Is Rationality Bounded? An Interpretation on Equity Premium Puzzle

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Abstract

Since equity premium puzzle had long been a problem, many economists tried to give reasonable interpretations to the puzzle. I focus on the type of theories using bounded rationality as the answer to the problem. I am willing to find out that whether the puzzle still exists in recent decades. If it does exist, are the theories of bounded rationality still able to explain the puzzle? In the beginning, I introduce two theories referring to bounded rationality. Afterwards, I empirically analyze the data of the U.S., Japan and Euro-area by using a simpler model based on rationality. Interestingly, circumstances vary a lot from country to country. One theory may be suitable for one country but not for the others. Even so, the “suitable” theory fails to completely explain the whole tendency of variation during the observed period in the country. In the future, we still need to explore in depth of the puzzle.
1. **Introduction**

The difference between the rate of return on stock and return on risk-free investment (such as bonds) is called equity premium. The equity premium puzzle implies that an unexpectedly high equity premium induces a suspiciously high degree of risk aversion. Mehra and Prescott (1985) were the first to formulate the concept of “equity premium puzzle”, and their research was based on rationality. Rationality has long been the foundation of modern economic theories. However, an increasing number of economists began to question the rational assumption as it is always generating deviations while investigating actual situations. Therefore, whether rationality is bounded or not plays an important role in improving economic theories in order to better understand our economic world. This paper only studies equity premium puzzle to see if rational expectation fails to reflect reality.

1.1. **What Is the Puzzle?**

Mehra and Prescott (1985) claim that under a pure exchange economy (Lucas, 1978), people get utility from consumption. Assume \( C_t \) is the consumption at time \( t \), and \( \delta \) represents a constant discount rate. Utility denotes by \( U \). So the present value of life time utility is:

\[
\sum_{k=1}^{\infty} \frac{U(C_{t+k})}{(1+\delta)^k}
\]

Now we only take two-period utility: \( U(C_t) + \frac{U(C_{t+1})}{1+\delta} \) into consider. A rational person seeks to maximize his or her utility under the budget. Let \( Y_t \) to be income, \( r \) to be the asset return and all the income is consumed.

\[
\max U(C_t) + \frac{U(C_{t+1})}{1+\delta}
\]
s.t. \[ C_t + \frac{C_{t+1}}{1+r} = Y_t + \frac{Y_{t+1}}{1+r} \]

Set up Lagrange function to solve the question above. The outcome is:

\[ 1 + \delta = \frac{MU(C_{t+1})}{MU(C_t)} \cdot (1 + r) \]

The form of utility function is \( U(C_t) = \frac{C_t^{1-\theta}}{1-\theta} \), so the Euler Equation can be transformed into

\[ 1 + \delta = \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \cdot (1 + r) \tag{1} \]

\( \theta \) is the relative risk aversion coefficient which represents the willingness to substitute consumption between periods. If the coefficient is high, individuals will hope to maintain the same level of consumption in all the periods.

For the equity asset, the return is stochastic as well as consumptions, thus people form expectation on future consumption as well as returns, so that equation (1) transforms into \( (r^e \) represents for stock return):

\[ 1 + \delta = E\left( \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \left[ 1 + r^e \right] \right) \tag{2} \]

For the risk-free asset, the return is not stochastic any more. \( r \) in equation (1) is replaced by \( r^f \) to denote risk free rate:

\[ 1 + \delta = \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \cdot (1 + r^f) \tag{3} \]

Combine equation (2) and (3), getting

\[ E\left( \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \left[ 1 + r^e \right] \right) = \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \cdot (1 + r^f) \tag{4} \]

in which

\[ E\left( \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \left[ 1 + r^e \right] \right) = E\left( \left( \frac{C_{t+1}}{C_t} \right)^{-\theta} \right) E\left[ 1 + r^e \right] + Cov\left( \left( \frac{C_{t+1}}{C_t} \right)^{-\theta}, (1 + r^e) \right) \tag{5} \]

As can be seen from equation (4), the equity premium \( (E(r^e) - r^f) \) is
determined by consumption growth rate and risk aversion coefficient. Mehra and Prescott (1985) claim that the plausible value of $\theta$ is between zero and ten. However, the observed equity premium is 6 percent and the consumption growth is about to be constant, leveling off at only 2 percent, by which $\theta$ is calculated to be around 48. As the coefficient of relative risk aversion remarkably exceeds 10, risk aversion alone cannot explain the high equity premium, so that equity premium puzzle emerges.

