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Why do high ability people also suffer from money illusion? Experimental evidence of behavioral contradiction

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Abstract. *Money illusion refers to the tendency of the individuals' decisions to be influenced by the nominal amount of money. It is a persistent phenomenon even for high ability people such as professional investors, and causes considerable aggregate nominal inertia. However, it has not been well discussed why they suffer from money illusion even though they are able to distinguish the nominal and real value.*
In this paper, we focus on numerical ability and investigate its relation to the tendency to suffer from money illusion. We show subjects two alternative funds (one fund has a higher nominal value and the other fund has a higher real value) and asked which one is preferable. Subsequently, they evaluated the attractiveness of each fund with a scale from 0 to 10.
Results show that high numeracy generally helps to distinguish the nominal and real value. However, when high numeracy individuals consider well-being, their decision is strongly affected by nominal value. Additionally, even though the high numeracy subjects were able to distinguish the nominal and real value, they evaluate the attractiveness of the fund with the high real value significantly lower than the fund with the high nominal value. Those behavioral tendencies prominently appeared when the nominal values are shown by the balance of assets.
The contradictory behaviors of high numeracy individuals may be largely involved in the integral emotions which accompanying with the nominal value.

Keywords: Money illusion; Numeracy; Decision-making; Emotional bias.

JEL Classification: C91; D81; D70; D91; G41.

1. Introduction

"Money illusion" occurs when the individuals' judgement is influenced by the nominal amount of money. For Fisher (1928, p. 4), who first coined the term and defined it as "*the failure to perceive that the dollar, or any other unit of money, expands or shrinks in value*", money illusion is a preventable phenomenon through recognizing the real value.

Conversely, Shafir, Diamond and Tversky (1997), that first advocated that money illusion is one of the "*cognitive bias*" and defined it as "*a tendency to think in terms of nominal rather than real monetary values*" (p. 341), emphasize the difficulty to remove money illusion from the decision-making even though the individuals could easily be aware of the difference between real and nominal values.

Money illusion is regarded as one of the psychosocial aspects (Animal Spirits) that leads people to irrational decision-making (Akerlof and Shiller, 2010). A myriad of empirical and experimental studies support that money illusion is an inevitable phenomenon even for professional investors with trillions of dollars at stake (Modigliani and Cohn, 1979; Campbell and Vuolteenaho, 2004; Chen et al., 2009; Cohen et al., 2005) and the few on individual-level money illusion cause considerable aggregate nominal inertia (Basak and Yan, 2010; Fehr and Tyran, 2001; Noussair et al., 2012). Also, any education such as economic or financial literacy is unable to counteract money illusion (Bakshi, 2009; Chytilova, 2017; Cipriani et al., 2008).

Our research motivation stems from a simple question, that is, why high ability individuals such as the professional investors also suffer from money illusion. Generally, money illusion is regarded as the cognitive bias caused by the confusion between the nominal and the real price (Akerlof and Shiller, 2010; Shafir et al., 1997; Modigliani and Cohn, 1979), but we suspect that money illusion is a much more complicated phenomenon and related to the physiological unconscious response.

In this paper, we showed that the individual's contradictory behavior in the financial decision-making; the individual changes the choice to the irrational one depends on the situation even after they found the rational one. As the result, they appear to suffer from money illusion. Any conventional theories of money illusion do not be able to explain this phenomenon. That is, we have to deviate somewhat from them.

In the following section, we will first show the past studies related to money illusion. Then, we will show the limitation of the conventional theories of money illusion. Third, we will propose our hypothesis of mechanism of money illusion. Finally, we demonstrate the case that individual inconsistently behavior between the different type of questions.

1.1. Interpretation of money illusion in the early days

Money is not something useful per se, but we can get satisfaction from what we purchased with money. In other words, not nominal monetary value but real monetary value should be important, because of its direct relationship with substantial purchasing power. Nevertheless, plenty of empirical and experimental evidence support that there is a tendency for people to decide their actions based on the nominal monetary amounts.

Irving Fisher, an American economist, first points the instability of the value of unit of money in his book *Money illusion* published in 1928. Around that time the United States was in the midst of the postwar prosperity, the so-called "Roaring Twenties"; it was a period of consecutive economic growth which established the distinctive cultures of the United States. As a symbol of the booming economy of that time, the Dow Jones grew six-fold within 10 years (from 993.19 points at January 1921 to 5449.37 points at August 1929). Whereas the US was enjoying an economic growth, the German economy was suffering from hyperinflation due to the reparation of World War I in the first half of 1920's.

