. AR(1) Regression results

	(1) Whole sample	**(2)** Pre-crisis	**(3)** Crisis	**(4)** Post-crisis
EP_{t-1}	.667***	.475**	.846	.757***
	(.097)	(.185)	(.499)	(.118)
S_t	-.956***	-.842**	-.853*	-1.049*
	(.266)	(.362)	(.268)	(.742)
h_t	1.972***	2.170***	.989	2.741***
	(.685)	(.717)	(1.764)	(.886)
π_t	-.883	1.193	-.659	-9.601**
	(1.330)	(2.299)	(6.174)	(6.123)
$Constant$	7.637	-13.259	19.580	57.718***
	(10.423)	(20.501)	(77.197)	(20.148)
$\bar{R}^2$	.5178	.3198	.6064	.6356

Standard errors in parentheses. ***p<0.01, **p<0.05, *<0.1.

Using model (7) formalized in section 3.4, we can fill in the obtained beta coefficients into our model. Prior to discussing the regression results we list the models below. We should note that the number in front of the model refers to the number in the regression table above. The fit of the model captured by the adjusted r-squared ($\bar{R}^2$). We find that our overall model has a predictive power of 51.78%, i.e. the model explains about half of the variability of the data around the mean. The pre-crisis model has less predictive power with an adjusted r-squared of .3198. In contrast, the crisis and post-crisis models increase in explain power significantly. All coefficients being statistically significant and having the highest $\bar{R}^2$ of 63.56%, the post-crisis model shows the highest overall fit.

(1) $$\widehat{EP}_t = 7.367 + .667EP_{t-1} - .956S_t + 1.972h_t - .883\pi_t. \tag{8}$$

(2) $$\widehat{EP}_t = -13.259 + .475EP_{t-1} - .842S_t + 2.170h_t + 1.193\pi_t. \tag{9}$$

(3) $$\widehat{EP}_t = 19.580 + .846EP_{t-1} - .853S_t + .989h_t - .659\pi_t. \tag{10}$$

(4) $$\widehat{EP}_t = 57.718 + .757EP_{t-1} - 1.049S_t + 2.741h_t - 9.601\pi_t. \tag{11}$$

4.2.1 Investor sentiment

Explaining the models, an increase of 1 unit in investor sentiment (P>|t|= .001) would mean a decrease of .956 in the equity premium puzzle, ceteris paribus. High levels of investor sentiment, i.e. high notation of the VAEX, basically means that there is a lot of fear in the stock market. If there is a lot of fear, the equity premium puzzle will thus decline by the magnitude of .956 per unit increase of the fear gauge. For the individual time periods, we find estimated beta coefficients that also have a negative sign and a magnitude almost equal to the whole sample magnitude. We find that the beta coefficient is most significant pre-crisis (P>|t|= .032) and less significant during (P>|t|= .085) and after the crisis (P>|t|= .092). The negative relationship is observable by **figure 4**. Except from the outliers in the top area of the graph, a clear negative pattern is illustrated.