This paper is not going to set up models in order to solve the puzzle. Instead, I explain in detail and show the implication from two representative theories involving bounded rationality. After that, I use updated data of last decades in the U.S., Japan as well as Euro-area respectively to see whether the puzzle exists recently. I choose these countries because they own a large amount of financial asset in the world and they have the least restrictions on investment comparing with majority countries. The tendency of changes and the distinctions among countries are showed via the outcomes.

1.2. What Is Bounded Rationality?

Simon is the pioneer of the theory of bounded rationality. With the goal of better characterizing the realistic behavior in human decision making, he (Simon, 1972) provides the construction of bounded rationality as follows:

- He believes people face to risk and uncertainty when they make decisions. As a result, the demand function and the cost function will be complicated. Hence individuals cannot fully know the variables of the functions.
- People do not own complete information. They always substitute maximized level with satisficing as searching for more information costs more. If they want to have fully information, the cost will be extremely high.
- As actual decision making environment is rather complex, people

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1 The investigating periods for the U.S., Japan and Euro area are 1975-2010, 1975-2009, 1981-2010, respectively.
may have trouble in calculating the gains and costs of an action. Although calculators and computers are always here to help, it is unlikely to use mathematical ways to characterize all the aspects,

As bounded rationality is quite a new area of research, it cannot be given an exactly definition. Selten (1999) defines it in an opposite way by saying what it is not. He emphasizes that it is not irrationality. Individuals who are not fully rational do not mean that they lose their reason. They seek for rationality but fail due to limited recognition. They chase after aspiration adaptation rather than utility maximization.

Jones (1998) argues that: “limits on rational adaptation are of two types. One is procedural limits, which are limits on how people go bout making decisions. Another is substantive limits, which effect particular choices directly.” The first theory I refer to in this paper is myopic loss aversion (Benartzi and Thaler, 1995): the combination of loss aversion and frequently evaluating the portfolios, which can be attributed to the first type of bounded rationality. The other theory involved is the influence of pessimism and doubt on risk free rate and equity premium (Abel, 2002), which belongs to the second type of bounded rationality.

1.3. The Structure of the Paper

In the second section a review of the previous literature of solving the puzzle is provided. It helps introduce the background and status quo of the research. Section 3 explains the theory of myopic loss aversion as a solution to equity premium puzzle thoroughly. Section 4 presents similar process except that the theory changes into effects of pessimism and doubt on asset returns. In the next section, I motivate the equation to calculate the risk aversion coefficient which is quite similar to Mehra and Prescott (1985)’s but simpler. After that, I introduce the selected data that are involved in the calculation, describing the tendencies of consumption growth, stock return and interest
rate in the U.S., Japan and Euro area during last decades of years. With certain intervals, the risk aversion coefficients are computed. I figure out whether the puzzle exists recently, whether the theories of bounded rationality are in need of interpreting the equity premium puzzle and whether there are different circumstances in different countries. Conclusion is made in the sixth section.

2. Literature Review of Solving the Puzzle

A large number of economists have devoted to interpreting the puzzle. They do their research based on empirical and theoretical revision of the model of Mehra and Prescott. Weil (1989) tries to explain the puzzle by breaking the link between risk premium and intertemporal substitution elasticity of consumption. Although he uses more complicated utility function, the model still bases on rationality. Not only does he fail to resolve the puzzle, but also he raises risk free rate puzzle: the historical risk free rate is too low to match the model’s result.

Epstein and Zin (1989) developed the utility function based on the research of Weil by introducing first-order risk aversion. Their finding accounts for 2% of average equity premium. They adopts rank-dependent theory (Yaari, 1987) which is also used by Benartzi and Thaler (1995).

Mankiw and Zeldes (1991) point out that consumers are made up of stockholders and nonstockholders (account for the majority of Americans). Stockholders are triple sensitive to the fluctuation of the stock market. Unfortunately, it only partially solves the puzzle. Constantinides (1990) puts forward the behavior of habit formation. He modifies the utility function, making utility of consumption depends on comparing current level of consumption with previous level. Habit formation induces investors to dislike short-term contraction in consumption more than long-term contraction, which serves as a basic idea of myopic risk aversion.
However, Benartzi and Thaler (1995) cast doubt on habit formation by arguing that the stock return does not closely relate to consumption. So they assume that investors get utility from returns, rather than consumption. Abel (1990) revises the approach by using the utility function that the utility of one’s consumption can be affected by others’ consumption level. When others enjoy a higher level of consumption, the one who consumes less will get negative utility. Campbell and Cochrane (1995) deepen the form of habit persistence by introducing a probability that bad shocks reduce consumption level. They claim that bad shocks let people down for suffering from a lower consumption level, so that they need a higher equity premium to compensate the terrible state.

