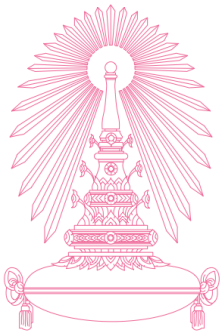

SENIOR RESEARCH

Cognitive Ability, Anchoring Bias, and Market Efficiency

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Chairman

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Abstract

This study aims to determine the relationship between cognitive abilities and anchoring bias, which is one of the existing cognitive biases and one of the contexts studied in the frame of Behavioral Economics. Anchoring bias defies the belief in Economics that most individuals are rational thinkers and that they incorporate all aspects of possible existing information when making decisions. This research assesses the degree of cognitive ability by using 9 questions that are categorized into 3 main parts, which are designed to test the ability to think intuitively, logically, and numerically. In figuring the degree of anchoring bias, 4 variables are proposed regarding this paper. The model used in analyzing the result is robusted OLS and the result shows that there is a statistical significance of the relationship between cognitive ability and anchoring bias; that is, the higher the degree of cognitive ability one possesses the lower the degree of anchoring bias of that individual. This study also explains that the effects of anchoring bias on rational thinking seem to have a spill over to market mechanisms which causes market inefficiency. This research proposed an idea to improve the market mechanisms and efficiency by empowering the consumers (demand side) through increasing the degree of cognitive ability and not just tackling to change the market regulations (supply side).

Overview

Many of the economic theories taught in classrooms often refer to the rationality of individuals when it comes to making decisions which is a driver of market efficiency. However, in reality, humans do not always make rational thinking like mentioned in the theory due to many internal and external factors. The causes of this irrationality is explained well through the theory of Behavioral Economics. The environment and the unconsciousness within an individual lead to certain cognitive biases, one of which is anchoring bias.

Anchoring bias is considered to be an unconscious thinking process of humans that causes the decision to be made irrationally or without true logic, thus, leading to inefficiency of the market as a whole. The bias determines that consumers do not purchase or consume products truly on their willingness to buy nor the utility that they expect to receive from the consumption like demand theory has mentioned, but they intuitively 'anchor' the price paid to a series of anchor factors within the thinking process during making decisions. Without the invisible hand mechanisms happening in the market, the supply and demand of a product will not be able to reach its equilibrium output and will cause imperfect competition leading to inefficient markets.

Humans have various decision making processes and this paper focuses to research specifically about anchoring heuristics and anchoring bias. Tversky and Kahneman (1974) has proposed about anchoring bias for the first time in his experiment in which he incurred two main components of 'anchoring' decision making

process: 1) specifying an 'anchor' point and 2) adjusting the anchor to evaluate its existence when people make decisions. Tversky (1974) performed an experiment that divided the sample into 2 groups: the first group had to figure out the product of 1x2x3x4x5x6x7x8, on the other hand, the second group had to figure out the product of 8x7x6x5x4x3x2x1, in which there is only one true answer (identical for both groups). The experiment result shows that the median of the first and the second group were 512 and 2250, respectively. This research by Tversky shows that number ordering has an impact on the decision making in valuation methods, despite the fact that the numbers are exactly the same, of the participants in which they were anchored by the first number of the sequence.

The work of Bergman, Ellingsen, Johannesson and Svensson (2010) also contributes as an inspiration to this paper in which they have researched about the relationship between cognitive ability and the willingness to pay on consumer goods. Bergman et. al. found that anchoring bias has a negative relationship with the cognitive ability of decision makers; that is, the higher the cognitive ability the lower the anchoring bias within that individual. However, decision makers who have high degrees of cognitive ability still possess anchoring bias, thus, an improvement in the degree of cognitive ability can only mitigate the degree of anchoring bias, but cannot solely eliminate it.

Objective

- This research aims to study the relationship between cognitive ability and anchoring bias

Terminology

Anchoring Bias - Tversky et. al. were the first to research about the existence of anchoring bias in which they explained that anchoring bias refers to the human tendency to rely too much on the first (prior) information when making future decisions, especially in making subsequent judgements that are unknown to the decision maker (i.e., unknown quantity or questions that do not associate with experience or knowledge). Tversky's experiment shows that decisions made by individuals will tend to have a value associated with the first information they obtained.

Cognitive Ability - cognitive ability refers to the ability to think rationally and logically which is an outcome from 3 cognitive processes: System I, System II, and numerical, which act as the reference to the degree of cognitive ability one has and is the variable of interest that is used to determine the relationship with anchoring bias.

Related Theory

This research paper is related to the concept of Behavioral Economics which aims to study the factors that contribute to the irrationality of the decision making of individuals, namely the effects of

psychological, social, cognitive, and emotional, as well as its consequences towards market prices, returns, and resource allocation. One of the theories that is associated with the related field of study is the theory of "Dual Process Model" by Kanehman et. al. (2001). Kanehman states that human has 2 systems of cognitive processes: System I Processes and System II Processes. System I Processes refer to the ability to think fast, intuitively, and without great emphasis on logic, which are the thoughts that are used in everyday life. On the other hand, System II Processes refer to the ability to think rationally and logically which tend to use more time, concentration, reasons, and analysis compared to System I Processes. Cognitive thinking involving System II will drain out more brain power than System I, for example, when solving for a complex math problem or to accept and achieve a certain challenge.

Literature Review

A study about anchoring bias by Ariely, Loewenstein, and Prelec (2003) states that the valuation of a product will be anchored by either the consumers' past experience, familiarity with the quality, or the quantity, which revolves around a certain thinking structure formed by each individual's contentment. To illustrate, Ariely et. al. constructed an experiment that asked the participants to figure out their willingness to accept (in terms of U.S. Dollars) from listening to a series of disturbing signal sound. The sample are divided into 2 groups: the first group will be asked to determine their willingness to accept (WTA) by listening to a 10, 30, and 60 seconds sequence of disturbing signal sounds and the second group will be asked to do the same, but by listening to a 60, 30, and 10 seconds disturbing sounds with both of the groups hearing the same amount of the sound. As a result, Ariely et. al. found that the means of WTA for the first group were 0.24, 0.38, and 0.67 U.S. Dollars, respectively, and the means of WTA for the second group were 0.47, 1.32, and 2.11 U.S. Dollars, respectively. The means of the 2 groups were significantly differ in size. This experiment implies that the order of the time in which the participant was chosen to listen has an impact to the prize they will pay to hear the noise. That means the starting number of seconds they were chosen to listen become the anchor factor in determining the WTA.