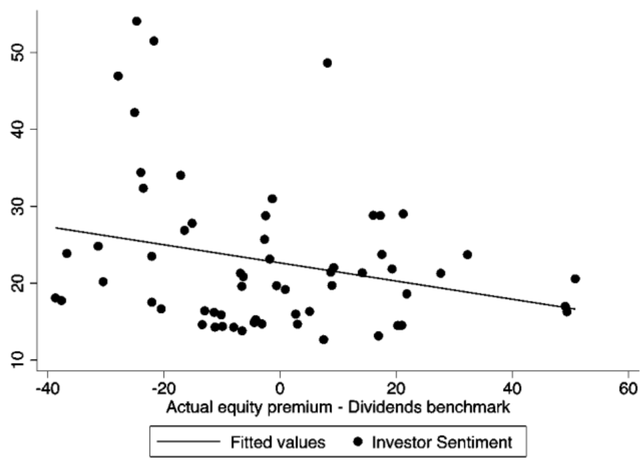

Figure 4 – Scatterplot S_t

To test our hypothesis $(H_0: \beta_2 \geq 0, H_A: \beta_2 < 0)$, we must calculate the critical t-statistic. As we expect our sign to be positive, we use a one-sided t-test with a level of significance of 5%. We find value for t_c equal to –1.674. We reject $H_0: \beta_2 \geq 0$ if the t-value of our regression is below –1.674. For all models (1-4) we find t-values that are below –1.674. Specifically, we report a t-value of –3.59, –2.33, –3.20, and –3.12, respectively. Taking into account that the beta coefficients of investor sentiment provide the expected sign under H_A, we accept our second hypothesis that investor sentiment has a negative effect on the equity premium puzzle.

4.2.2 Volatility

Volatility (P>|t|= .000) shows a stronger magnitude with a beta coefficient of 1.972. The coefficient signals an increase of 1.972 in the equity premium puzzle per 1 unit increase in volatility, ceteris paribus. Thus, high levels of volatility increase the equity premium puzzle. We should relate this to investor sentiment, since a high VAEX (negative sentiment) typically comes with high levels of volatility. Therefore, we find it necessary to test whether multicollinearity plays a role in our regression coefficients. A rule of thumb holds that when the value inflation factor (VIF) is greater than 5, multicollinearity plays a role in the regression (Studenmund, 2017). **Table 5** presents the results of the multicollinearity test. The low VIF scores signal that strong multicollinearity is not present in the regression.

Table 5. VIF scores

	VIF	$1/VIF$
EP_{t-1}	1.08	.929
S_t	1.80	.555
h_t	1.85	.542
π_t	1.15	.870
mean	1.47	

We graphically show the relationship in **figure 5**. The fitted line shows a slightly positive slope, but the pattern is certainly less clear compared to investor sentiment. Still, as we expected our sign to be positive $(H_0: \beta_3 \leq 0, H_A: \beta_3 > 0)$, we use a one-sided t-test with a level of significance of 5% finding a value for t_c equal to 1.674. We reject $H_0: \beta_2 \leq 0$ if the t-value of our regression exceeds 1.674. We report a t-values of 3.78, 3.03, .56, and 3.09 for model 1-4, respectively. We can thus reject H_0 for all models except for the crisis period. We find the signs to be in line with the theory and the sign does not change in any time period, therefore we find the t-value of .56 in the crisis period not too problematic. Consequently, we accept our third hypothesis stating that volatility significantly positively affects the equity premium puzzle.

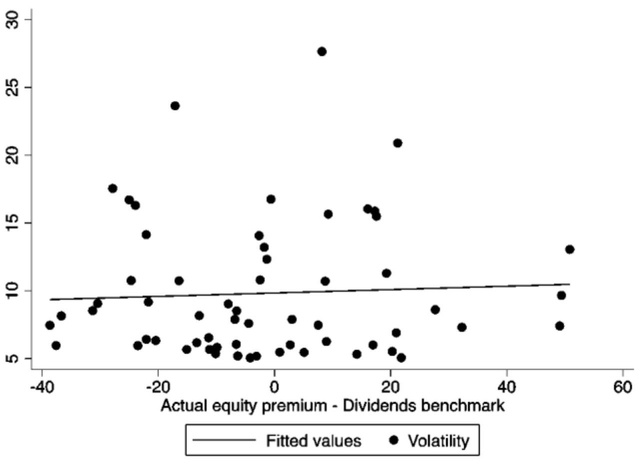

Figure 5 – Scatterplot h_t

4.2.3 Trade volume

Our final explanatory variable is only significant in the post-crisis time period (P>|t|= .019). The 95% confidence interval of trade volume post-crisis is [–17.50, –1.70], meaning it is statistically significant different from zero and shows the expected negative sign. Unfortunately, we cannot argue the same for the other models. The evidence does not suggest trade volume has no effect on the equity premium puzzle; it only suggests that within our dataset there is not enough evidence to prove there is a significant effect. Similar as for the other variables, we include a graphical representation in **figure 6**. We observe a negative pattern, although the variability is great.