Myopic loss aversion is an early theory in respect of behavioral finance. It focuses on distributing financial account to stock and bond in single period. Later on, Barberis et al. (2001) construct a model including intertemporal consumption. They confirm that loss aversion alone cannot explain the equity premium, and they introduce the dynamic loss aversion coefficient changing along with previous investment performance. When the loss exceeds the existing wealth or there is already some loss in prior period, the degree of loss aversion will increase at an astonishing rate. This model managed to match the high equity premium observed in historical data. Another research involves behavioral finance is using the disappointment aversion preference framework developed by Gul (1911) to solve the puzzle (Ang et al., 2005). As there is great fluctuation in stock revenue, deviation from the reference level is common. The larger the negative-going deviation, the more disappointed investors are.

Our second theory (Abel, 2002) belongs to the type of approaches that consider bounded rationality in making decisions. The included approaches are displayed as follows:

Disasters cause people to worry about the fluctuation on economy, which may reduce the consumption level even though the possibility is quite low
As a result, the equity return increases. Cecchetti et al. (2000) set up their model containing departures from the fully rational approach raised by Campbell and Cochrane (1999). They believe that agents’ subjective expectation of consumption growth is distorted by rules of thumb. By holding the view that people are gloomy about the persistence of expansions and contractions, they set up a model to explain the high equity premium. Compare to Cecchetti et al., (1998), Abel (2002) uses a simpler asset pricing model to explore how pessimism and doubt affect asset returns. Details will be discussed in the later section of the paper.

Several economists are interested in the imperfections of the market as a solution to the puzzle (see Ravi and Coleman, 1996; Constantinides et al., 1998; Gollier and Sehlee, 2003). As these approaches do not have direct relation with the theories I study, I will not enumerate them in detail.

3. Myopic Loss Aversion

Myopic loss aversion is the combination of two concepts. The first one is loss aversion, which is an important component in prospect theory (Kahneman and Tversky, 1979). Loss aversion means that individuals loathe losses more than enjoying gains. Being different from expected utility theory, individuals get utility from gains and losses which is defined with a reference point when investors make decisions under uncertainty in prospect theory. Besides, the slope of the utility function for losses increases faster than the decreasing of the slope of utility function for gains.

Kahneman and Tversky (1979) set up a segmented function to characterize the value of a consequence with non-constant risk aversion.

\[
v(x) = \begin{cases} 
    x^\lambda, & x \geq 0 \\
    -\theta(-x)^\lambda, & x < 0,
\end{cases}
\]
in which \( x \) is a consequence of a state. When here comes to neutral consequences, \( x=0 \). For gains or losses, \( x \) are positive or negative numbers, respectively. \( \theta \) is the coefficient of loss aversion. \( \lambda \) is median exponent of the value function. They use regression estimating that \( \lambda = 0.88 \). \( \theta = 2.25 \).

They let uncertain prospect “\( f \)” to be the function of states that presents a sequence of consequences. \( V(f) \) denotes the utility of the sequence of consequences.

\[
V(f) = \sum_{i=0}^{n} \pi_i \nu(x_i)
\]

\( \pi \) represents decision weight of the outcome. The relationship between \( \pi \) and \( p \) (probability of obtaining \( x \) as the outcome) is: \( \pi_i = w(p_1) - w(p_2) \), where \( w \) is capacity. For a positive outcome, \( p_1 \) means “the outcome is at least as good as \( x_i \)”, and \( p_2 \) denotes “the outcome is strictly better than \( x_i \)”. As for a negative outcome, \( p_1 \) turns into “the outcome is at least as bad as \( x_i \)”. The same is with \( p_2 \). Then they come up with a weighting function:

\[
w(p) = \frac{p^\alpha}{(p^\alpha + (1 - p)^\alpha)^{1/\alpha}}
\]

If \( x \) is a positive number, then \( \alpha \) is 0.61; if \( x \) turns out to be negative, then \( \alpha \) is 0.69.

