# The end of the equity premium puzzle? An analysis of the European financial markets

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**Abstract**

This paper evaluates the magnitude of the equity premium in the European financial markets of the last twenty years. We document a substantial decrease in its value, especially after the onset of Great Recession. A habit consumption model predicts a value for the equity premium much higher than observed in data. Conversely, a simple general equilibrium model in the spirit of Mehra and Prescott (1985) is now able to explain the premium without resorting to extremely high coefficients for risk aversion.

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The usual disclaimer applies.

# 1. Introduction

Since the seminal paper of Mehra and Prescott (1985), the so-called equity premium puzzle has been one of the most debated topics in financial economics. Mehra and Prescott showed that a standard general equilibrium model of the financial markets was not able to explain an average difference between risky and non-risky securities of about 6%, as observed in the United States in the previous ninety years. The only way to match theory and data was to assume an unrealistically large coefficient for risk aversion.

Many studies have sought a solution to this puzzle[3], in most cases by adding new features in the Mehra and Prescott's framework or by abandoning the assumption of perfectly rational agents[4]. Among these works, models of habit formation, which assume consumption choices of individuals are influenced by their habits, appear particularly successful in their attempt to bridge the gap between neoclassical asset pricing theory and data (see Cochrane, 2005 and 2017).

This paper computes the value of the equity premium in the European financial markets over the last twenty years. Our analysis indicates that, looking at the entire sample years 2000-2019, the average equity premium is close to 0.5%. If we focus just on the period after the onset of the Great Recession until 2019, the equity premium takes a value of about -2%, something that never occurred for such a long interval in the past seventy years. Conversely, by looking at the period between 2000 and 2007, we find that the premium is about 4%, below the average historical value.

To replicate this evidence, we make use of two alternative equilibrium frameworks. The first is a habit formation model, in the spirit of Campbell and Cochrane (1999). The utility of the individuals does not simply depend on the value of current consumption but on the difference between actual consumption and a standard (habit). The ability of such models in matching data lies on an intuitive rationale. A relatively small reduction in current

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[3]Mehra and Prescott (2003) and Mehra (2007) provide a thorough survey on the subject.

consumption leads to a large drop in the demand for risky assets if individuals fear their well-being will decrease below a certain standard. In turn, this makes risky assets less pricey, increasing their expected returns.

However, applying such a framework to understand the evolution of risky and riskless assets in Europe in the last twenty years gives poor results. The implied theoretical premium is almost 9 percentage points higher than the observed one. A habit model over-predicts the results obtained in data.

We show that such a failure is almost entirely due to the economic-financial turmoil that has greatly altered the financial markets since 2008. Habit models fall short in periods of great turbulence, when the current values of income and consumption are close to the habit standard X. In such circumstances, the model implies an extremely high degree of risk aversion for the representative household, whose utility function depends on relative consumption.

To fit data, we then adopt a second equilibrium framework, the one considered by Mehra and Prescott (1985) to present the equity premium puzzle the first time. In contrast to other models that we discuss in the next section, it is a standard setting, in which there is no capital, markets are efficient and complete, and all individuals are rational, utility maximizers. Under such a scenario, we are able to replicate the values for the equity premium found in data. Imposing a reasonable coefficient of 3 for relative risk aversion, we get an equity premium of 0.5%, as observed in data.

Of course, it would be premature, at least, to call off the existence of an equity premium puzzle just by looking at this period. It could be the case that the years subsequent the Great Recession have been exceptional, and in the future the discrepancy between theory and data will appear again. We think however that the results of the present paper offer a useful contribution to the literature on the subject. A successful model of asset pricing must be able to explain the risk premium even taking into account investors' behaviour in periods when equities offer relatively low returns.

The paper is organized as follows. Section 2 presents the literature review. Section 3 illustrates data. Section 4 presents the model and compares theory and data. Section 5 concludes.