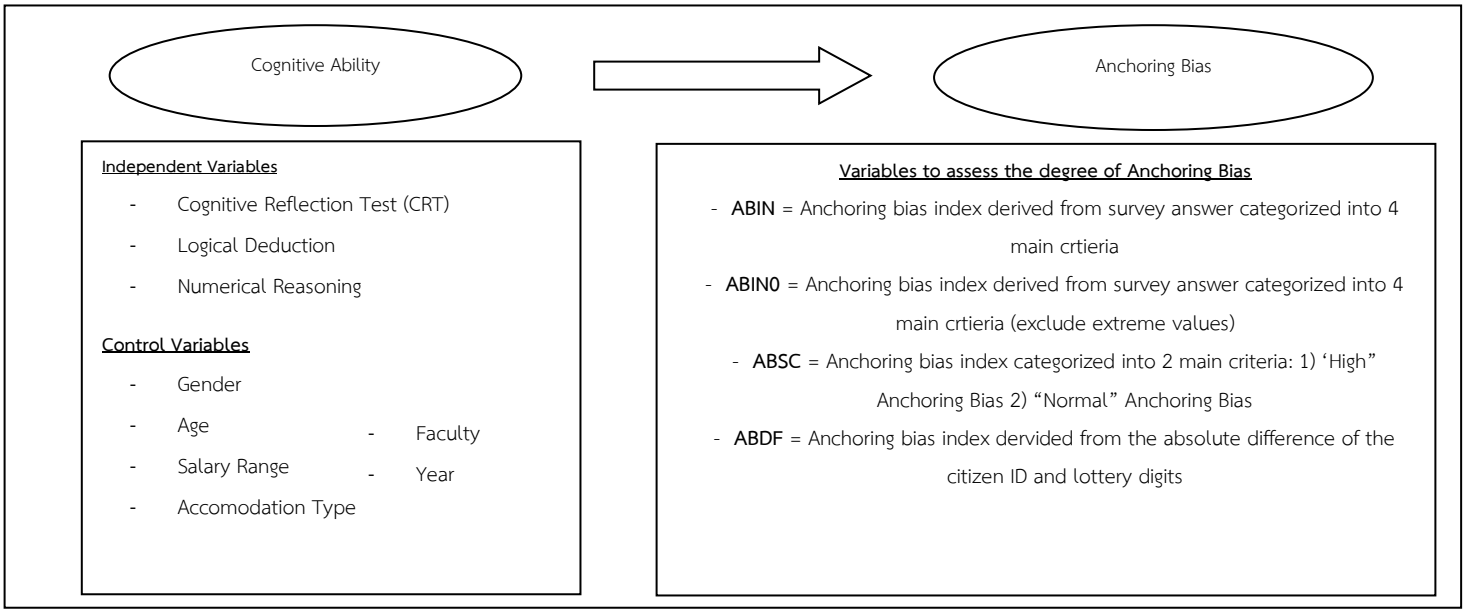
The research conducted by Bergman, Ellingsen, Johannesson, and Svensson (2010) concludes that the willingness to pay of a consumer to consumer goods will be affected by uninformative anchor such as consumer unconsciously use their last two digits of their national citizen ID as an anchor to their willingness to pay. In addition, their study also found that individuals who have higher cognitive abilities tend to have lower anchoring bias as well.

Conceptual Framework

This paper has adapted from the work of Bergan et. al. (2009) related to finding the relationship between cognitive ability and anchoring bias and is designed to adopt an international standard in order to assure legitimacy.

Bergan et. al. experimented with a sample of bachelor students from Stockholm School of Economics and University of Sodertom. Their experiment focuses on determining the willingness to pay that is rooted from an anchor factor which has adapted from the work of Dan Ariely et. al. (2003). Bergan et. al. assess the cognitive ability using Cognitive Reflection Test (CRT), a 3 questions test designed to determine the ability of thinking in System I process, and the Common Admission Test (CAT), a test designed to determine the thought process in multiple areas: quantity, language, analysis, and reasons. The aim of the experiment was also to figure out which test is a better approximate of forecasting the degree of anchoring bias. The result of their work shows that CAT is proved to be superior at determining the amount of anchoring bias than CRT with statistical significance.

Table 1 Conceptual Framework



Methodology & Data Collection

To contribute and further improvise the work of Bergan et. al. (2009) this paper assume that the use of solely on CRT alone may not be enough to help determine the degree of anchoring bias. The reason is that CRT only tests the ability of the respondents to correctly use their intuitive answers (the answer that comes first to mind), but the cognitive process of a human does not purely depend on the System I processes, but

also in System II. This research then incorporates the use of logical reasoning and numerical reasoning in order to better understand the overall thinking process of an individual that implies an improved estimator of the degree of anchoring bias. Therefore, to add onto the research done by Bergan et. al. the assessment of degree of cognitive ability will be categorized into 2 types: 1) Non-numerical and 2) Numerical, in which the non-numerical part will test both System I and System II thought processes. This paper also tests the degree of anchoring bias in 4 different ways in order to better fit to the Thai society context that is considered to have a much more complex thinking processes when dealing with numbers due to various factors such as the belief in certain superstitions or ways to come up with lottery digits.

A survey was designed for data collection and was distributed to bachelor students throughout Chulalongkorn University using 'friends-to-friends' method. The data obtained consist of multiple faculty: Economics, Engineering, Communications & Art, Commerce & Accountancy, Education, Science, and Political Science with a total of 145 responds during the collection period between January and February 2018. The sample in this research is considered to have a higher degree of cognitive ability than an average individual in Thailand, thus, the results of this research will also be able to apply to other groups of individuals in Thailand as well; the trend of the relationship between cognitive ability and anchoring bias should be in the same direction, but only with a different magnitude. Anchoring bias is also considered a cognitive bias towards System I processes (by intuitively), thus, all typical humans should share a common respond when it comes to decision making associated with an anchor value.

Survey Design

Survey (See attached documents) used in this research is developed from the work of Ariely et al. (2003) in which the first part consists of 2 questions to determine existence and the degree of anchoring bias. The first question is the 'anchor value' or the first information with the aim to anchor the respondents unconsciously by asking "What is the last two digits of your citizen ID?" This question was also asked in the survey by Ariely et. al. because it uses the principle of pure random in which there is no other possible information that can alter the last two digits of the citizen ID and the fact the last two digits were assigned randomly from birth. The second question that follows is "What do you think is the last two digits of the first prize lottery ticket of last year February were?" in which this question will determine the about of anchoring bias of the respondent. Frankly, the closer the guessed lottery digits are to the citizen ID, the higher the degree of the anchoring bias because the two questions are unrelated and it is nearly impossible to know the correct answer, thus, the answers of both questions should also derived from pure random not from anchoring. The questions were also designed to avoid using any numbers within the question itself to avoid wording bias that could promptly be another anchor besides the digits from the citizen ID.