In such a historical background, Irving Fisher claims the instability of value of any unit of money through the example of inflation in Germany; even though buying power had been changed with upheavals in prices, the general public overlook this problem because of *money illusion*. This term *money illusion* has first been coined and defined by Fisher as "*the failure to perceive ... unit of money, expands or shrinks in value*" (p. 4). In his book *Money illusion,* he describes the various examples in which the illusion of money is hidden to show the difficulty for lay persons to discern the differences between the real and nominal prices, in situations such as commercial transactions, the currency exchanges and dividend valuation.

The presence of money illusion has frequently drawn criticism from the scholars who support neutrality of money such as neoclassical economics (Patinkin and Steiger, 1989) and natural rate of unemployment (Friedman, 1968; Tobin, 1972). However, money illusion has been attracting attention through the growing body of empirical and experimental evidence in various domains, for instance, in housing markets (Brunnermeier and Julliard, 2008), in labor markets (Akerlof, 2007; Akerlof and Shiller, 2010; Fair, 1971), in consumption-saving decision (Miao and Xie, 2013; Thaler and Benartzi, 2004), or when the euro currency was introduced in Europe at 2000's (Gamble, 2006, 2007; Gamble et al., 2002; Cannon and Cipriani, 2006). Nowadays, money illusion is known as an ubiquitous phenomenon and is commonly used to explain the various irrationals behaviors in economics.

Money illusion began to receive remarkable attention in the financial market as the U.S. economy declined in 1970's. In the late 1960's, the postwar boom of World War II ended and it had been gradually apparent that the economic growth was slowing down. Subsequently in 1970's, the US economy, which had been depending on the heavy manufacturing industry, was diminished with the two oil crises and the increase in imports of manufacturing goods. At the same time, the inflation rate had remained high and the US economy had been in a slump (called "stagflation").

In this historic context, Modigliani and Cohn (1979) cast doubt on the commonly accepted theory at this period that the equity had been regarded as an ideal hedge against inflation. According to their analysis, the level of the S&P 500 stock index at the end of 1977 had fallen to half in real terms owing to inflation, even if it was the same as it was in the second half of the 1960's in nominal terms. They state that this fundamental mistake has been tied to investor's two kinds of error based on money illusion: first, the investors calculate equity earnings at a rate that parallels the nominal interest rate rather

than the real rate. Second, investors fail to allow for the gain accruing to stockholders from the nominal obligatory depreciation. Additionally, they emphasize the importance of money illusion in the actual economy as "*one must also be prepared to entertain the likelihood that lending institutions and business managers are subject to similar illusions, with real consequences for the behavior of firms and adverse effects on their profitability*" (Modigliani and Cohn, 1979, p. 36).

The findings of Modigliani and Cohn (1979) have deeply impacted subsequent studies and been cited as the evidence of the negative relation between the stock value and the inflation (called "Modigliani-Cohn hypothesis"). Campbell and Vuolteenaho (2004) break down the dividend yield into three components and identify that some dividend yield is accrued from the mispricing attributed to the market's irrational forecast. In addition, they find that the level of inflation explains almost 80% of the time-series variation in stock market mispricing by formalizing the Modigliani-Cohn hypothesis with "Gordon growth model"(1) and "Fed model"(2). Subsequently, Chen et al. (2009) examine the reason of stock mispricing by formalizing the investors' irrationality into money illusion and the resale option hypothesis (Scheinkman and Xiong, 2003). As a result, it is shown that money illusion explains partially the stock mispricing in the US market.

Cohen et al. (2005) enter into a discussion from basic questions such as whether the stock market investors with trillions of dollars at stake make the same mistake a pedestrian would. At the beginning, they claim that the small number of wealthy and rational arbitrageurs may be very conservative in accommodating supply and demand due to money illusion. By simultaneously examining the future returns of Treasury bills, safe stocks, and risky stocks, they find the evidence supported by the Modigliani-Cohn hypothesis; when inflation is high, irrespective of the riskiness of the particular stock, a stock provides higher than justified future returns relative to short-term bonds.

The relation between inflation and stock returns has been verified for various periods and countries. Similarly, to the Modigliani and Cohn (1979), a negative relation has been reported in the post-war data of the US and other countries (e.g., Bodie, 1976; Fama and Schwert, 1977; Gultekin, 1983; Jaffe and Mandelker, 1976, Lee, 2010; Lintner, 1975; Nelson and Schwert, 1977; Svedsäter, Gamble and Gärling, 2007). Conversely with Modigliani and Cohn (1979), a positive relation between inflation and stock returns has also been reported in the pre-war period (Kaul and Seyhun, 1990; Hess and Lee, 1999; Lee, 2010). Following those empirical studies, Lee (2010) point that the stock return-inflation relation is time depending and those relations is not necessarily constant through the whole period and countries.