The other concept plays a central role in myopic risk aversion is mental accounting (Kahneman and Tversky, 1984; Thaler, 1985). Individuals do mental accounting so that they may not accept a single bet but they are likely to change their mind if the bet is repeated. When individuals evaluate their portfolio, it is quite similar with taking up a bet. As a result, frequently evaluating causes people who are averse to risk to be away from stock, thus a high premium is required.

They emphasize that planning horizon is different from evaluation period. One may hold an asset with the planning period of ten years, but he or she
evaluates it every month, so that the evaluation period is only one month.

They use simulations with data of returns in stocks, treasury bills and bonds from 1926 to 1990. They figure out the evaluation period with which the prospective utility for holding whole-bond-asset or whole-stock-asset makes no difference is one year. Although they prefer to do the simulations via nominal returns and compare stock returns with bond returns, they still take real returns and the comparison with treasury bill returns into account. They also find out that the form of value function and weighting function are not important. After that, in order to approach reality, they get the outcome that, with the evaluation period of one year, the allocation of asset to stocks generating maximized utility is between 30 percent and 55 percent.

To draw the conclusion, the evaluation period of one year is able to match the historical equity premium (6.5 percent). As loss aversion cannot be easily adjusted, they alter the evaluation period to see the magnitude that the equity premium can be reduced by extending the evaluation period. The following graphic shows the outcome of their study:

4. **Pessimism and Doubt**

Abel (2002) assumes that the consumption growth rates are independent
identical distributed as he focus on the formation of expectations. So there are differences in assumption between Abel (2002) and the traditional way to calculate. He introduces pessimism and doubt into the traditional equation, which owns the function of augmenting the equity premium. He claims that the price of the stock \( P_t \) is the proportional function of the dividend, which equals to the income: \( P_t = kY_t \). As \( r^e = \frac{P_{t+1} - P_t + Y_{t+1}}{P_t} \), he get

\[
1 + r^e = \frac{k + 1}{k} \cdot \frac{C_{t+1}}{C_t}
\]  

(6)

Substitute equation (6) into (2),

\[
\frac{k + 1}{k} = \frac{1 + \delta}{E\left\{ \frac{C_{t+1}^{1-\theta}}{C_t} \right\}}
\]  

(7)

Combine equation (6) and (7), he gets

\[
1 + r^e = \frac{(1 + \delta) \cdot \frac{C_{t+1}}{C_t}}{E\left\{ \frac{C_{t+1}^{1-\theta}}{C_t} \right\}}
\]  

(8)

For the risk-free asset,

\[
1 + r^f = \frac{1 + \delta}{E\left\{ \frac{C_{t+1}^{-\theta}}{C_t} \right\}}
\]  

(9)

He uses \( E\left\{ 1 + r^e \right\} \) to measure objective expectation of equity premium that affected by pessimism and doubt. Helped by equation (8) and (9), he obtains the formula of equity premium as

\[
E\left\{ \frac{C_{t+1}}{C_t} \right\} \cdot E^*\left\{ \frac{C_{t+1}^{1-\theta}}{C_t} \right\}
\]

\[
E^*\left\{ \frac{C_{t+1}^{-\theta}}{C_t} \right\}
\]

(10)

Notice that the superscript * denotes for subjective expectation for
consumption growth rather than the expectation under rationality.

He believes that pessimism reduces the expectation of consumption growth, hence people save more currently, which draws down the interest rate. He defines “uniform pessimism” to be the leftward translation of consumption growth. Under pessimism,

$$E^p \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\vartheta} \right\} = E \left\{ \left( e^{\Delta} \cdot \frac{C_{t+1}}{C_t} \right)^{-\vartheta} \right\} = e^{-\vartheta \Delta} E \left\{ \left( \frac{C_{t+1}}{C_t} \right)^{-\vartheta} \right\}$$  \hspace{1cm} (11)

which causes the natural logarithm of interest rate dipping by the amount of $-\vartheta \Delta$ (use equation (9) and (11)).