The second part of the survey consists of the questions from Cognitive Reflection Test developed by Frederick (2005). The CRT is made up of 3 questions to assess the ability to think in System I process of the respondent in which it is designed so that the first answer that comes to mind (Intuitive answer) will be wrong. For example, "A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? _____ cents." Most of the respondents will answer 10 cents, which is incorrect (The correct answer is 5 cents), thus, a higher number of correct answers in CRT imply a high cognitive ability in System I process namely the aspects to think fast and accurate.

The third part of the survey composed of 3 questions to assess the ability to use deductive reasoning, the means of finding conclusions by reasoning using prior information assuming certain beliefs, rules, and definitions are true. This part of the survey specifically tests the cognitive process of System II. The questions are gathered from the logical reasoning part of GMAT, an international standardized assessment test that is accepted worldwide and is used to test the aspects of language and logic.

The fourth part of the survey tests the ability to use numerical reasoning which consist of 3 questions from the SAT, an international standardized assessment test. The questions are designed to assess 3 main numerical areas: 1) World-problem solving skills; this questions involving cracking the problem, analyzing it, and solving it. It can be an obstacle to those respondents that do not have the foundation of mathematics such as in the branch of history and communications. 2) Basic algebra; this questions a common easy-to-solve math problems and does not use a tremendous effort to complete. 3) Basic statistics. This question involves a deeper understanding into analyzing the data. Respondents who answer this question correctly are commonly from students who learned in the area of Statistics. Therefore, these 3 questions will then be able to assess the overall expertise of numerical reasoning of the respondents which involves not only thinking by logic, but also numerical skills.

Data Analysis

To study the relationship between anchoring bias and cognitive ability, this research will use econometrics method of Ordinary Least Squares Regression: OLS with Robustness and to control other possible endogeneity variables, gender, salary range, age, faculty, year, and accommodation type are used. However, all the mentioned control variables except gender of the students (respondents) do not differ much causing inappropriate estimators and therefore do not appear statistically significant. The limitations of this paper statistical research are that the sample selected is by pure random, is independent of each other, and do not acknowledge this study while performing the survey with independent and dependent variables are summarized in the following tables:

Table 2 Dependent Variable Summary

Dependent Variables	
Abbrev.	**Definition**
Anchoring Bias Index Number (ABIN)	Comparison (Specify index number 3,2,1,0) between 2 digits of the citizen ID and 2 digits of the lottery ticket categorized into 4 main conditions: 1. 0 = 2 digits number of citizen ID and lottery ticket are the same or in alternating sequence Example: **28**,**28** or **28**,**82** = 0 2. 1 = One of the digits are identical Example: **2**8,**2**5 or 2**8**,3**8** = 1 3. 2 = One of the digits in the 2 digits of the lottery ticket is in between +/- 1 of the 2 digits of the citizen ID Example: **2**8,**1**5 (**1** = **2**-1) = 2 4. 3 = Does not belong to any conditions 1-3. Example: 28,45 = 3
Anchoring Bias Index Number Without 0 (ABIN0)	Comparison (Specify index number 3,2,1,0) between 2 digits of the citizen ID and 2 digits of the lottery ticket categorized into 4 main conditions, but without those who scored index of 0 (Based on the assumption they might be the error terms of the data)
Anchoring Bias Straight and Cross (ABSC)	Comparison (Specify index number 0 or 'X') between 2 digits of the citizen ID and 2 digits of the lottery ticket categorized into 2 main conditions 1. If the 2 digits of the lottery ticket are in the opposite position of the citizen ID digits, then scores 0 [Straight] Example 28,82 = 0 2. If does not follow condition 1, then find the sum of the absolute difference of the left digits and the right digits [Cross] Example 28,95 = |(9-2)|+|(5-8)| = 10
Anchoring Bias Absolute Difference (ABDF)	The absolute difference of the 2 digits of the citizen ID and the last 2 digits of the lottery ticket Exaple: 28,82 = |28 – 82| = 54

Table 3 Independent Variable Summary

Independent Variables					
	Expected Sign				
Abbv.	ABIN	ABIN0	ABSC	ABDF	Definition and Reason
SYS1	+	+	+	+	The number of correct answers in the second part of the survey (CRT) assuming that the more corrected answers (Higher degree of System I Processes) the lower the anchoring bias. In other words, the respondent is likely to be able to adapt quicker and does not primarily depend on prior information. (Max score: 3)
SYS2	+	+	+	+	The number of correct answers in the third part of the survey assuming that the more corrected answers (Higher degree of System II Processes) the lower the anchoring bias because the respondent will be more likely to incorporate all relevant information in making decision and does not answer purely depending on the prior information (Max score: 3)
NUM	+	+	+	+	The number of correct answers in the fourth part of the survey assuming that the more corrected answers (Higher degree of numerical skills) the lower the anchoring bias due to a complex numerical reasoning skills (Max score: 3)

For each dependent variable used in the OLS regression there will be 8 associated equations (total of 4 (dependent variables) * 8 (equations) = 32 equations) in order to achieve robustness and to understand better the relationship between cognitive ability (Number of corrected answers in each part) and anchoring bias. Each dependent variable will have the complete equation as follows (for example: ABIN):

$$ABIN = \beta_0(SYS1) + \beta_1(SYS2) + \beta_2(NUM) + \beta_3(GENDER)$$

This complete equation will be applied and run repeatedly for other variables: ABIN0, ABSC, and ABDF. The regression will also apply the condition "r no constant" to assume that if the respondent answers all the parts of the survey wrong (Considerably low degree of cognitive ability) then the respondent should possess a very high degree of anchoring bias as well, that is, ABIN should score a value of 0. Therefore, $\beta_3(GENDER)$ will be the only variable remaining meaning the starting point of anchoring bias for male and female

Results

Table 4 and 5 shows the regression results of anchoring bias equations categorized into 4 formats based on the dependent variables: ABIN, ABIN0, ABSC, and ABDF with ABIN0, ABSC, and ABDF as robustness

check. Each variable consists of 8 equations with equations (1) (2) (9) (10) (17) (18) (25) (26) or the first two equations of each dependent variable refer to the correlation between System I (SYSI) cognitive process and anchoring bias. Equations (3) (4) (11) (12) (19) (20) (27) (28) or the third equation of each dependent variable shows the relationship between System II (SYSII) cognitive processes and anchoring bias. Lastly, the equations (5) (6) (13) (14) (21) (22) (29) (30) tests the link between numerical reasoning (NUM) and anchoring bias. The last equation of each variable is the complete equation that assesses the relationship of all variables with anchoring bias.