Not only the empirical studies but also the experimental studies conducted in laboratory also support that money illusion affects the market pricing at the aggregate level, and furthermore, those well-designed experiment have revealed some characteristics of money illusion. Fehr and Tyran (2001) define money illusion as the situation where "*people behave differently when the same objective situation is represented in nominal or in real terms*" (1997, p. 1), and design a pricing game implementing an anticipated monetary shock at the half of the game to observe the adjustment process of prices in nominal as well as in real value.

As a result, they point out that part of the subjects suffered from money illusion, which caused a considerable aggregate nominal inertia. This result has been supported by Noussair et al. (2012) by way of experimental study and Basak and Yan (2010), which analyses the asset price and investor behaviour under the presence of money illusion. Furthermore, Fehr and Tyran (2001) states the lack of coherence about subjects' behaviour depending on the way of payoff presentation and the nature of nominal shocks. In particular, when the payoff information is presented to subjects in nominal terms, the nominal inertia has been observed much more noticeably than when payoff information is presented in real terms. In addition, while the nominal inertia is quite substantial and long lasting after a negative shock, it is rather small after a positive shock.

Whereas most researches on money illusion in financial markets are mainly concerned with its influences to the aggregate market under inflation (or deflation) situation, Svedsäter et al. (2007) points out that money illusion may also happen depending on the way of the nominal representation of stocks even though under no inflation (or deflation) situation. They investigated using a survey questionnaire whether the investors' reaction following the company's earnings announcement would change depending on the nominal value of stocks. According to their result, when the nominal share prices show high values, the investors expect less change in share prices than when the nominal prices are presented in low. It is also important whether prices are given in euros or Swedish crowns (approximately equal to 0.1 euro). Numbers of nominal value are higher in Swedish crowns, and, consistent with previous results, when the nominal share prices are presented in Swedish crowns, the investors expect less change in share prices than when the nominal prices are presented in euros.

From those results, they conclude that, the investors relate the nominal share prices to the performance of the company (Low stock prices are related to poor performance of the company, and high stock prices to good performance), therefore the investors tend to expect that share prices showing low nominal value is more affected by the fundamentals effects than the high nominal value of share. Finally, they investigate whether changes in nominal prices affect participants' trading following a split or a reverse split of share prices. The results show that both buyers and sellers are more willing to trade when the stock is presented with lower nominal price following a stock split than when the stock is presented with higher nominal price following a reverse stock split. They state that it is maybe because of the inexpensiveness of the stock, buyers and sellers are more willing to trade but the reason for this increase/decrease is not clear.

It also has been discussed whether we could alleviate money illusion with individual ability. Firstly, economic and financial literacy[3] has attracted attention as an ability to alleviate money illusion. Several studies tried to verify the impact of the economic and financial education on money illusion at an individual level (Bakshi, 2009; Chytilova, 2017; Cipriani, Lubian and Zago, 2008), however, those are failed to find any conclusive evidence.

1.2. Emotion as biases in decision-making

In the 1960's the cognitive psychologists began to adapt their cognitive models of decision-making under risk and uncertainty to economics. This new field called "behavioral economics" has explained various irrational behaviors that could not be explained under the models of rational economics. Under such circumstances, money illusion has been highlighted as an example of irrational behavior.

Shafir et al. (1997), first adopted cognitive psychology to money illusion and defined it as "a tendency to think in terms of nominal rather than real monetary values" (p. 341). They highlighted the saliency of the nominal value in the transaction at a single point in time or over a short period, and point out that the tendency of people to think in the nominal amount of money even though they aware the differences between real and nominal money.

Their innovative interpretation of money illusion as a cognitive bias broke the mainstream thought that money illusion is a preventable phenomenon through recognizing the real value. Nowadays, Shafir et al. (1997) has been widely accepted among scholars who study money illusion and it has constituted the bedrock of the concept of money illusion. (e.g., Basak and Yan, 2010; Miao and Xie, 2013; Raghubir and Srivastava, 2002; Svedsäter et al. 2007).

However, the cognitive bias is not able to explain the mechanism of money illusion for professional investors. According to a psychological theory called "dual process theory"[(4)], complex decisions, such as investment decision-making are processed in the reasoning processes, not in the belief-based processes. For instance, the instantaneous decisions that govern most of our lives (e.g., choosing which meals to eat or what to wear at morning) are linked to System 1. In comparison with daily small continuous decision-making, the complex decisions, such as deciding which house to buy, whether to change careers or investment decision-making are linked to System 2. Even if people would have some gut feelings about each option, most of the people would likely try to collect as much information about each option as possible and try to decide rationally (Kahneman and Egan, 2011).