## 2. Literature Review

Equities usually have higher returns than riskless assets. This excess return (premium) can be interpreted as the remuneration investors receive for bearing a higher risk. The quantification of the optimal risk premium is the objective of the Mehra and Prescott (1985) model. They compute the excess return guaranteed by a risky U.S. asset compared to that paid by a risk-free U.S. treasury bill, over the period 1889 to 1978, obtaining a premium of about 6%. This figure is the result of a high average return for the S&P500 index (6,98%) and a very low yield for the risk-free security (on average equal to 0,80%). Other studies (for instance Kocherlakota, 1996; Goetzmann and Ibbotson, 2012) have also found high values for the equity premium, by considering slightly different time horizons, which also include the early 2000s.

Mehra and Prescott's main result is that a standard neoclassical general equilibrium model is unable to explain such a large premium, unless we are willing to assume that individuals have an unrealistically high level of risk aversion. If we consider a constant relative risk aversion (CRRA) utility function, reasonable values for the coefficient of risk aversion range from 1 to 5. In Mehra and Prescott's model only by imposing a coefficient ranging from 15 to 40, is possible to get realistic values for the equity premium. But, an individual with a relative risk aversion equal to 20, for instance, a person with 100 dollars of initial consumption would have a certainty equivalent of less than three and one-half dollars for a lottery ticket paying a prize of 100 dollars with a probability ½.[5] People are so risk averse that companies must offer very high returns to make stocks attractive[6].

Over the past thirty years many economists have tried to find a solution to this puzzle. The literature on the subject is so vast that accounting for all the possible strategies adopted to reconcile theory and data goes beyond the scope of this work. A recent survey by Cochrane (2017) divides the research stream on the subject in several different avenues.

Besides the aforementioned habit models (first pioneered by Constantinides, 1990)[7], another popular approach makes use of a recursive utility function (Epstein and Zin

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[5] For a critique on the use of a standard expected utility function and Taylor expansion to infer risk aversion in case of small risks see Thomas (2016) and O'Donoghue and Somerville (2018).

[6] To complicate things even further, assuming a really high level of risk aversion makes it impossible to explain why the riskless real interest rate has been so low in the same period of time (the so-called "risk-free interest rate puzzle). See Weil (1989) for details.

[7] Other papers making use of habit models to explain the equity premium puzzle are Chen and Ludvigson (2009), Shrikhande (1996), Grishchenko (2010). See also Ljungqvist and Uhlig (2010) for an analysis of

1989). In such a framework, bad news about long-run future consumption growth make investors less willing to buy stocks, increasing their returns. In the same vein we can list papers that focus on the long run risk, in which uncertainty about the future state of the economy is the main driver of the equity premium (Bansal and Yaron, 2004; Bansal, Kiku, and Yaron, 2012).

Other studies focus on the idiosyncratic risk (Constantinides and Duffie 1996). In such a context, people are afraid that stocks might decrease in an economy with a lot of idiosyncratic risk. As long as they are risk averse, fear of the losses outweighs the happiness in case of gains, so demand for risky assets decreases.

Even models with heterogeneous preferences (such as Gârleanu and Panageas 2015) are adopted to explain the equity premium puzzle. In this scenario, people do not have the same degree of risk aversion. When the market goes down, less risk averse investors (that own a larger share of stocks in the economy) lose more money, so becoming a smaller part of the overall market. The market as a whole becomes more risk averse after a fall in value, pushing down prices even further.

Another popular explanation lies on the gulf between the fear and the real occurrence of rare disasters (Reitz 1988; Barro, 2006). Investors worry about rare events with very low consumption growth, then the variance of marginal utility will be larger than the variance we measure in a sample that does not include any rare events.

A different rationale for the puzzle is provided by papers focusing on the role of institutions and rules in financial markets. Brunnermeier (2009) and Krishnamurthy and He (2013) argue that leverage and capital constraints at banks are frictions that dampen the demand for risky assets.