The result shows that when run the regression with only one variable the System I cognitive ability has an effect on anchoring bias with statistical significance at 1% level as shown in equation (1) and (2). Furthermore, the robustness check with ABIN0 (Without those who has extreme values) also shows a statistical significance between the relationship of SYSI and anchoring bias at 1% level which ensures robustness of the equation. Despite changing the anchoring bias assessment index, the statistics report still show parallel results, which is also applicable to equations (3) and (4) that shows the relationship between System II cognitive process ability and anchoring bias with statistical significance at 1% and 5% levels, respectively and equations (5) and (6) that shows the correlation between numerical reasoning ability and anchoring bias with statistical significance at 1% level. This also imposes a certain degree of robustness with regression with ABIN0, ABSC, and ABDF in which the results do comply with the expected signs, thus, concluding that individuals who have higher cognitive ability tend to have lower degree of anchoring bias. In addition, when looking at the compete equations, cognitive ability has an effect on an anchoring bias with statistical significance at 1% and 5% levels in the equations (16) and (4) (28) (32), respectively. The regression results of the full equations imply that the numerical reasoning portion of the cognitive assessment becomes the dominant factor when incorporating all variables. That is, when using numerical anchor factor, the higher the degree of numerical reasoning one possesses the lower the anchoring bias. Nonetheless, the 3 independent variables (SYS1, SYS2, and NUM) share the same directional relationship because respondent has only one source of cognitive process, the mind, and also from a correlation test that shows the same result. When incorporating the control variable, gender (GENDER), into the regression, such as the equations (2) (4) (10) and (12), the results show that System I and System II cognitive processes are still statistically significantly affect the degree of anchoring bias while gender also plays a role to the dependent variable with positively correlated. That means a woman tend to be able to reduce the anchoring bias at a greater magnitude than man as the cognitive abilities improve. However, when used gender as a part of the complete functions in the equations (8) (16) (24) and (32), there is no statistical significant correlation, showing that it is unable to conclude that gender is a factor that contributes to the degree of anchoring bias.

Conclusion & Recommendations

Irrationality arise from anchoring bias causes consumers to anchor their judgements to prices in which the consumers tend to be reluctant to changes in price of goods in the market and will decide to consume only the goods that share the usual price levels without considering the quality or the utility that one believe to receive from consuming. This phenomenon leads to price stickiness in the market that becomes an obstacle to producers to change prices and to receive greater potential profits. Without appropriate profits that relate to the product quality and benefits, producers do not have incentives to invest in future R&D and innovation. In addition, producers will also be able to exploit anchoring bias through advertising. With consumers anchoring to prior information (What they often see), the firm that invests a lot in exposing its products to the consumer will have greater market power and monopoly. This further causes imperfect competition in the market and eventually an inefficient market.

Therefore, one way to improve market efficiency is to reduce anchoring bias. This study concludes that individuals with higher cognitive abilities tend to have lower degree of anchoring bias implying that improvement in training cognitive ability skills such as the ability to think in System I, System II, and numerically will help reduce the anchoring factors in the market. This is also an irregular way to improve the market efficiency by empowering the consumers by trying to help individuals be more rational when it comes to making decisions and does not incorporate purely on changing market regulations like the usual. Therefore, if consumers are able to make decisions with rational cognitive processes then market mechanisms will also be improved. This is because as consumers possess various decision making behaviors this leads to the developments of higher quality goods and services which eventually increase the efficiency of the market.

Table 4 Statistical Report (1)-(16)

	ABIN								ABIN0							
VARIABLES OF INTEREST	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SYS 1	0.537***	0.247***					0.016	0.030	0.820***	0.331***					0.017	0.013
	(0.046)	(0.083)					(0.118)	(0.119)	(0.042)	(0.086)					(0.118)	(0.114)
SYS 2			0.880***	0.242**			0.081	0.071			1.336***	0.348***			0.012	0.024
			(0.104)	(0.121)			(0.126)	(0.126)			(0.138)	(0.129)			(0.152)	(0.148)
NUM					0.454***	0.378***	0.420***	0.336**					0.706***	0.577***	0.691***	0.561***
					(0.034)	(0.097)	(0.089)	(0.138)					(0.031)	(0.095)	(0.084)	(0.131)
CONTROL VARIABLE																
GENDER		0.422***		0.561***		0.126		0.127		0.703***		0.891***		0.214		0.215
		(0.097)		(0.073)		(0.146)		(0.149)		(0.104)		(0.075)		(0.149)		(0.150)
STATISTICS REPORT																
Observations	145	145	145	145	145	145	145	145	94	94	94	94	94	94	94	94
R-squared	0.440	0.506	0.302	0.487	0.527	0.530	0.528	0.531	0.673	0.777	0.459	0.761	0.820	0.824	0.820	0.825

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5 Statistical Report (17)-(32)

	ABSC								ABDF							
VARIABLES OF INTEREST	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
SYS 1	1.661***	0.508*					-0.128	-0.019	11.972***	2.672					-2.236	-1.330
	(0.161)	(0.295)					(0.414)	(0.417)	(1.080)	(1.889)					(2.871)	(2.800)
SYS 2			2.766***	0.560			0.277	0.204			19.922***	2.955			1.401	0.793
			(0.314)	(0.414)			(0.443)	(0.443)			(2.056)	(2.495)			(2.715)	(2.763)
NUM					1.431***	0.842***	1.442***	0.806**					10.534***	5.542***	11.703***	6.412**
					(0.120)	(0.303)	(0.314)	(0.399)					(0.756)	(1.853)	(2.050)	(2.685)
CONTROL VARIABLE																
GENDER		1.678***		1.939***		0.979**		0.964**		13.546***		14.914***		8.295***		8.023***
		(0.345)		(0.275)		(0.461)		(0.462)		(2.151)		(1.710)		(2.922)		(2.945)
STATISTICS REPORT																
Observations	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
R-squared	0.389	0.486	0.276	0.479	0.484	0.498	0.485	0.499	0.432	0.566	0.305	0.562	0.560	0.582	0.563	0.583

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

References

Ariely, Dan, George Loewenstein, and Drazen Prelec. 2003. ""Coherent Arbitrariness": Stable Demand Curves Without Stable Preferences." *The Quarterly Journal of Economics* 118 (1): 73-106.

Bergman, Oscar, Tore Ellingsen, Magnus Johannesson, and Cicek Svensson. 2010. "Anchoring and Cognitive Ability." *Economics Letters* 107 (1): 66-68.

Frederick, Shane. 2005. "Cognitive Reflection and Decision Making." *Journal of Economic Perspectives* 19 (4): 25-42.

Kahneman, Daniel, and Shane Frederick. 2002. "Representativeness Revisited: Attribute Substitution in Intuitive Judgement." *The Psychology of Intuitive Judgement, Cambridge University Press*. 49-81.