Ultimately, the main argument of the "dual process theory" is that emotions should become detached from rational decision-making, processing in "System 2". As a matter of fact, emotions are extremely powerful for individual decision-making and have even influence evenly (Lerner et al., 2015). For instance, the type of emotion that is aroused by facing the choice or judgement at hand (i.e., integral emotion) strongly shape individuals' decision-making (Damasio[(5)], 1994, 1996; Greene and Haidt, 2002). Furthermore, the integral emotion associated with judgment target is difficult to detach (Rozin et al. 1986), and it affects strongly the individuals' behavior even though they realize the better alternative choices (Loewenstein, 1996).

Only the negative view of the role of emotions in decision-making tends to attract attention, but we are able to make decisions more efficiently and quickly with the aid of the emotion (Damasio, 1994). For instance, past studies found that the patients injured to the ventromedial prefrontal cortex (vmPFC), which is an important area of the brain for

integrating the emotion and cognition, tend to trapped by impulsive and immediate interests, and are unable to learn from failure (Bechara et al., 1994; Bechara et al. 1996). Interestingly, vmPFC activation increased with the nominal value, even though the subjects perfectly understand the real value is stable (Weber et al., 2009). It implies that the individual feels some emotional implications from the nominal value.

Moreover, the high ability does not necessarily help when the individuals suffer from the emotional biases. Peters et al. (2006) argues that high ability (in this case "numeracy"(6)) prevents rational decision-making in the question related to the evaluation of the choices: high numeracy individuals draw more emotional meaning from probabilities and numerical comparisons than lower numeracy individuals do, and consequently, they make a worse decision. The similar phenomenon is reported by Shafir et al. (1997) in the case of money illusion, people purposely chose the irrational choices even though they knew which choice was rational when they face the questions about happiness(7).

A series of studies imply the existence of emotions as a confounding factor between the perception of nominal value and money illusion. Nevertheless, past studies focused only on the relation between the perception of nominal value and money illusion, and no one discussed the existence of emotion as a cause of money illusion. Hence, we hypothesize that money illusion is not only the mistake or the cognitive biases but also caused by the emotions that are aroused by perceiving nominal quantities of money.

To investigate the role of emotion in money illusion, we conducted a survey experiment based on the Shafir et al. (1997). Subsequently, we hypothesized the results by formalizing the individuals' decision-making who suffer from money illusion. Generally, money illusion cannot be formalized by any theory premised on the accretion of utility that depends on the consumption of a product. Therefore, we formalized money illusion by incorporating the individuals' psychological utility into the individuals' utility function.

Analyzes showed that high numeracy generally helps to distinguish the nominal and real value. However, when high numeracy individuals consider well-being, their decision is strongly affected by nominal value. This behavioral tendency appeared prominently when the nominal values were shown by the balance of assets: the emotions accompanying the perception of the nominal value strongly affected the individuals' financial decision-making based on their well-being.

Furthermore, the evaluations of the bonds were basically given based on the nominal values. Especially the high numeracy individuals who perceived the nominal value with the balance of assets were strongly affected by the nominal value.

Our result showed the complexity of money illusion: it is caused not only by the confusion between the real and nominal value, but also by individuals making decisions by taking into consideration psychological aspects such as well-being.

2. Survey experiment

2.1. Method

The survey mainly consisted of 1) questionnaire of money illusion, 2) assessment of numeracy and 3) test about the ability to distinguish between the real and nominal value.

We conducted the survey after having asked the subjects' general information(8). The questionnaire of money illusion was conducted based on Shafir et al. (1997). At first, we showed the subjects the funds' performance during two different periods (period 1 of fund A and period 2 of fund B(9)) and asked four types of questions. First question only asked about the economic performance of two funds (hereinafter called "economical question"). The second question asked in which period you were happier (hereinafter called "well-being question"). Finally, they were asked to rate the attractiveness of each fund from 0 (not attractive) to 10 (very attractive).

Also, we set two conditions: one condition presented the nominal value as the total amount of the value of an asset ("total condition"). The other condition presented the nominal value as the investment balance ("gain/loss condition"). To even the degree of difficulty, the rate of asset growth in nominal values was shown in both conditions.

Subsequently, the subjects were tested on their numeracy, and finally, we set up a question to confirm whether the subjects properly understood the concepts of nominal and real value. We excluded the subjects who could not correctly answer this question from the samples. In order to avoid the subjects to be anchored in real value by this confirmation question, we asked it at the end of our survey.