$\varepsilon$ denotes the natural logarithm of equity premium with fully rationality. He computes via equation (10) and (11) getting that, under pessimism, $\varepsilon$ changes into $\varepsilon^p$ equaling:

$$\varepsilon^p = \varepsilon + \Delta \hspace{1cm} (12)$$

Afterwards he draws into doubt. He uses mean-preserving spread of consumption growth to manifest doubt. As there is a law of diminishing marginal utility, the expectation on substitution elasticity of consumption growth will go up. As can be seen from equation (9), the interest rate is reduced. The logic implied in the approach is that doubt makes investors feel scared in attributing their money to stock. Thus they allocate more on risk free asset, which induces a lower interest rate.

He characterizes doubt with a parameter $\beta$,

$$\beta = \ln(1 + \frac{\text{Var}^d \left\{ \frac{C_{t+1}}{C_t} \right\}^2}{E^d \left\{ \frac{C_{t+1}}{C_t} \right\}^2}) - \ln(1 + \frac{\text{Var} \left\{ \frac{C_{t+1}}{C_t} \right\}^2}{E \left\{ \frac{C_{t+1}}{C_t} \right\}^2})$$  \hspace{1cm} (13)

the superscript $d$ denotes doubt and $\text{Var}$ is variation.

From equation (10) and (13), he gets the formula of $\varepsilon$ under doubt,

$$\varepsilon^d = \varepsilon + \theta \beta$$  \hspace{1cm} (14)
This verifies that the cognition of higher level of risk couples with higher equity premium.

Then he assumes that the consumption growth is lognormal.

\[ \ln\left(\frac{C_{t+1}}{C_t}\right) \sim N(\mu, \sigma^2) \]

by which he calculates to get \( \varepsilon \) under pessimism and doubt (denoted by \( \varepsilon^{pd} \)) is:

\[ \varepsilon^{pd} = \varepsilon + \Delta + \theta \beta = \theta \sigma^2 + \Delta + \theta \beta \] (15)

By transforming the equation (15), he acquires the risk aversion coefficient under pessimism and doubt to be

\[ \theta = \frac{\varepsilon^{pd} - \Delta}{\sigma^2 + \beta} \]

After substituting the observed number obtained by Mehra and Prescott (1985), he managed to explain to what extent the equity premium puzzle could be solved by pessimism and doubt. His outcome is displayed on the following table:

<table>
<thead>
<tr>
<th>( \beta )</th>
<th>0</th>
<th>0.005</th>
<th>0.01</th>
<th>0.02</th>
<th>0.03</th>
<th>0.055</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>48.44</td>
<td>44.37</td>
<td>40.30</td>
<td>32.16</td>
<td>24.02</td>
<td>3.66</td>
</tr>
<tr>
<td>0.0010</td>
<td>26.70</td>
<td>24.46</td>
<td>22.21</td>
<td>17.73</td>
<td>13.24</td>
<td>2.02</td>
</tr>
<tr>
<td>0.0020</td>
<td>18.43</td>
<td>16.88</td>
<td>15.33</td>
<td>12.24</td>
<td>9.14</td>
<td>1.39</td>
</tr>
<tr>
<td>0.0040</td>
<td>11.38</td>
<td>10.42</td>
<td>9.47</td>
<td>7.55</td>
<td>5.64</td>
<td>0.86</td>
</tr>
<tr>
<td>0.0060</td>
<td>8.23</td>
<td>7.54</td>
<td>6.85</td>
<td>5.46</td>
<td>4.08</td>
<td>0.62</td>
</tr>
<tr>
<td>0.0100</td>
<td>5.30</td>
<td>4.85</td>
<td>4.41</td>
<td>3.52</td>
<td>2.63</td>
<td>0.40</td>
</tr>
<tr>
<td>0.0150</td>
<td>3.67</td>
<td>3.36</td>
<td>3.05</td>
<td>2.43</td>
<td>1.82</td>
<td>0.28</td>
</tr>
<tr>
<td>0.0163</td>
<td>3.39</td>
<td>3.11</td>
<td>2.82</td>
<td>2.25</td>
<td>1.68</td>
<td>0.26</td>
</tr>
</tbody>
</table>

The first row indicates the various degree of pessimism and the first column shows the variation of doubt. The figures in the cells are different risk aversion coefficients under different degree of pessimism and doubt. The cells in grey are the ones that are plausible.
5. **Can Theories Interpret the Variation for Last Decades?**

Comparing with the equation with fully rationality that Mehra and Prescott (1985) used to compute the relative risk aversion coefficient, I develop a simpler one.