Tversky, Amos, and Daniel Kahneman. 1974. "Judgment under Uncertainty: Heuristics and Biases." *Science (American Association for the Advancement of Science)* 185: 1124-1131.

แบบสอบถาม (Survey)

<u>แบบสอบถามทดสอบความสามารถเชิงรู้คิด</u>

<u>ส่วนที่ 1</u>

1. เลขสองหลักสุดท้ายของบัตรประจำตัวประชาชนของคุณคือเลขอะไร? _____
2. คุณคิดว่าเลขสองหลักสุดท้ายของรางวัลที่หนึ่งของสลากกินแบ่งรัฐบาล (หวย) งวดแรกของเดือนกุมภาพันธ์ปีที่ผ่านมาคือเลขอะไร? _____

<u>ส่วนที่ 2</u>

<u>Cognitive Reflection Test (CRT)</u>

1. ไม้เบสบอลและลูกบอลมีราคารวมทั้งหมด 1.10 เหรียญ ไม้เบสบอลมีราคามากกว่าลูกบอล 1.00 เหรียญ ลูกบอลมีราคาเท่าไร? _____ เซนต์
2. ถ้าเกิดใช้เวลา 5 นาทีในการที่เครื่องจักร 5 เครื่องผลิตวิดเจ็ต 5 ชิ้น จะต้องใช้เวลากี่นาทีถ้าใช้เครื่องจักร 100 เครื่องผลิตวิดเจ็ต 100 ชิ้น? _____ นาที
3. ในทะเลสาบมีดอกบัวและทุกๆ หนึ่ง วันดอกบัวจะมีจำนวนมากขึ้น 2 เท่า ถ้าเกิดใช้เวลาทั้งหมด 48 วันที่ดอกบัวจะคลอบคลุมทั้งทะเลสาบ ต้องใช้เวลากี่วันถ้าจำนวนดอกบัวจะคลอบคลุมถึงครึ่งของทะเลสาบ? _____ วัน

<u>ส่วนที่ 3</u> (จงกากบาทข้อที่ถูกต้องที่สุด กากบาทได้เพียงข้อเดียว)

<u>Topology/Data Sufficiency Tests (GMAT)/Logical Deduction</u>

1. ทุกถนนคือสายน้ำ สายน้ำบางสายคือเรือ

a. เรือบางลำเป็นถนน

b. สายน้ำทุกสายเป็นเรือ

- ❑ A. มีเพียงข้อ **a** ที่เป็นจริง
- ❑ B. มีเพียงข้อ **b** ที่เป็นจริง
- ❑ C. ไม่ข้อ **a** ก็ข้อสรุป **b** ที่เป็นจริง
- ❑ D. ไม่มีข้อไหน ที่เป็นจริง
- ❑ E. ทั้งข้อ **a** และ **b** เป็นจริง

2. ถ้า **a** และ **b** เป็นค่าบวก กี่เปอร์เซ็นต์ของ **b** เป็น **a**?

(โดยมีข้อเท็จจริงดังต่อไปนี้)

a. **a** = 3/11

b. **b/a** = 20

- ❑ A. ต้องการเพียงแค่ข้อ **a** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ B. ต้องการเพียงแค่ข้อ **b** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ C. ต้องการทั้งข้อ **a** และ **b** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ D. เมื่อมีแค่ข้อ **a** หรือ **b** ตามลำพังก็เพียงพอสำหรับการตอบคำถาม
- ❑ E. เมื่อมีทั้งข้อ **a** และ **b** ก็ยังไม่เพียงพอสำหรับการตอบคำถาม ซึ่งต้องมีข้อมูลเพิ่มเติมสำหรับการตอบคำถาม

3. เมื่อวานฝนตกที่กรุงเทพฯ แล้วที่เชียงใหม่ฝนตกไหม?

(โดยมีข้อเท็จจริงดังต่อไปนี้)

a. เมื่อไรที่ฝนตกที่เชียงใหม่ ฝนก็ตกที่กรุงเทพฯ

b. ถ้าฝนไม่ตกที่เชียงใหม่ ฝนก็ไม่ตกที่กรุงเทพฯ

- ❑ A. ต้องการเพียงแค่ข้อ **a** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ B. ต้องการเพียงแค่ข้อ **b** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ C. ต้องการทั้งข้อ **a** และ **b** ถึงจะเพียงพอสำหรับการตอบคำถาม
- ❑ D. ข้อสรุป **a** หรือ **b** เพียงข้อเดียวเพียงพอสำหรับการตอบคำถาม
- ❑ E. เมื่อมีทั้งข้อ **a** และ **b** ก็ยังไม่เพียงพอสำหรับการตอบคำถาม ซึ่งต้องมีข้อมูลเพิ่มเติมสำหรับการตอบคำถาม

(กรุณาทำแบบสอบถามต่อด้านหลัง)

<u>ส่วนที่ 4</u>

Numerical Reasoning Test

1. ถ้าเอมี่สามารถวิ่งได้ในความเร็ว 6 กิโลเมตรต่อชั่วโมง โดยที่วิ่งในอัตราความเร็วเท่าเดิม เอมี่สามารถวิ่งกี่กิโลเมตรภายใน 90 นาที?
    a. 4
    b. 6
    c. 8
    d. 9
    e. 12

2. ถ้า x+1 = 23, จงหาค่าของ 3x+3
    a. 22
    b. 46
    c. 66
    d. 69
    e. 72

    2, 4, 6, 8, 10, 12, 14, 16, 18

3. หากมีการสุ่มเลือกตัวเลขจากรายการข้างต้น จงหาความเป็นไปได้ที่ตัวเลขนั้นจะสามารถหารได้ด้วย 3
    a. 1/3
    b. 4/9
    c. 5/9
    d. 2/3
    e. 1