Testing the hypothesis ($H_0\colon \beta_4 \geq 0, H_A\colon \beta_4 < 0$), we once more use t_c equal to –1.674. We reject $H_0\colon \beta_2 \geq 0$ if the t-value of our regression is below –1.674. Not surprisingly, we only find an exceeding t-value of –2.50 post-crisis. Based on the little evidence we find we cannot accept our hypothesis that trade volume significantly affects the equity premium puzzle. This means we remain inconclusive, as an effect is shown for some of the data. We most certainly do not argue there is no effect at all.

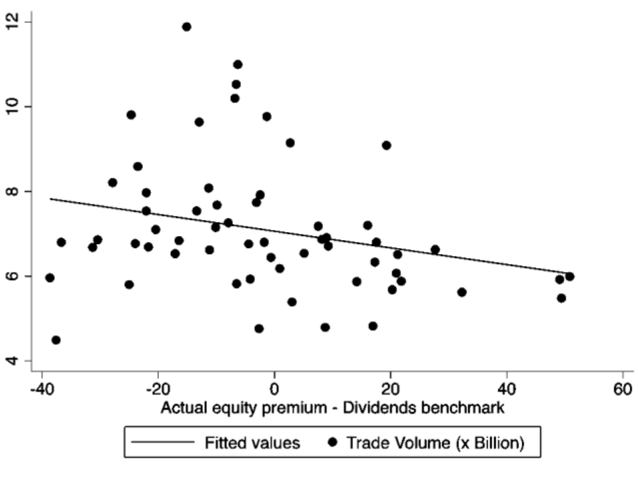

Figure 6 – Scatterplot π_t

4.3 Critical reflection and suggestions

Finally, we seek economic meaning of our presented results. We find that investor sentiment plays an important role in our study. Baek et al. (2005) argue that changes in investor sentiment may explain short-term price movements better than fundamentals, such as dividends and earnings. Bandopadhyaya and Jones (2006) support the statement by finding that their sentiment index explains a significant proportion of price movements. Our results suggest that when our proxy for investor sentiment is high (i.e. there is much fear and therefore a negative sentiment) the equity premium puzzle can become seriously negative. This implies that during times of great fear, the actual equity premium can become significantly lower than the premium estimated by the theoretical benchmarks. We would recommend further research on this particular relationship. One suggestion would be to include multiple measurements of investor sentiment (volatility index, high-low index, bull/bear-index etc.) to investigate which indicator may explain most of the equity premium puzzle.

Moreover, the results suggest that increased conditional return volatility leads to a higher equity premium puzzle. The relationship makes economic sense because we expect volatility to have a greater impact on price movements (capital gains in RX_t) compared to the impact on fundamentals (dividend and earnings growth in RXD_t and RXY_t, respectively). Investors may or may not want to hold equities that are typically more volatile than others, a fact we use to build a bridge to portfolio diversification. The market portfolio is already a diversified 'basket' of stocks listed on a market index with a β equal to 1. Interesting for further research would be to investigate the impact of portfolio diversification on the equity premium puzzle.

Another important feature of the equity premium puzzle is the risk-free rate. We used the short-term interest rate or treasury bill rate as a proxy for the rate of return on a riskless asset. However, a fair discussion can be hold as opposed to whether, for example, a government bond is actually risk-free. We think it can be highly interesting to use another financial product as the risk-free asset. Specifically, we would recommend to (also) use the return on gold in future studies as gold is seen by many investors to be a very safe investment. It is typically used for storing of wealth as it keeps its value over a long-time horizon. It is highly interesting whether the equity premium puzzle would remain when we alter the risk-free rate of return when using gold.