It is known that consumption level should closely relate to the equity return. If investors are lucky that they get a high stock return, consumption will increase; if they unfortunately get a lower return, they will suffer from a lower level of consumption. Thus a high return is needed to keep investors from selling the stocks in order to reduce the instability in consumption. As a result, the difference of the returns between stock and risk free asset can be explained by their different covariance of consumption growth with the degree of risk aversion. So equation (4) can be simplified by first order Taylor approximation:

\[
E(r^e) - r^f = \theta \cdot \text{cov}
\left( \frac{\Delta C}{C_i}, r^e \right)
\]  

(16)

It’s a linearized version of equation (4). The left hand side of the equation is the so called equity premium. Mehra and Prescott (1985) claim that the high equity premium and the low covariance together generate an abnormally high relative risk aversion coefficient. They used data for the period 1889-1978, while I update the data to explore the answer of the following questions: Does equity premium puzzle still exist? Are there any distinctions among different countries? Whether bounded rationality is badly in need of fully interpreting the puzzle? As I only study short periods, my calculations cannot fully reflect the true expected risk premium and covariance. Thus the outcome may deviate from the truth.

5.1. **The Case of the U.S.**

In the liberal market oriented US economy firms rely mainly on the stock
market to finance their investment. In such a context, economic fluctuations and changes in the stock market are relatively large. The period of the data is from 1975 to 2010. I collected personal consumption expenditures data by major type of product and by major function from National Economic Accounts of Bureau of Economic Analysis (BEA). The annual equity return and treasury bill return is found in Aswath Damodaran (2011).

The variance of consumption growth during all these years is shown on figure 1. As can be seen on the graphic, the fluctuation of consumption growth is relatively small. The growth rate has a downward trend and its mean is 6.95%.

Figure 2 displays the relationship between stock returns and treasury bill returns. The treasury bill returns level off at about 5.48%, while the stock returns rise and fall frequently in a large range, so does the equity premium. The average equity premium is 7.65%.
Figure 3 displays the covariance between consumption growth and stock returns. Sometimes covariance turns out to be negative, that is, the augment of consumption growth rate is accompanied by diminishing return on stocks (e.g. 2009-2010) or a dip in consumption growth couples with a ascendant stock return (e.g. 1981-1982). The covariance over the whole period is 0.0537\%, which goes against the traditional theory that consumption growth covaries with stock return to a great extent. With equation (16), we get the outcome that risk aversion coefficient is 142.55. This number is about three times larger than previous result (which is 48). Even if people truly averse risk a lot, it makes no sense to trebly drive up the degree suddenly. Not only does the puzzle exist, but also it has developed into a more serious
Myopic loss aversion can be applied for solving the puzzle but just in theoretical way. For Benartzi and Thaler (1995) only take returns as consequence of a state. They ignore that the risk aversion coefficient can be affected by the change of the covariance between stock returns and consumption growth. Their “indifferent between the historical distribution of returns on stocks and bonds” is not consistent with our concept of risk neutral. Even though the equity premium is unchanged, if the covariance varies, the degree of risk aversion will change. It may be true that the high equity premium is generated by frequently evaluating the portfolio, but it is hard to say to what extent it can solve the puzzle.

In terms of the second theory, with a greater degree of risk aversion, individuals become more pessimism and doubt. We talk about pessimism and doubt at average level measuring all investors in the U.S. It is known that one person might be a lot more pessimism and doubt in decades of years, but as people are not identical, the average level cannot easily vary that much in such a short time. Therefore, either there are other types of bounded rationality that should be contained in solving the puzzle, or theories refer to some other reasons (e.g. market imperfection) are required to answer the question jointly.

In order to see the internal variation trend of the risk aversion coefficient over these years, I break the period into three intervals. The hard part is to choose the breakpoint, for the outcome may vary considerably even though the breakpoint only shifts one year earlier or later. I fix the point on where the tendency is quite similar with the neighbor years.

The first interval is from 1975 to 1985, where the average consumption growth rate is 10.22%, the average equity premium is 8.28%, and covariance turns out to be a negative number, which is -0.0355%. I compute the risk aversion coefficient to be -233.32. Is it indicating that people are extremely risk-seeking during that time? Of course not. Besides, with that negative
coefficient, neither loss aversion nor pessimism and doubt are reasonable.