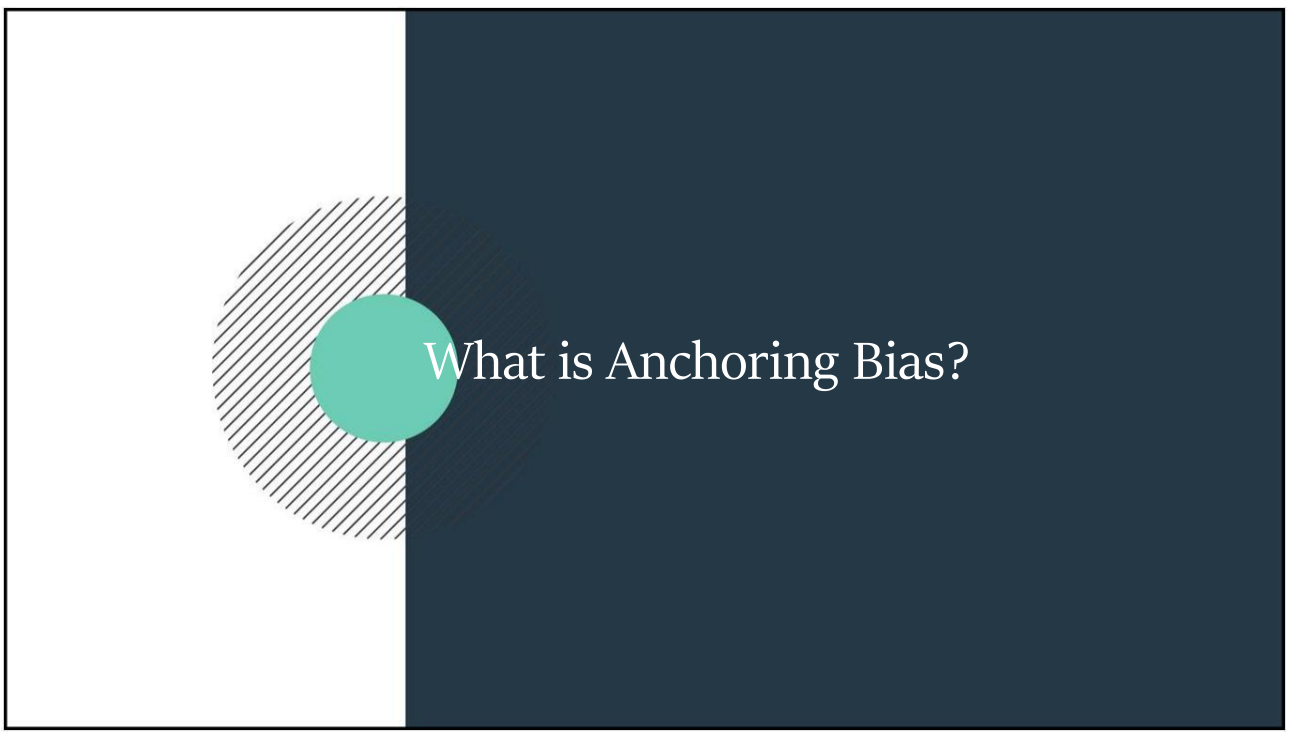
    a. ชาย
    b. หญิง
    c. เลือกที่จะไม่ตอบ
2. อายุ (ปี): _____
3. รายได้ต่อเดือนของคุณ
    a. 0-10,000 บาท
    b. 10,001-20,000 บาท
    c. 20,001-30,000 บาท
    d. มากกว่า 30,000 บาท
4. คุณพักอาศัยอยู่ที่ไหน?
    a. หอพัก
    b. บ้าน
    c. อื่นๆ โปรดระบุ: _____
5. มหาวิทยาลัย:_____

    คณะ: _____ ภาค: _____
6. ชั้นปีที่
    a. 1
    b. 2
    c. 3
    d. 4

<u>ส่วนที่ 5</u>

1. เพศ


Cognitive Ability, Anchoring Bias, and Market Efficiency


What is Anchoring Bias?