5. Conclusion

This paper aimed to investigate the equity premium puzzle during the global financial crisis and the impact of investor sentiment, volatility and trade volume on the existence of the equity premium puzzle over the period 2002 - 2016. Based on the statistical results, we find the actual equity premium to be negative (–9.32%) during the financial crisis. The result is highly interesting, since it would imply that investors yield a higher return on risk-free assets compared to the “risky” market index. We report an average actual equity premium of the whole sample period yielding 4.11% and a benchmark equity premium based on dividends (earnings) of 5.94% (2.48%). In light of the literature, we typically find slightly higher reported premiums (Dimson et al, 2003; Salomons and Grootveld, 2003). We do not find this a surprising result, as the bulk of the years in our study show evidence of similar magnitudes as in other studies.

An equity premium puzzle is present when the difference between the actual equity premium and the benchmark equity premium is statistically significant different from zero. We find that on average the puzzle is greatest during the crisis period, as hypothesized. In the AR(1) model, we include one lagged version of the equity premium puzzle. We find evidence for a significantly negative impact of investor sentiment on the equity premium puzzle. Furthermore, we find a significantly positive beta coefficient for volatility. Unfortunately, our data does not provide enough evidence for a significant effect of trade volume for the whole sample period.

This paper contributes to the existing literature in terms of new evidence on the equity premium puzzle and how it is affected during the global financial crisis using the AEX. We document significant factors that affect the existence of the equity premium puzzle: investor sentiment and volatility. Moreover, we report a significant negative relationship between trade volume and the equity premium puzzle for post-crisis period. The results suggest that the excess equity premium shrinks when there is serious fear in the financial market, potentially becoming severely negative.

Based on the results of this paper, we make four recommendations for further research. First, would recommend further research on the effects of the recent COVID-19 pandemic on the equity premium puzzle. We already mentioned that the earnings growth model shows patterns of recovery after 2016. Vitor Gasper, a top official of the IMF (International Monetary Fund) stated in an interview that the effect of the COVID-19 pandemic may be even worse than the global financial crisis (The Economic Times, 2020). Secondly, we recommend further research on the relation between investor sentiment and the equity premium puzzle. One suggestion would be to include multiple measurements of investor sentiment (volatility index, high-low index, bull/bear-index etc.) to investigate which indicator may explain most of the equity premium puzzle. Thirdly, it would be interesting to investigate the impact of portfolio diversification on the equity premium puzzle. Finally, replacing the risk-free rate of return by using the long-term return on gold may lead to helpful insights.

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APPENDICES

Appendix I: Listed firms with the Amsterdam stock exchange

The Amsterdam Exchange index is a composition of 25 Dutch firms that are being traded on Euronext in Amsterdam. As for the composition for the timeframe of the research, we constructed the following table to gain insight which firms are listed.

Table 5. Listed firms AEX

Listing code	Corporation
AALB-NL	AALBERTS N.V.
ABN-NL	ABN AMRO BANK N.V.
ADYEN-NL	ADYEN N.V.
AGN-NL	AEGON N.V.
AD-NL	AHOLD DELHAIZE N.V.
AKZA-NL	AKZO NOBEL N.V.
MT-NL	ARCELORMITTAL N.V.
ASML-NL	ASML HOLDING N.V.
ASRNL-NL	ASR NEDERLAND N.V.
GLPG-NL	GALAPAGOS N.V.
HEIA-NL	HEINEKEN N.V.
IMCD-NL	IMCD N.V.
INGA-NL	ING GROEP N.V.
PHIA-NL	KONINKLIJKE PHILIPS N.V.
NN-NL	NN GROUP N.V.
PRX-NL	PROSUS N.V.
RAND-NL	RANDSTAND N.V.
REN-NL	RELX PLC
DSM-NL	ROYAL DSM N.V.
RDSA-NL	ROYAL DUTCH SHELL N.V.
KPN-NL	ROYAL KPN N.V.
VPK-NL	ROYAL VOPAK N.V.
URW-NL	UNIBALL-RODAMCO-WESTFIELD N.V.
UNA-NL	UNILEVER N.V.
WKL-NL	WOLTERS KLUWER N.V.