Finally, behavioural finance has also offered various explanations (for instance Benartzi and Thaler, 1995; Siegel and Thaler, 2014). A common feature of these models is the departure from rationale expectations assumptions on people's behaviour to motivate wrong probability assessments.

## Data Results

these models.

Data about the equity premium and the riskless interest rate of the period 2000-2019 are collected by using the OECD database.

More precisely, we choose the STOXX Europe 600 index for the return of the risky assets. It is a basket of European stocks with a fixed number of 600 components representing large, mid and small capitalization companies among 17 European countries, covering approximately 90% of the free-float market capitalization of the European stock market. For the risk-free securities we choose the three-year German Government bonds. Data for the STOXX Europe 600 index are freely available from the Yahoo Finance website, while those for three-year German Government bonds are obtained from the financial platform Investing.com.

The OECD database also provide data for the real GDP per capita levels. As we will explain in detail later on, for the standard habit we use the past five years average of the GDP per capita data.

Figure 1 illustrates data about the annual returns for the STOXX Europe 600 stock index. The European market showed a significant growth during different years such as 2000, 2005, 2006, 2014, while it recorded an important slowdown in others, especially during the crisis.

In Table 1 we show how the returns were affected by the Great Recession started in 2008. If we look at the entire period, average returns are positive, albeit not large enough to generate a significant equity premium. If we focus just on the interval 2000 - 2007 (pre-crisis mean) returns are about 4%, twice as large as the ones obtained considering the entire period. As expected, it is the post-crisis 2008-2019 period that delivers the most meagre results.

In the last row of Table 1 we also compute the average returns by ignoring the two main years of the crisis (2008 and 2009). The average without crisis is indeed close to 5%, more than 2 percentage points higher than the actual mean.

As concerns the riskless securities, Figure 2 present the returns of German 3-year government bonds from 2000 to 2019. Yields have been falling continuously since 2000, with a strong rise in the crisis years and with ever lower values following it.

The difference in yield between the STOXX Europe 600 index and the 3-year German government bond is the equity premium, presented in Table 2.

Even at a first glance, it is easy to observe the large volatility of such a difference, that directly stems from the high variation of the STOXX index. There are periods with really large premiums (i.e. 28,46% in 2000) and other years with very negative ones (-24,62% in 2008). In Table 3 we also present the average of the stock premium by dividing the entire period in some significant intervals.

The average value calculated over the entire time horizon (2000-2019) is tiny, about 0,43%, a value very far from the 6% observed by Mehra and Prescott in the United States between 1889 and 1985. Of course, the financial crisis is the main culprit for such a result. Indeed, returns calculated over the 2000-2007 period are close to 4%, whereas after the crisis they are negative and about -2%. This figure is particularly striking, as it underlines the total change that took place in the financial markets following the Great Recession. As before, we also calculate the amount of the risk premium ignoring the most dramatic years of the crisis. The average computed in this way is equal to 2,97%, still more than 3 percentage points lower than the historical value in Mehra and Prescott (1985).

# 4. The Model

## 4.1 The Habit Consumption Model

In this section, we briefly present the central equations at the heart of a standard habit model, and we refer to Gollier (2001, chapter 5) and Cochrane (2005, chapter 1) for the primitive conditions under which they are derived.

Suppose an economy composed by several identical individuals that live per one period.

We denote with $\tilde{y}$ the random variable representing the level of consumption per capita, or, equivalently in this static model, the level of income per person.

The fundamental pricing formula that links marginal utilities and stocks returns can be written as follows:

$$E\,\tilde{r} - r \quad = \quad -\,cov\,(\widetilde{M};\tilde{r}\,) \qquad (1)$$

The term $\tilde{r}$ is a random variable standing for the return of a risky asset, whereas $r$ is the return of the risk-free security. The term $\widetilde{M} \equiv \frac{u'(\tilde{y})}{Eu'(\tilde{y})}$ is the relative value of agent's marginal utility (it is often called the stochastic discount factor or the pricing kernel of the economy).