We conducted the survey experiment via internet(10). We gathered data for 125 subjects, but eliminated the ineligible data(11), and as a result we used 77 individuals' data. The subjects were randomly assigned to one of the two conditions, and as a result the number of subjects in the gain/loss condition was 41, and 36 for the total asset condition. In both conditions, the majority of subjects were male (27 males in the gain/loss condition and 23 males in the total asset condition) in their 30's. Most of the subjects had a bachelor degree or higher (80% of subjects in the gain/loss condition and 83% of subjects in the total asset condition).

2.2. Decision models and hypotheses

In this chapter, we would like to simulate the situation that the individuals choose the irrational choice even though they know the rational one.

We first distinguished the individuals' decision-making process into two behaviors: 1) calculate the real value, and 2) choose from the options. The accuracy of calculation (p_i) depends on the individuals' numeracy. That is, p_i for the high numeracy individuals (p_i^h) is higher than for the low numeracy individuals (p_i^l). We suppose that when they face the economical question, the individuals' decision only depends on their calculations. Therefore, the high numeracy individuals distinguish the rational choices more easily than the low numeracy individuals.

Hypothesis 1:

When they face the economical question, the high numeracy individuals suffer less from money illusion than the low numeracy individuals.

Subsequently, we simulate the individuals' decision making in the well-being question. According to the result of Shafir et al. (1997), when the individuals face the question about their happiness, they tend to suffer from money illusion even if they know which choice is rational. We suspect that emotions play an important role in their decision-making.

In the question about well-being, the decision is made based on the evaluation of which option makes them happier. It means that the individuals consider the psychological utility which comes not only from the real value but also from the nominal value.

We defined the emotions which are aroused by perceiving the nominal amount of money as E, and also distinguished between the magnitude of high numeracy individuals' emotions (E^h) and the magnitude of low numeracy individuals' emotions (E^l). Peter et al. (2006) shows that the high numeracy individuals tend to draw strong emotional meaning from numerical information. Therefore,

$$E^h > E^l \geq 0. \quad (1)$$

When individuals face a question about well-being, they consider the magnitude of emotions that come from both the real value (E_r) and the nominal value (E_n). Their psychological utility depends on the magnitude of emotions for both.

$$U = u(E_r, E_n) \quad (2)$$

For instance, when the magnitude of the negative emotion accompanying the perception of the nominal losses surpasses the positive emotion which comes from the real gain ($|E_n| - |E_r| > 0$), the psychological utility increases with making the decision based on the nominal value.

Hypothesis 2:

The high numeracy individuals suffer from stronger money illusion in the well-being question than in the economical question.

Once again, we suspect that money illusion is caused by the emotions which are aroused by perceiving the nominal value, not by perceiving the nominal money. To verify our assumption, we set the two conditions in our experiment: one condition presented the nominal value as the total amount of the value of an asset ("*total condition*") and the other condition presented the nominal value as the investment balance ("*gain/loss condition*").

In the total condition, the individuals first perceive their wealth with positive numbers unless the suffer losses over their initially invested amount of money. Conversely, in the gain/loss condition, the individuals perceive directly the gain with the positive numbers and the losses with negative numbers. Directly perceiving the volatility of their wealth

may arouse a stronger emotion. Especially for the high numeracy individuals, this small perceptive difference may arouse big differences of level of the emotions.

The differences between those two conditions cannot be explained by any theory premised on utility maximization, such as prospect theory (Kahneman and Tversky, 1979) because both present the same degree of losses. That is, if the perception of the nominal value causes money illusion, there should be no behavioral difference between the two conditions. If behavioral differences are observed, the correctness of our theory will be proved.

Hypothesis 3:

High numeracy individuals suffer from stronger money illusion in the gain/loss condition than in the total condition.

3. Results

3.1. Economical and well-being question

Numeracy of the subjects was assessed with the scales developed by Lipkus, Samsa and Rimer (2001)[12]. The measure of numeracy consisted of 10 items, but 1 item required 2 answers therefore the maximum numeracy score was 11. The mean numeracy score was 8.75 (SD = 2.64, median 10) out of 11.

We divided the subjects into two groups according to the median numeracy score because the distribution was highly skewed (hereinafter called “high numeracy group” and “low numeracy group”). Thus, our analyses compared the participants who were most numerate (10, 11 items correct) with those who were less numerate (0–9 items correct). Since there were variations in the number of samples, we adopted Bayesian estimation[13] for the analysis in this section.