Appendix II: Stationarity Test

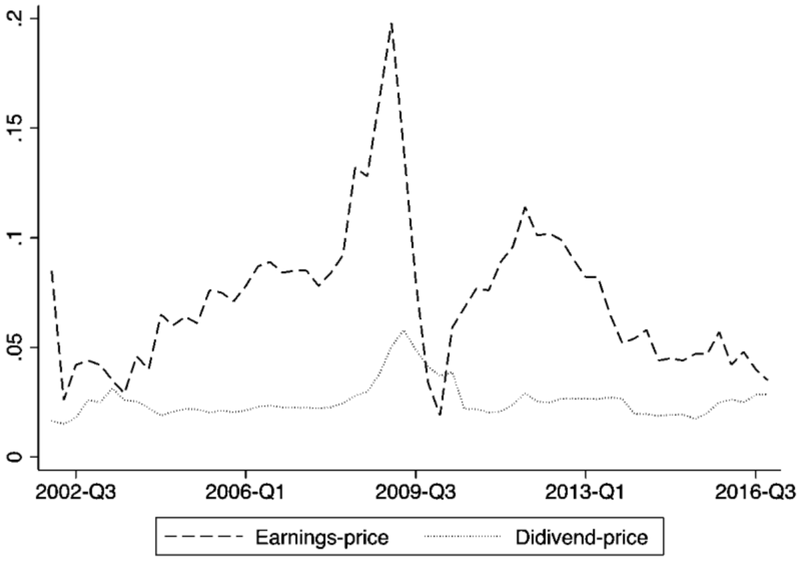

Figure 7 – Graphing stationarity

Appendix III: Residual plots

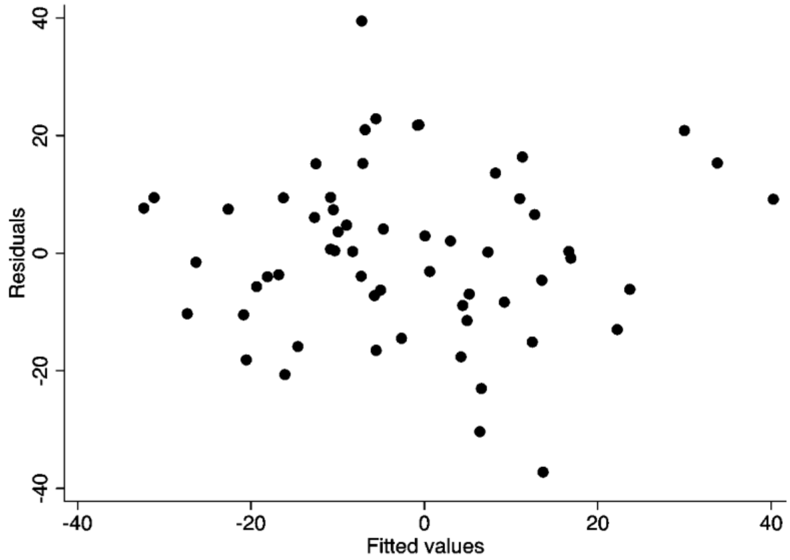

Figure 8 – Heteroskedasticity

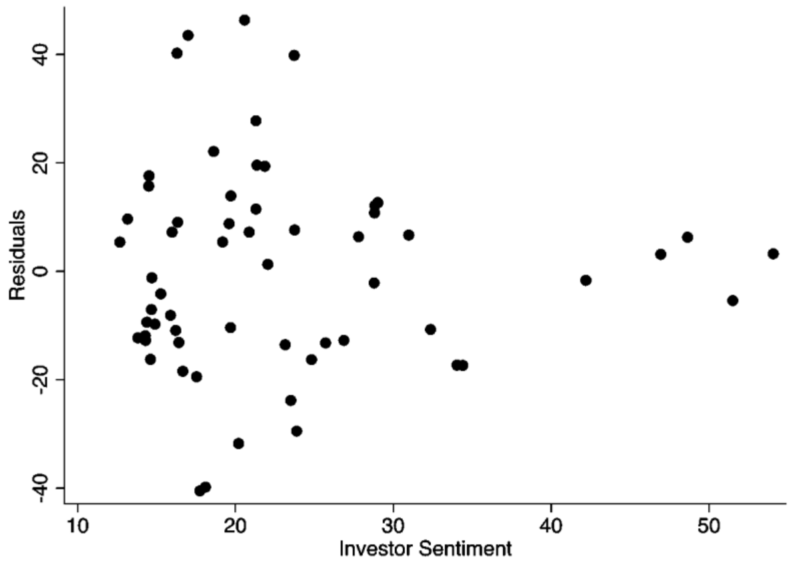

Figure 9 - Residual plot investor sentiment

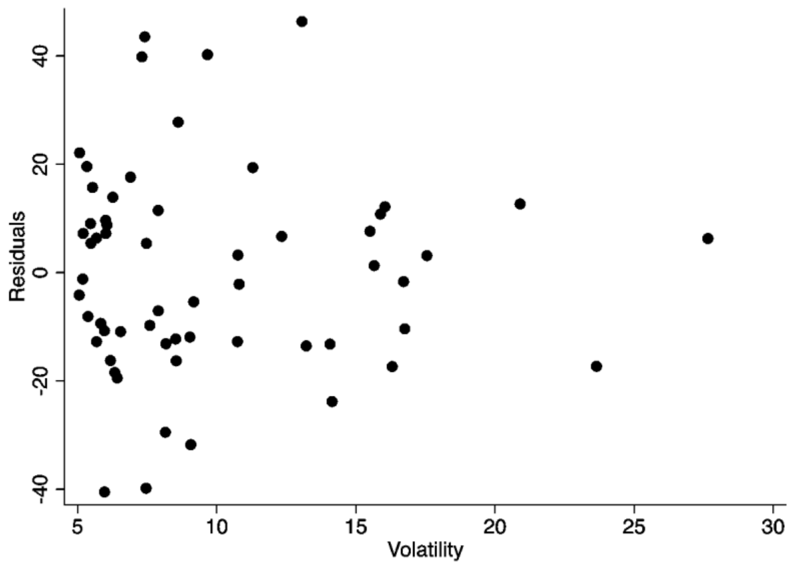

Figure 10 - Residual plot volatility

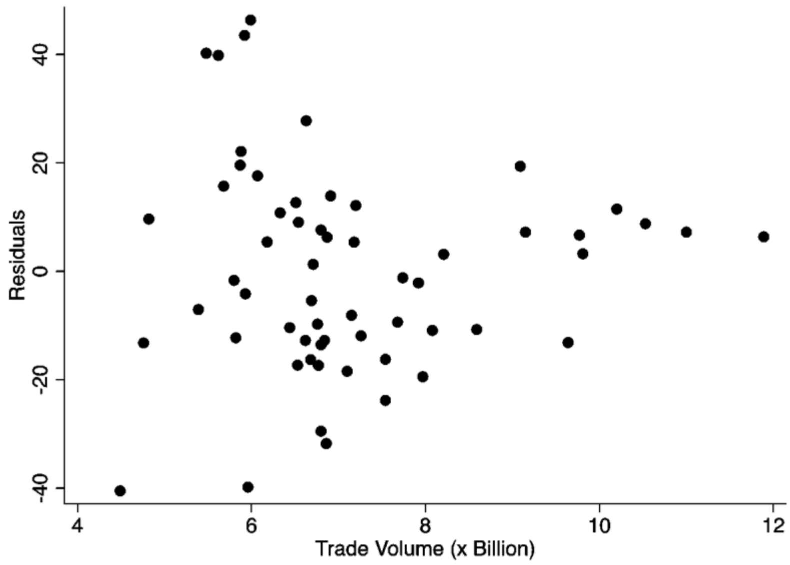

Figure 11 - Residual plot trade volume

Appendix IV: Non-stationarity

We first screen for (non-) stationarity by graphing all variables over time. We also perform the Dickey fuller test to formally prove non-stationarity. We find a test-statistic of –3.489 for the equity premium, which is smaller than all critical values (–2.616, –1.950, –1.610 for the 1%, 5% and 10% critical value, respectively). For investor sentiment, volatility and trade volume we report a test statistic of –2.852, –3.219, and –2.915, respectively. These negative statistics provide us with evidence of what the graphs already show, i.e. the variables are not exploding over time but rather return to zero or a constant.