This equation tells us that the risk premium is large when the covariance takes a very negative value. If stocks yield negative returns in periods when expected marginal utility is high (or equivalently, consumption is expected to be low), the term at the RHS tends to assume a large positive value. Risk averse individuals would rather not hold securities that increase the volatility of their consumption stream, so equities must ensure very large returns at the equilibrium.

Since variation in real income per capita historically takes small values, a Taylor approximation allows use to write the equity premium as:

$$E\,\tilde{r} - r \;\; = \frac{Var\,(\tilde{y})}{E[\tilde{y}]^2} * R \qquad (2)$$

in which $R \equiv -\frac{E\tilde{y}\,u''(E\tilde{y})}{u'(E\tilde{y})}$ is the coefficient of relative risk aversion evaluated at the mean. It is obvious that the more risk averse people are (or the larger the variance of income per capita), the larger the equity premium is.

To check the empirical validity of equation (2) we need therefore an assumption on the utility function. Following Campbell and Cochrane (1999) we consider a standard constant relative risk aversion function:

$$u\,(\tilde{y}) \;=\; (\tilde{y} - \mathrm{X})^{1-\gamma}$$

In this specification, X stands for the habit point. The closer the current consumption $\tilde{y}$ gets to X, the higher the increase in the risk aversion. Indeed, we have that

$$R \equiv -\frac{E\tilde{y}\,u''(E\tilde{y})}{u'(E\tilde{y})} \;=\; \frac{\gamma}{S} \qquad \text{in which } \mathrm{S} \equiv \frac{E\tilde{y} - X}{E\tilde{y}} \qquad (3)$$

Risk aversion is not simply equal to the parameter γ, as in a standard framework with no habit, but it also depends on the difference $E\tilde{y} - X$. The same expected variation in income (consumption) delivers very different results depending how close to the habit X consumption is.

In other terms, habit models can solve the equity premium puzzle by increasing the index of relative risk aversion of individuals, R, and providing a rationale for that.

For habit X we consider the average of the previous five annual GDP per capita. Figure 3 shows the trend. European per capita GDP has exhibited a small but steady increase for the last twenty years, except for the period 2008-2009 (the Great Recession) and 2012 (because of the euro zone's sovereign-debt squeeze).

Notice also that in periods when the average X is higher than the consumption level C, the value of R in equation (3) becomes negative. This should lead to a negative risk premium. Such a scenario has not been envisaged by Campbell and Cochrane, as they tested their model on years with recessions not as serious as the one in 2008/2009. We circumvent this problem by taking the absolute value of R. It implies that a level of income one percent lower than X gives the same level of risk aversion than a level of income one percent higher than X. This may appear odd, as one could imagine that the eventuality of being poorer than the habit level should be a stronger incentive to keep investors away from stocks. Notice however that taking this into account would entail a larger equity premium. As we will see, applying the habit framework in such a context leads to an over-prediction of the equity premium. So, giving more weight to a negative variation with respect to X than a positive one would worsen the empirical consistency of the model even more.

It is easy to see from Figure 3 that the value of X standard remained almost always below the current level of GDP per capita, except for the most critical years. During these years, a significant increase in the 1/S ratio occurred, with a peak in 2011 at a value of 290.

Using equation (2) and (3), we compute the equity premium implied by a habit formation model. Tables 4 and 5 report the results for different values of $\gamma$. It is easy to see that, even for low values of such a parameter, the model is unable to match the results presented in the previous Tables and Figures. For example, if we focus on period 2000-2018 and take a value of $\gamma$ equal to 1, the habit formation framework predicts an equity premium equal to 10,42%, ten percentage points higher than the one observed in data.

We also consider different and more limited time horizons. Still the model fails to fit data. It is interesting to notice that, for the pre-crisis period, our framework incurs the “usual” problem of “under-prediction”. For instance, with $\gamma$ equal to 1, we get an average risk premium of 2.71% for the interval 200-2007, compared to the 4.3% obtained from data. Conversely, after the Great Recession, the habit model fails in the opposite direction, by implying a value for the risk premium that is much larger than the real one (8.3% for the post-crisis period against a -2% observed in data). Even ignoring the two years 2008-2009 theory is unable to replicate data with a gap of almost 9 percentage points (last row of Table 5).