10

65

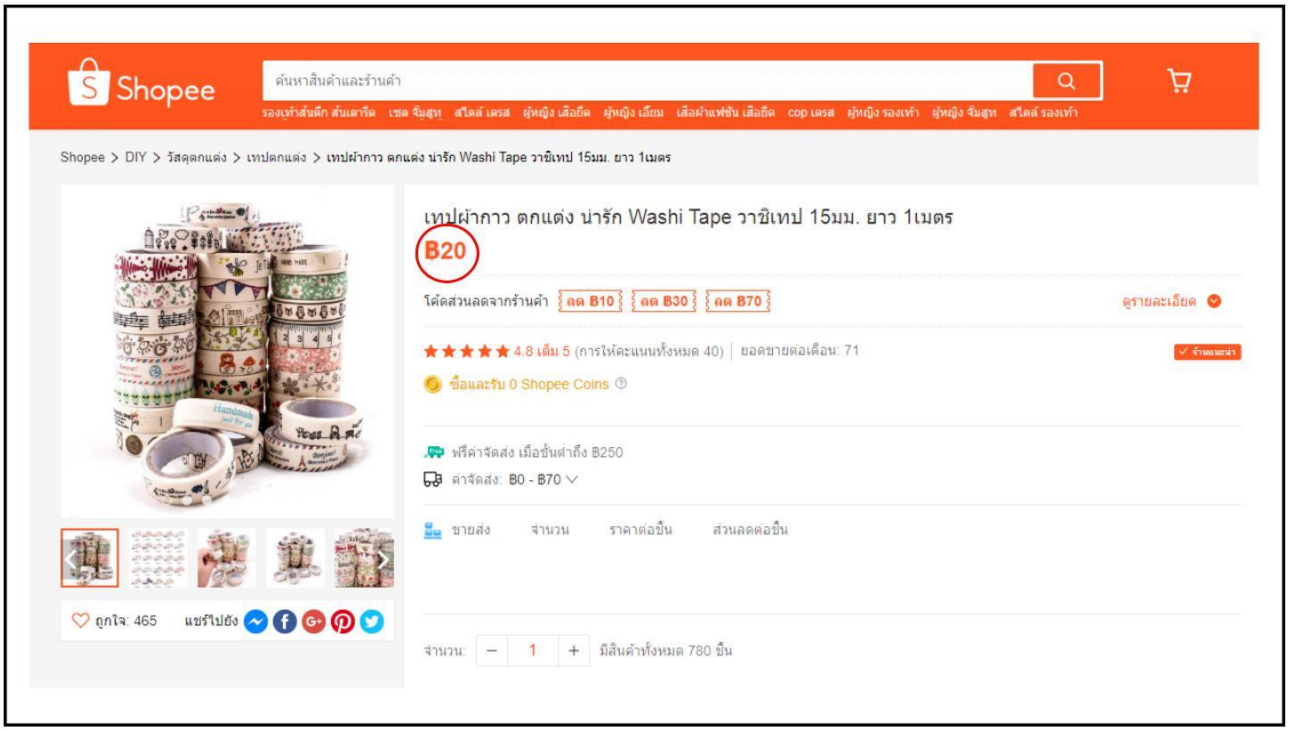
25

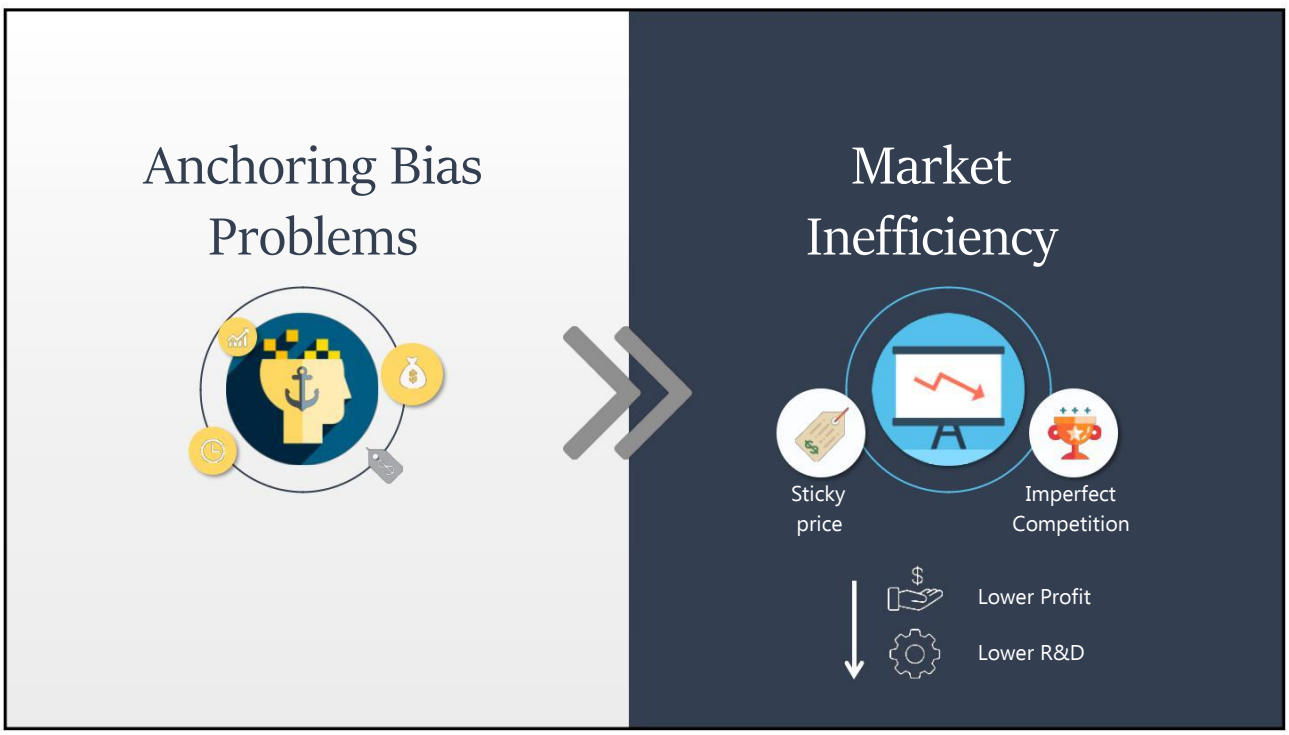
What is the last two digits of your phone number?

45

t was the last two digits of the first prize
ry for February last year? (first round)

150 BAHT


Shopee
ค้นหาสินค้าและร้านค้า
Shopee > DIY > วัสดุตกแต่ง > เทปตกแต่ง > เทปผ้ากาว ตกแต่ง น่ารัก Washi Tape วาชิเทป 15มม. ยาว 1เมตร
เทปผ้ากาว ตกแต่ง น่ารัก Washi Tape วาชิเทป 15มม. ยาว 1เมตร
B20
โค้ดส่วนลดจากร้านค้า
ลด B10
ลด B30
ลด B70
ดูรายละเอียด
4.8 เต็ม 5 (การให้คะแนนทั้งหมด 40)
ยอดขายต่อเดือน: 71
ซื้อและรับ 0 Shopee Coins
ฟรีค่าจัดส่ง เมื่อขั้นต่ำถึง B250
ค่าจัดส่ง: B0 - B70
ขายส่ง
จำนวน
ราคาต่อชิ้น
ส่วนลดต่อชิ้น
ถูกใจ: 465
แชร์ไปยัง
จำนวน:
1
มีสินค้าทั้งหมด 780 ชิ้น


Anchoring Bias Problems
Market Inefficiency
Sticky price
Imperfect Competition
Lower Profit
Lower R&D

What & Why do we study?

Cognitive Ability

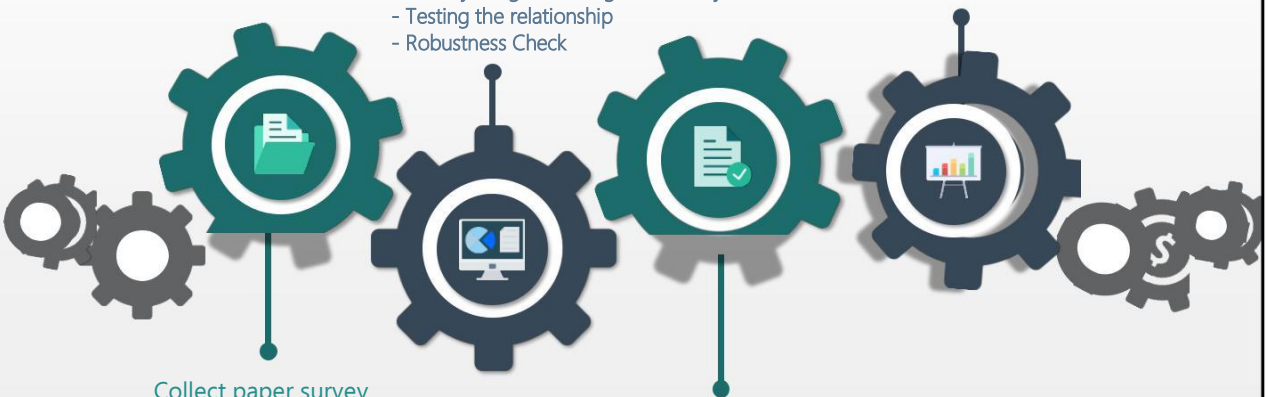
Anchoring Bias

Efficient Market

Methodology

Statistical Analysis
- Detect degree of anchoring bias
- Classify "Degree of Cognitive Ability"
- Testing the relationship
- Robustness Check

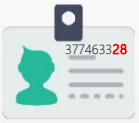
Conclusion
- Conclusion with recommendation



Collect paper survey
(145 responses)
- CRT Tests (SYS1)
- Logical Deduction (SYS2)
- Numerical Reasoning (NUM)
- Control Variables

Results & Interpretation
- Interpretation from relationship tested by Robusted OLS