The next period is 1986-1996. It has a similar condition with the prior period. It owns a lower consumption growth rate (6.22%), a higher equity premium (10.81%) and still negative covariance (-0.0530%). The relative risk aversion coefficient is -203.86, which is slightly less abnormal. It is due to the sinking of mean equity return from 16.92% to 16.3% and the corresponding dip of consumption growth that raise the absolute value of the covariance.

In contrast to the outcomes above, the coefficient of risk aversion gotten in the period 1997-2010 is 236.02. Consumption growth rate goes further down to 4.95%. The equity return and equity premium fall a great deal (7.68% and 4.69%, respectively). Covariance is finally positive but quite small at 0.0199%. This suddenly change questions all the three theories. At this time, applying the theory of myopic loss aversion to the puzzle, a strange result emerges. As the average equity premium is less than 6.5 percent (1926 to 1990), individuals tend to evaluate their portfolio with a longer evaluation period according to their theory. It seems that investors are becoming more rational than before and the condition is not that bad anymore. Unfortunately, it is just a castle in the sky. The problem is that they only take equity premium into consider, ignoring the possible change in covariance between stock returns and consumption. In the case of covariance drops more than equity premium, the theory fails to explain the puzzle.

All in all, in the case of U.S., traditional theory based on rationality generates the abnormal result that investors change from tremendously risk-seeking to enormously risk-averse. Myopic loss aversion fails to interpret the phenomenon at certain conditions and pessimism as well as doubt can only partially do it.
5.2. The Case of Japan

Different from the U.S., banks affect the economy more in Japan. The stronger government intervention helps keep the economy steady. The data covers the years from 1975 to 2009. Consumption growth is computed by the data of actual individual consumption from OECD.Stat (Statistics of Organization for Economic Co-operation and Development). The equity returns are calculated with the formula: \[ r^e = \frac{P_{t+1} - P_t}{P_t} \]. Because the dividend is small and approximately constant over years, it is ignored in this paper. \( P \) is extracted from Tokyo Stock Price Index (1st Section) by Industry and Nikkei Stock Average on Statistics Bureau, Director-General for Policy Planning & Statistical Research and Training Institute of Japan. I also get short-term money market interest rates from there as the risk free rate.

Figure 4 shows the consumption growth rates in this period. Being similar to the U.S., the consumption growth has a downward tendency, and is basically steady. The average level is 4.33%.

The equity premium is implied on Figure 5. The risk free rate is going through a slightly downtrend with the mean of 3.38%. Consequently, the equity premium fluctuates with stock returns. The average premium is
1.32%, which is quite low comparing with the U.S.’s equity premium.

As can be seen from Figure 6, the covariance between consumption growth and stock returns is not that obvious and sometimes still comes out to be negative. However, the mean is 0.2594%, which is much higher than the U.S.’s figure.

I calculate the mean risk aversion coefficient to be 5.08. As it satisfies the reasonable range raised by Mehra and Prescott (1985), the puzzle does not exist in Japan. Hence theory based on fully rationality might be plausible. Applying the theories of bounded rationality to explain the result, individuals evaluate their portfolio with longer intervals and they show little pessimism and doubt.
I likewise divide the whole period into three intervals. The first one is from 1975 to 1984. This period, however, acquires an outcome which is not that optimal. The average equity premium is 3.54% and the covariance is -0.1520%. Thereby the risk aversion coefficient is -23.29, which is similar to the first two periods in the case of the U.S. but with lighter degree of risk seeking. All the theories, base on bounded rationality or not, suffering from the failure of interpreting the data.

Being better off in 1985-2002, the risk aversion coefficient is 3.39 (with the covariance of 0.1315% and equity premium of only 0.445%). In the next period (2003-2009), the risk aversion coefficient continues going down to 1.76. During this period, the equity premium is 0.386% and the covariance is 0.219%. The sound degree of risk aversion in 1985-2009 is owing to the considerably low average equity premium and the high covariance.

5.3. The Case of Euro-Area

The economy of Euro area highly relates to its bank system as well as stock market. I study the case of Euro-area among 1981 to 2010. Data of private final consumption expenditure for 14 countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Slovenia, Slovakia) used to compute the consumption growth rate and data of short-term interest rate is acquired from OECD.Stat. The stock price indices are found on Dow Jones STOXX 50. Nevertheless, the data before 1987 is lost, so I calculate the mean price indices via several countries’ data (Spain, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovak Republic, Slovenia, Austria) that I obtain from OECD.