Figure 12 - Equity premium puzzle stationarity

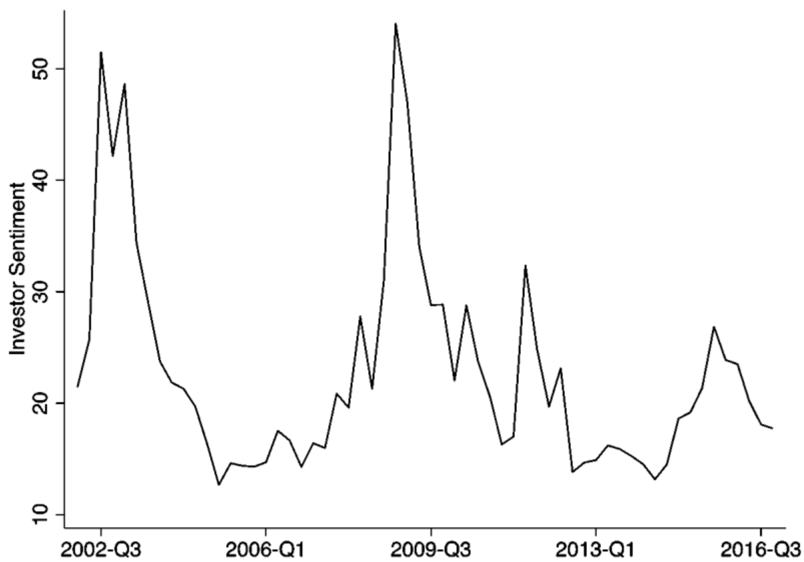

Figure 13 - Investor sentiment stationarity

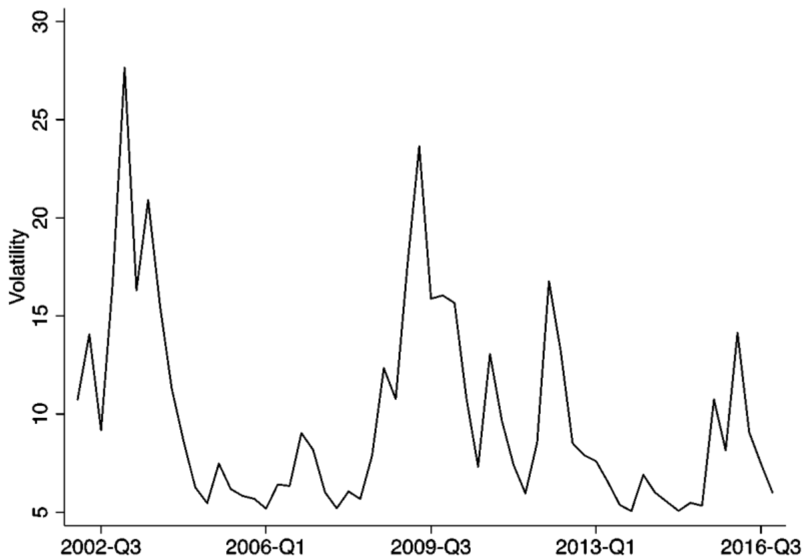

Figure 14 - Volatility stationarity

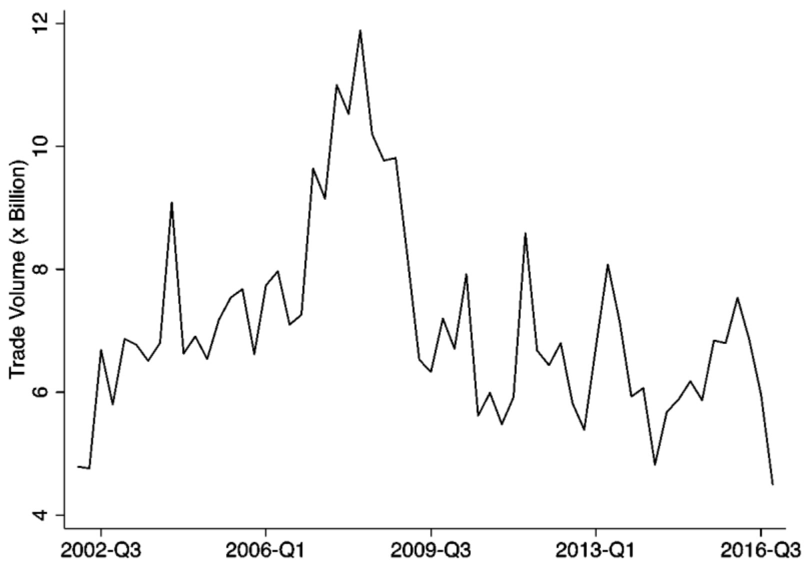

Figure 15 - Trade volume stationarity

Appendix V: Robustness check

We perform a final test for the robustness of our results. We run the regression once more, however, this time we exclude the lagged dependent variable as a regressor. We present the regression results in **table 6**. We observe that the coefficient for investor sentiment remains reasonably negative and statistically significant for the whole sample period. Moreover, the results show that volatility still has a significantly positive effect on the excess equity premium over the whole sample period and during the pre-crisis period. Our final explanatory variable, trade volume, remains insignificant for all periods investigated.

Table 6. AR(1) Regression results leaving out EP_{t-1}

	(1) Whole sample	**(2)** Pre-crisis	**(3)** Crisis	**(4)** Post-crisis
S_t	-.871**	-.877**	-.614	-.534
	(.357)	(.405)	(.288)	(.742)
h_t	1.183**	1.783**	-.003	1.758
	(.685)	(.790)	(2.122)	(1.393)
π_t	-2.108	-.142	.363	-9.509
	(1.745)	(2.354)	(7.835)	(6.123)
$Constant$	21.433	-.673	2.956	57.189**
	(13.541)	(20.791)	(97.641)	(32.167)
$\bar{R}^2$	.1142	.1175	.3601	.0711
$(table\ 4\ \bar{R}^2)$	.5178	.3198	.6064	.6356

Standard errors in parentheses. ***p<0.01, **p<0.05, *<0.1.

We should take note of the dramatically decreasing explanatory power of the overall adjusted model. The latter model, after leaving EP_{t-1} out of the regression, can be formally written as follows:

$$EP_t = \beta_0 + \beta_1 S_t + \beta_3 h_t - \beta_4 \pi_t + \epsilon_t. \tag{12}$$

As EP_{t-1} is left out, the adjusted r-squared decreases from 51.78% to 11.42% over the whole sample period. We find similar declining patterns for $\bar{R}^2$ in all other periods. Such decreases suggest that leaving out the lagged excess equity premium has a great impact on the model's explanatory power. The adjusted r-squared adjusts for the number of variables included in the model, hence it only increases when the additional variable actually improves the overall model (unlike the R^2). We argue it is safe to say that the previous value of the excess equity premium thus contains important information on the current value, therefore being reasonably included in the regression analysis.