Testing Anchoring Bias



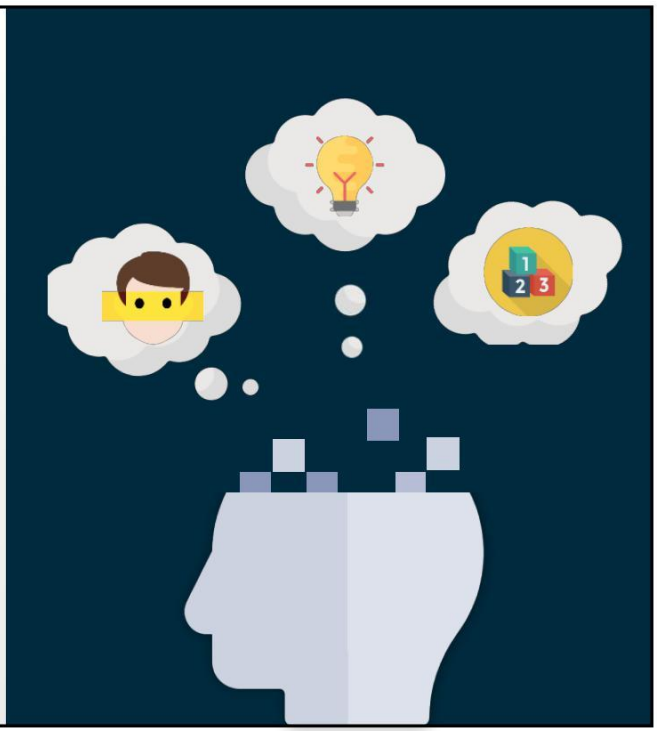
What is the last two digits of your ID card number?

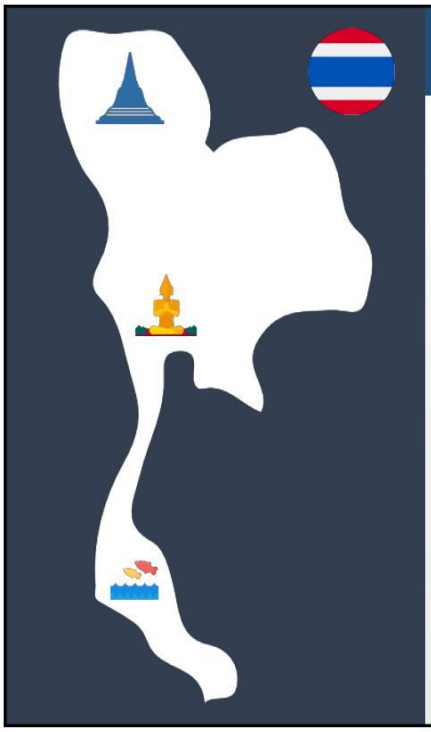
What was the last two digits of the first prize lottery for February last year?

Measure Cognitive abilities

Degree of Cognitive Abilities
("X" Variable)

- CRT Test – System 1 process (SYS1)
- Logical Deduction – System 2 process (SYS2)
- Numerical (NUM)





Degree of Anchoring Bias (“Y” Variable)

1. Anchoring Bias Index Number (ABIN)

28 (CIZID),82 (LOT) = 0

28,15 (1=2-1) = 2

28,25 OR 28,38 = 1

28,45 = 3

NOTE***: CIZID: 2 digits of Citizen ID; LOT: 2 digits of lottery ticket

2. Anchoring Bias Index Number without o (ABINo)

3. Anchoring Bias Straight and Cross (ABSC)

28,82 = 0

28,95 = |(9-2)|+|(5-8)| = 10

4. Anchoring Bias Absolute Difference (ABDF)

28,82 = |(28-82)| = 54

Results

“X” Variable

“Y” Variable

SYS1

SYS2

NUM

ABIN

Anchoring Bias

Results

	Anchoring Bias Index Number (ABIN)								Anchoring Bias Index Number Without 0 (ABIN0)							
V. OF INTEREST	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SYS 1	0.537***	0.247***					0.016	0.030	0.820***	0.331***					0.017	0.013
	(0.046)	(0.083)					(0.118)	(0.119)	(0.042)	(0.086)					(0.118)	(0.114)
SYS 2			0.880***	0.242**			0.081	0.071			1.336***	0.348***			0.012	0.024
			(0.104)	(0.121)			(0.126)	(0.126)			(0.138)	(0.129)			(0.152)	(0.148)
NUM					0.454***	0.378***	0.420***	0.336**					0.706***	0.577***	0.691***	0.561***
					(0.034)	(0.097)	(0.089)	(0.138)					(0.031)	(0.095)	(0.084)	(0.131)
CONTROL V.																
GENDER		0.422***		0.561***		0.126		0.127		0.703***		0.891***		0.214		0.215
		(0.097)		(0.073)		(0.146)		(0.149)		(0.104)		(0.075)		(0.149)		(0.150)
STATS																
N	145	145	145	145	145	145	145	145	94	94	94	94	94	94	94	94
R^2	0.440	0.506	0.302	0.487	0.527	0.530	0.528	0.531	0.673	0.777	0.459	0.761	0.820	0.824	0.820	0.825
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1																

Signal of Robustness, which means Robusted OLS should be statistically significant and accurate

Results

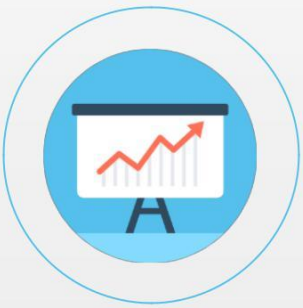
	Anchoring Bias Straight and Cross (ABSC)								Anchoring Bias Absolute Difference (ABDF)							
V. OF INTEREST	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
SYS 1	1.661***	0.508*					-0.128	-0.019	11.972***	2.672					-2.236	-1.330
	(0.161)	(0.295)					(0.414)	(0.417)	(1.080)	(1.889)					(2.871)	(2.800)
SYS 2			2.766***	0.560			0.277	0.204			19.922***	2.955			1.401	0.793
			(0.314)	(0.414)			(0.443)	(0.443)			(2.056)	(2.495)			(2.715)	(2.763)
NUM					1.431***	0.842***	1.442***	0.806**					10.534***	5.542***	11.703***	6.412**
					(0.120)	(0.303)	(0.314)	(0.399)					(0.756)	(1.853)	(2.050)	(2.685)
CONTROL V.																
GENDER		1.678***		1.939***		0.979**		0.964**		13.546***		14.914***		8.295***		8.023***
		(0.345)		(0.275)		(0.461)		(0.462)		(2.151)		(1.710)		(2.922)		(2.945)
STATS																
N	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145	145
R^2	0.389	0.486	0.276	0.479	0.484	0.498	0.485	0.499	0.432	0.566	0.305	0.562	0.560	0.582	0.563	0.583
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1																

Conclusion

Higher degree of
Cognitive Ability

Lower
Anchoring Bias

Market Efficiency



THANK YOU