It seems clear that such inability is almost entirely due to the economic-financial turmoil that has greatly altered the financial markets since 2008. Habit models are unable to replicate the observed variations in the equity premium in periods of great turbulence, when the current vales of income and consumption are close to the habit standard X. In such circumstances, a representative household whose utility function depends on relative consumption would exhibit a degree of risk aversion, and a consequent reluctance to hold equities, much larger than the one we observe in data. Conversely, habit frameworks are good at explaining the risk premium in more normal situations, like the subset 2000-2007 period in our dataset. If it is true that with $\gamma = 1$, the premium implied by the model is too low, but assuming $\gamma = 1.5$ we get a value of 4,07%, that almost coincides with the real one.

## 4.2 The Mehra Prescott model

The analysis illustrated so far has shown how a habit formation fails to solve the equity premium puzzle. We must observe however that, even by neglecting the crisis years, the average premium for the last twenty years in Europe is much below the historical level. A natural question is whether the original model of Mehra and Pescott, that originated the debate and proved incapable to fit data when the premium was large, is now better suited to explain the movements in financial markets.

Computing the equity premium implied by equation (2) and (3) with $X = 1$ corresponds to the original Mehra and Prescott model (see Gollier, 2001, chapter 5, and Eeckhoudt *et al.*, 2005, chapter 11 for details). Table 6 shows the results. Without the habit assumption, implied equity premiums are much lower, ranging from 0.09% to 0.87% for values of relative risk aversion going from 1 to 5. In particular, with $\gamma$ taking a value between 2 and 3, the model is able to replicate data for the entire period.

Such a model proves to be much more successful than the habit one in explaining data.

## 5. Conclusions

The Great Recession initiated in 2008 has deeply affected the European financial markets. The main European stock index shows a rather volatile trend, which alternates decidedly positive variations with particularly marked reductions in prices. In addition, the average return for stocks is considerably lower than the value found in the past. Yields of riskless bonds are lower than in the previous twenty years, although this decrease is less intense than that exhibited by risky securities. This has a considerable impact on the equity premium, so that the average is close to zero.

With income per capita hovering around a standard 5-years average, risk aversion implied by habit models predicts an excessively high return for the equity premium. Abandoning the assumption of habit preferences and resorting to a standard CRRA utility function deliver more realistic results, at least for the ten years subsequent the Great Recession.

To sum up our results, it seems that habit models are more successful than the Mehra Prescott model in explaining data if we ignore the crisis, whereas the opposite occurs if we put in the sample the most severe years of the Great Recession.

Some questions remain unanswered and deserve further investigation. First, it would be important to check the validity of these results even in markets different from the European one. Second, one should verify whether other frameworks, that in the past proved successful in explaining the premium, are also able to fit data of the last twenty years.

Finally, in the coming years it will be particularly interesting to pay attention to this evidence, in order to understand if what emerges from our analysis of the data is just temporary and in the future financial markets will exhibit again a large equity premium, or it is instead permanent, so representing a significant change in traditional financial thinking.