Table 1. *EAP of the mean performance rate of each questions and conditions*

			CI	
	EAP	SD	2.50%	97.50%
Economical question				
Low numeracy				
total	0.19	0.08	0.06	0.38
gain/loss	0.19	0.08	0.06	0.38
Higy numeracy				
total	0.47	0.11	0.26	0.70
gain/loss	0.42	0.23	0.61	0.37
Well-being question				
Low numeracy				
total	0.19	0.08	0.06	0.38
gain/loss	0.24	0.09	0.17	0.43
Higy numeracy				
total	0.31	0.13	0.24	0.53
gain/loss	0.12	0.07	0.03	0.28

Table 1 shows expected a posteriori mean performance ratings (MPR) of each question and condition. At the economical question, the MPR of the high numeracy group was significantly higher than for the low numeracy group in both conditions: odd-ratio was

5.24 (SD = 3.40, 95%CI = 1.58-13.70) and 4.08 (SD = 2.51, 95%CI = 1.24-10.37) in the total condition and in the gain/loss condition. However, in the well-being question, the significant differences between the high and low numeracy group disappeared both in the total condition (odd-ratio = 2.49, SD = 1.52, 95%CI = 0.73-6.43) and in the gain/loss condition (odd-ratio = 0.48, SD = 0.31, 95%CI = 0.12-1.29).

For the high numeracy group, the MPR was generally higher in the economical question than in the well-being question. The MPR was 0.44 (SD = 0.06, 95%CI = 0.33-0.55) in the economical question and 0.19 (SD = 0.04, 95%CI = 0.11-0.28) in the well-being question. Odd ratio was 3.68 (SD = 1.41, 95%CI = 1.69-6.96). This result exposed the behavioral tendency in the well-being question that the individuals in the high numeracy group choose the irrational choice, even though they could choose correctly in the economical question.

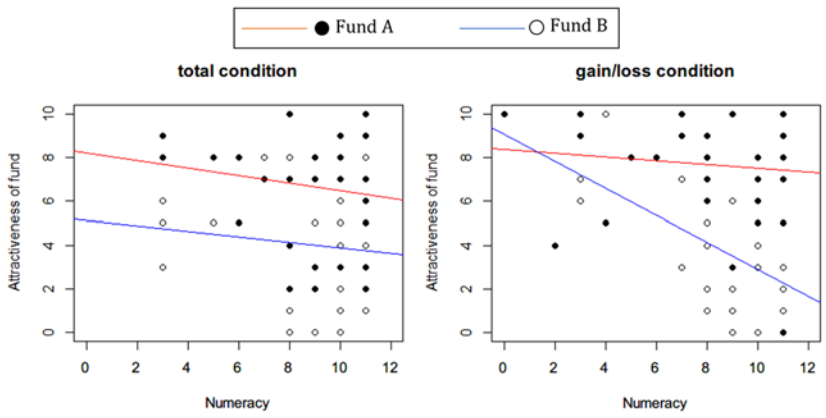
This behavioral tendency occurred particularly frequently in the gain/loss condition: the MPR was significantly higher in the economical question than in the well-being question (odd-ratio = 7.58; SD = 5.30; 95%CI = 2.06-22.58): more than 90% of the subjects who answered correctly in the economical question chose the irrational choice in the well-being question. However, in the total condition, difference of MPR was not significant between the economical question and the well-being question (odd-ratio = 1.91; SD = 0.89; 95%CI = 0.74-4.15): over the half of the subjects who answered correctly in the economical question could keep their rational choice also in the well-being question.

Hence, for the high numeracy group in the well-being question, the MPR was higher in the total condition than in the gain/loss condition (odd-ratio = 4.66; SD = 3.51; 95%CI = 1.27-13.30).

3.2. Attractiveness of each fund

In this section, we investigate whether the evaluation of each fund is different depending on the individuals' numeracy. Graph 1 shows the scatterplot with fitted regression line in each condition.

Graph 1. *Scatterplot with fitted regression line*



The regression line suggests that the attractiveness of fund A was generally higher than the attractiveness of fund B. From AIC comparison[14], we adopted the model that supposes that each single regression models (dependent variable: attractiveness of each fund in each condition, independent variable: numeracy) have perfectly different parameters.

Table 2 shows the parameters of each regression. The intercept coefficient was significant only for the fund B under the gain/loss condition ($F(1,39) = 26.74$, $p < .00$), with an R^2 of 0.407. Participants' predicted evaluation of fund B was equal to 9.071 + -.618 (numeracy) points when the fund attractiveness was assessed from 0 (not attractive) to 10 (very attractive). That is to say, only the evaluation of fund B in the gain/loss condition decreased along with the increase in numeracy, while in the other condition or for fund A in the same condition were the equivalent levels regardless of the numeracy.