The consumption growth curve showed on Figure 7 is not very smooth. It has been through three peaks, happened in 1989, 1999 and 2006. Moreover, there are two moments that it drops down to negative growth. The average
growth rate is 1.83%. As different country has different fiscal policies, the total consumption growth rate, to some extent, may vary more when OECD adds countries together. OECD uses Euro as the currency unit for all these countries as well as the aggregate consumption level. Before Euro was adopted as the uniform currency, nominal exchange rates are used for calculating the total consumption in these countries. Figure 8 exhibits the variance of equity premium overtime by the differences between stock returns and interest rates. The interest rates are descending stably again. The mean equity premium is 2.68%, which is higher than Japan’s but lower than the U.S.’s.
The undulation of consumption growth is negligible when it is put together with stock returns (see Figure 9). The mean covariance is 0.0931% and the risk aversion coefficient is 28.74.

Although myopic loss aversion can only take responsibility of solving the puzzle theoretically, the good news is that pessimism and doubt can completely explain the high equity premium now. Besides, lower level of pessimism and doubt is needed than in the case of the U.S. with the period of 1889-1978.

During the years of 1981-1986, the relative risk aversion coefficient is 59.91 (the covariance is 0.1278%, and the equity premium is 7.65%). After that, the risk aversion coefficient sinks to 43.07 (1987-2003), owing to the low equity premium which is 2.17%, even though covariance goes down to 0.0504%. Myopic loss aversion as well as pessimism and doubt are able to figure out the puzzle.

Things changed in the next period (2004-2010). Although the covariance turns out to be higher (0.1378%), the mean equity premium is slightly negative-going (-0.368%). Thus the risk aversion coefficient is -2.67. The traditional theory based on rationality does not refer to whether slightly risk seeking is an abnormal behavior. Admittedly, there are some people who are risk-seeking. Nevertheless, whether or not they account for the majority part is hard to say.
6. **Conclusions**

Mehra and Prescott (1975) find out that there is equity premium puzzle if the analysis is based on rationality. After that, Benartzi and Thaler (1995) as well as Abel (2002) apply bounded rationality to account for the puzzle. This paper analyze whether these theories work during last decades of years. Things are quite different in different countries. In the case of the U.S., rational theory fails to explain the puzzle whereas pessimism and doubt can account for it partially. Myopic loss aversion sometimes gets implausible outcome. In terms of Japan, the equation based on rational theory is able to come up with reasonable risk aversion coefficient except in the first period for the coefficient is negative. With respect to Euro area, theories with bounded rationality can solve the puzzle in the first two periods. For the third period, I obtain negative risk aversion coefficient again.

The negative coefficient is generated by two possibilities: negative covariance or negative equity premium. In terms of the first probability, it indicates that consumption growth sinks when equity return rises, which goes against the rule in rational theory. It is unreasonable that when people have more money, they consume less. For the other probability, the equity premium should have been positive to make up for the risk. However, the observed negative equity premium means that investors pay for having risks, which is not in accordance with the assumption of all the theories involved in this paper that investors are risk averse. The implausible result may be caused by the bad approximations to the true expected covariance and equity premium due to the short observation period. But if the approximations are consistent with the true value, some other theories will be required to be born.

Even though the risk aversion coefficient is positive, sometimes it is too high to be reasonable (in the case of the U.S. and Euro area). Economists
have always been focusing on “why the equity premium is so high?”, while I pay close attention to “why the covariance between consumption growth and stock return is quite low?” The low covariance is mainly owing to the fierce fluctuation in stock market. Stock prices always deviate from the true value, for the returns are highly related to people’s faith in economy. When the economy is booming, investors form a high expectation on returns, so that more money swarms into the market, which drives up the stock prices. Unfortunately, there were several financial crises during the period I investigated. When the crisis comes, people feel so depressed that they rush out of the stock market, which draws down the stock prices to the level below the true value.

According to my research, rationality is not bounded in Japan, and the situation is not same in the U.S. as well as Euro area. It is possibly due to the different culture (investors form their expectation diversely.) and financial regulations in these countries. As for the fierce variation among periods in one country, it is more likely owing to the business cycle rather than the change in individuals’ degree of risk averse because they can hardly change that much in such short periods on average. All in all, various theories are needed to explain the different situations in different countries.
References


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