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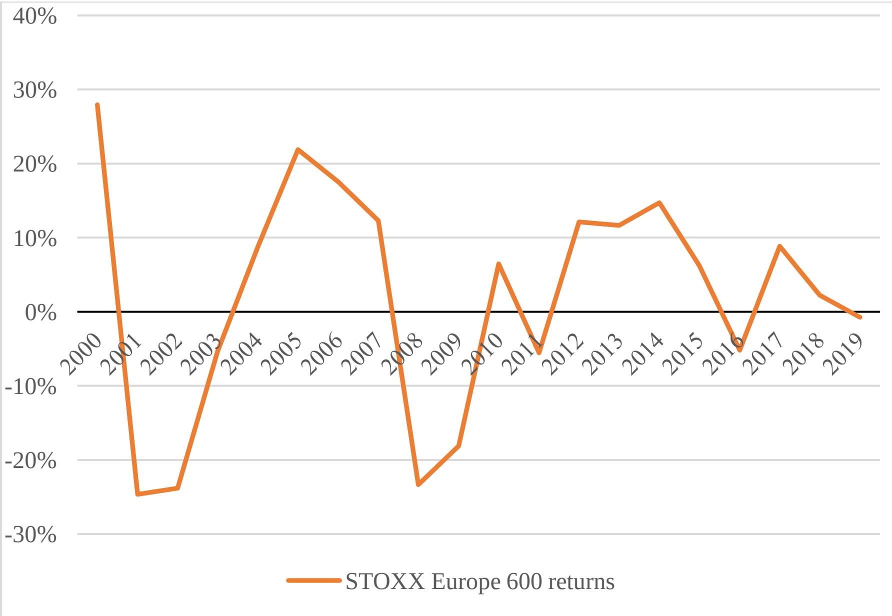


Figure 1: Annual returns of the STOXX Europe 600 index from 2000 to 2019. Source: Personal elaboration based on data downloaded from Yahoo Finance.

| | |
|---|---|
| Mean | 2,21% |
| Mean pre-crisis | 4,34% |
| Mean post-crisis | 0,79% |
| Mean without crisis | 4,76% |

Table 1: Average returns of the European index in different periods. Source: Personal elaboration based on data downloaded from Yahoo Finance.

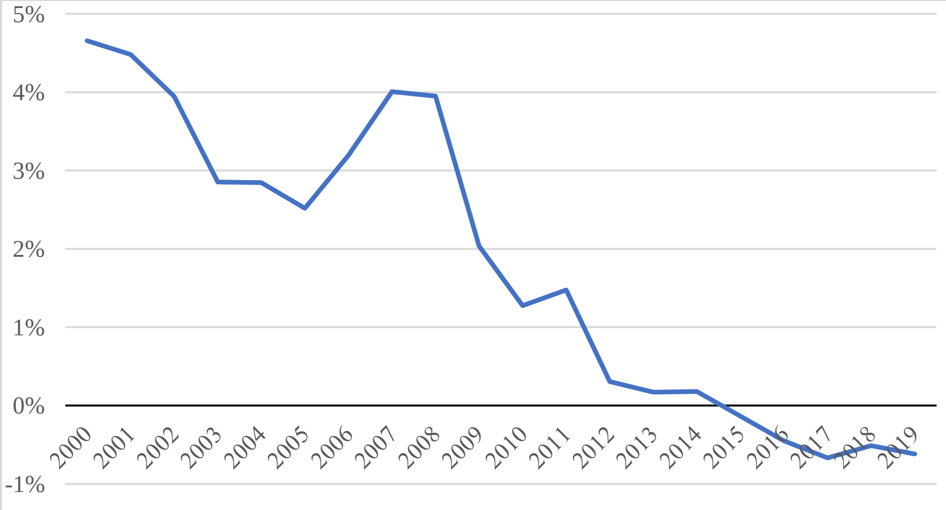


Figure 2: Yields of the 3-year German Government bond. Source: Personal elaboration based on data downloaded from the Investing.com dataset

| Year | Premium |
|---|---|
| 2019 | -0,11% |
| 2018 | -2,41% |
| 2017 | 4,35% |
| 2016 | -9,12% |
| 2015 | 3,37% |
| 2014 | 11,86% |
| 2013 | 9,16% |
| 2012 | 8,94% |
| 2011 | -9,53% |
| 2010 | 2,54% |
| 2009 | -20,14% |
| 2008 | -24,62% |
| 2007 | 10,83% |
| 2006 | 17,22% |
| 2005 | 21,74% |
| 2004 | 8,64% |
| 2003 | -5,21% |
| 2002 | -23,35% |
| 2001 | -23,97% |
| 2000 | 28,46% |

Table 2: Equity premium observed in the European market. Source: Personal elaboration based on data downloaded from Yahoo Finance.

| | |
|---|---|
| Mean | 0,43% |
| Mean pre-crisis | 4,30% |
| Mean post-crisis | -2,14% |
| Mean without crisis | 2,97% |

Table 3: Average European risk premium. Source: Personal elaboration based on data downloaded from Yahoo Finance and Investing.com.