Table 2. *Dependent Variable: Evaluation of each funds*

	total condition				gain/loss condition				
Variable	A		B		A		B		
Numeracy	-0.175		-0.123		-0.085		-0.618		**
	(0.163)		(0.182)		(0.123)		(0.120)		
con	8.227	**	5.106	*	8.382	**	9.070		**
	(1.474)		(1.651)		(1.130)		(1.101)		
N	36		36		41		41		
R-sq	0.032		0.013		0.012		0.407		

**p<.001, *p<.05

4. Discussion

In this study, we investigated the role of emotions in money illusion. From our survey experiment, we found mainly four points: 1) the high numeracy group better overcame money illusion than the low numeracy group when they faced the economical question. However, 2) in the well-being question, the high numeracy individuals, who answered correctly in the economical question, tended to change their choice to the irrational option. This behavioural tendency appeared prominently in the gain/loss condition. 3) Moreover, the high numeracy group in the gain/loss condition suffered more from money illusion than in the total condition. Additionally, 4) the evaluations of attractiveness of funds were basically given based on the nominal value. Especially the high numeracy individuals who perceived the nominal value with the balance of assets were strongly affected by the nominal value.

The first point of the result was consistent with Peters et al. (2006) and supported our hypothesis 1. That is to say, numeracy is one of the components likely to decrease money illusion: numeracy helped the subjects understand numerical information in various forms, and as a result, their cognitive biases decreased.

The second point of the result partially supports our hypothesis 2, and is consistent with the results of Shafir et al. (1997) who argue that there is a case where the individuals suffer from money illusion even when they are able to distinguish between real and nominal value.

The third point of the result supported our hypothesis 3: in the well-being question, the high numeracy group suffered more from money illusion when they perceived the nominal losses as negative numbers rather than as positive numbers. That is, there is a possibility that the money illusion may be more strongly induced depend on which information the individuals focus on at first.

The fourth point of the result might be directly related to the mechanism of money illusion: attractiveness to funds leads to other cognitive bias (e.g., Normalcy bias, confirmation bias, Halo effect, etc.) in a chain reaction and consequently causes money illusion. Here we will illustrate one of the examples of money illusion in finance: the stock market tends to underestimate during inflation periods since the investors tend to calculate their dividend based on nominal value (Modigliani and Cohn, 1979; Campbell and Vuolteenaho, 2004). I would like to argue that this explanation does not fit the current era since investors calculate their profit by using financial theory coupled with high-spec computers. Rather we may have to focus on a different point between rational choices based on financial theory and the process followed by investors to build their portfolio.

In this context, the reasonable price is calculated with financial theory such as CAPM, which considers the risk of the fund as the volatility of the stock prices. As a matter of fact, investors take into account the risks are not only the volatility of the stock prices but also other types of risks that are involved by investment, such as bankruptcy risk.

In inflation, investors feel attracted to risk-free assets since the nominal value increase even though the real value decrease. Subsequently, their positive integral emotion for risk-free asset cause other cognitive biases. For example, investors may link the performance of stock prices with the risks other than the volatility (e.g., the risks of the bankruptcy of stemming from the shortage of cash). Consequently, they may avoid buying stocks and shift the position to more risk-free assets more than necessary.

5. Conclusion

In this paper, we investigated the mechanism of money illusion beyond the accepted notion, that money illusion is stem from confusion between the nominal and the real value. As a result, we found that the integral emotions caused by the nominal value are involved in the mechanism of the money illusion.

Our research would make a great contribution to the research of individual's decision-making because we clearly demonstrated that the high ability individuals also suffer from money illusion even though they were able to distinguish the real and nominal value.

In order to better understand money illusion in various field, we should bridge the gap between the economic theory and the actual decision-making process. Studying the role of the integral emotion that influence decision-making using the experimental method may be a good way. Eventually, it may lead us to know why people behavior sometimes seems to be irrational.

Notes

(1) Gordon Growth Model is a stock valuation method assuming a future series of dividends that grow at a constant rate, regardless of current market conditions (Gordon, 1962).

(2) Fed model is a theory of equity valuation about the relation between the forward earnings yield of the stock market and the 10-year Treasury bond yield to maturity (Campbell and Vuolteenaho, 2004).

(3) The terms “economic literacy” and “financial literacy” have been defined many times (e.g., De Rooy, 1995; Winick, 2006; Lusardi and Mitchell, 2014; OECD, 2011). However, some studies refer to the term “economic literacy”, some to the term “financial literacy”, or those terms are intermingled. On the whole, it means the ability to understand the information and the skills to choose the optimal choices when facing financial risks or opportunities.