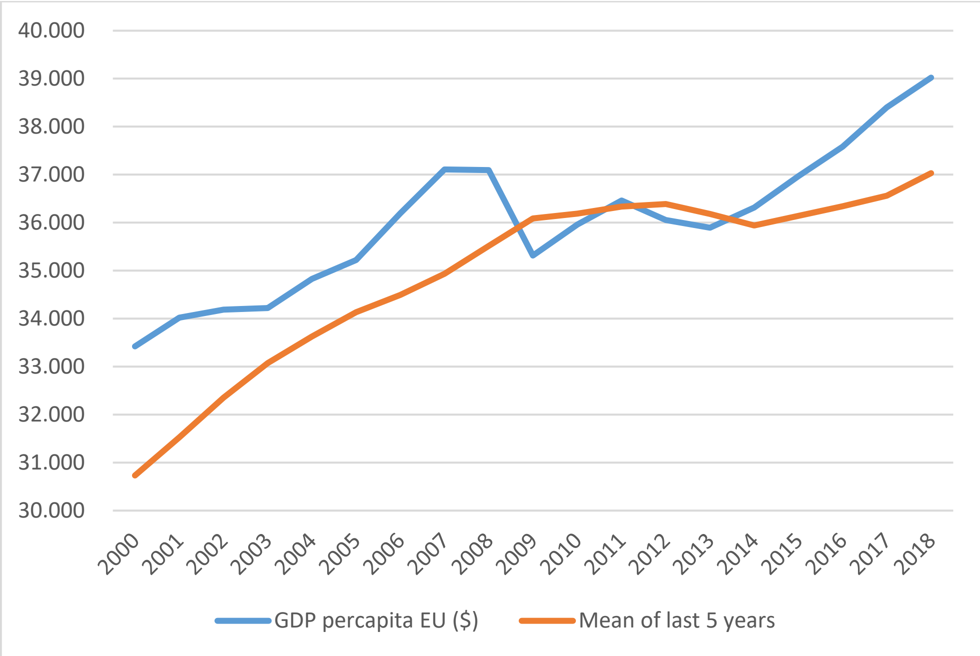


Figure 3: GDP per capita of the Euro area and average mean of the previous five years. Source: Personal elaboration based on data downloaded from the OECD database.

| **Period** | **γ = 0,5** | **γ = 1** | **γ = 3** | **γ = 5** |
|---|---|---|---|---|
| 2000 – 2018 | 5,21% | 10,42% | 31,26% | 52,09% |
| 2000 – 2007 | 1,35% | 2,71% | 8,12% | 13,54% |
| 2008 – 2019 | 4,15% | 8,30% | 24,91% | 41,51% |
| 2000-2007; 2010-2018 | 5,91% | 11,81% | 35,44% | 59,07% |

Table 4: Habit model: implied equity premiums for different γ and intervals.

| | **Data** | **Premium with γ = 1** |
|---|---|---|
| Mean | 0,43% | 10,42% |
| Mean pre-crisis | 4,30% | 2,71% |

| | | |
|---|---|---|
| Mean post-crisis | -2,14% | 8,30% |
| Mean without crisis | 2,97% | 11,81% |

Table 5: Comparison between data and the habit model.

| R = γ | 0,5 | 1 | 3 | 5 |
|---|---|---|---|---|
| Premium | 0,09% | 0,17% | 0,52% | 0,87% |

Table 6: Equity premium implied by the Mehra Prescott model.