(4) According to Kahneman (2003), that is one of the latest revised theories of the dual-process theory, people take on different cognitive systems depending on the situations: First, “Intuition” (or system 1) is activated automatically and processes information quickly. Usually this thinking process bonds with emotion. Second, “Reasoning” (or system 2) is activated by intention and processes information more slowly, but the reasoning is more speculative.

(5) Antonio Damasio formulated the “Somatic marker hypothesis”. He defines “Emotions” as a change in both body and brain states in response to stimuli (chapter 7), and argues that the individual experiences some gut feelings at the moment of perceiving stimuli (called ‘somatic markers’), and subsequently start the logical reasoning. This system improves the efficiency of our logical thinking by highlighting some options.

(6) They focused on the numerical ability (called ‘numeracy’), because it is the necessary ability to understand the numerical information (Schwartz et al., 1997; Black et al., 1995; OECD, 2013, 2016).

(7) Shafir et al. (1997) first present two persons' different financial situations for their subjects. One person gets a higher pay increase in the nominal value, but lower in the real value, than another person in the nominal value. After this presentation, the subjects were asked three types of questions. First one requires the subjects' rational evaluation for two alternative choices. The second one asked the well-being, and the third one asked about the attractiveness of the two choices. According to their result, most of the subject could answer correctly in the first question but not in the second and the third questions.

(8) General questions consist of gender, age, education level, and the assessment of loss aversion (Gächter, Johnson and Herrmann, 2007) and risk aversion (Holt and Laury, 2002).

(9) The value of fund A increased in nominal value but decreased in real value. Oppositely, the value of fund B decreased in nominal value but increased in real value.

(10) We recruited the subjects via Amazon Internet platform (Mechanical Turk; hereinafter called “MTurk”), on which the researchers can recruit participants with relatively low cost. The survey using MTurk is increasingly becoming the norm not only in consumer behaviour research (e.g., Smith et al., 2016; Goodman et al., 2013), but also in economics (e.g., Amir and Rand, 2012) and more recently in financial research (e.g., Bazley et al., 2017). Participant fee was $ 10.

(11) We eliminated the data of individual which answered for all items with same numbers, who did not answer for a required item, or who failed the question about financial knowledge.

(12) The validity of the numeracy scale is verified by Lipkus et al. (2001) (Cronbach's alpha (α) = 0.78).

(13) Mean performance ratings were calculated as expected *a posteriori* (EAP) by Bayesian statistical inference with Markov chain Monte Carlo (MCMC) using software R and RStan.

(14) We compare the three models: 1) the multiple regression model in which the dependent variable is the attractiveness of fund and the independent variables are numeracy and the type of fund. 2) The single regression models in which the dependent variable is the attractiveness of each fund and the independent variables are numeracy which have the perfectly different parameters. 3) The third model is almost the same as the second model, but those have the common residual variance.

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Appendix

1. Presentations of questionnaire

1) Gain/Loss condition presentation

Considering you invested in two different funds in two different years. One year, you invested $30,000 in Fund A. After a year, you got $600 (+2%) capital gain. During the year you invested in Fund A, there was no inflation. Another year you invested $30,000 in Fund B. After a year you invested in Fund B, you incurred a $-300 (-1%) capital loss. During the year you invested in Fund B, there was -4% deflation.

2) Total condition presentation

Considering you invested in two different funds in two different years. One year, you invested 30,000 USD in Fund A. After a year you invested in Fund A, your total holding in fund A was $ 30,600 (+2%). During a year you invested in Fund A, there was no inflation. Another year you invested $30,000 in Fund B. After a year you invested in Fund B, your total holdings in fund B were $29,700 (-1%). During a year you invested in Fund B, there was -4% deflation.

2. Questions (Common between the gain/loss condition and the total condition)

Q1. As you finished your two-year investment period, in which periods did you obtain the best economic performance? (*Economical question*)

Q2. As you received the reporting at the end of each year, in which year are you happier? (*Well-being question*)

Q3. Please rate the attractiveness of fund A (or fund B, range 0-10)

3. Question to understanding of nominal and real value

Suppose you have no savings or debt and you spend all of your monthly salary of 1600 dollar every month, but no more, that is to say, you cannot borrow money. Two scenarios are possible.

- Scenario A: There is 1% inflation and you get a 3% wage increase. Your salary goes from 1600 dollar to 1648 dollar.
- Scenario B: There is 4% inflation and you get a 5% wage increase. Your salary goes from 1600 dollar to 1680 dollar.