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High-income consumers may be less hyperbolic when discounting the future

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Abstract

We investigate to what extent high-income consumers are less hyperbolic than low-income consumers using a sample of 216 bank customers and 796 undergraduates. We assess whether participants who scored lower on a test of cognitive ability were also those who tended to discount the future hyperbolically. Our problem is then to find whether lower cognitive ability translates into hyperbolic discounting. The students had higher implicit discount rates, i.e. they were more hyperbolic, for both low stakes and high stakes when long delays were involved, a result in line with the literature. The undergraduates tended to be hyperbolic regardless of stake size, whereas the bank customers tended to be hyperbolic only when high stakes were involved. This makes sense, as high-income consumers should be less sensitive to low stakes. The bank clients showed superior cognitive ability and this may explain why their System 2 could be more capable of overriding cognitive biases, such as the present bias.

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1. Introduction

In a previous study that discriminated between high-income bank customers and university students, we found indebtedness to be associated with poor cognitive ability and lack of self-control for the students, but not for the high-income clients, for whom debt was related to leverage [1]. This is a follow-up study where we gather survey evidence on the relationship between cognitive reflection and intertemporal discounting. We assemble an enlarged sample of the original high-income customers (which now totals 216 individuals) to compare with a fresh sample made up of 796 undergraduates. We aim to investigate to what extent the high-income consumers are less "hyperbolic" than the low-income students.

Intertemporal choice shows a tradeoff between utility across different time periods, which is captured by a subjective discount rate, or the rate by which people discount future utility as a function of when a choice occurs. In "discounted utility theory" [2] [3], people discount all future utilities at a constant rate, which means preferences are stable over time. The simplest functional form of a discount function that declines at a constant rate is the exponential function. Yet the exponential function cannot accommodate an "instant gratification effect" because it does not decline more heavily in the short run. However, a hyperbolic function can capture the fact that today's preferences differ from tomorrow's. People may employ a higher rate when discounting in the short run [4]. Though this presents an empirical challenge to discounted utility theory [5], Laibson [6] shows how people can escape hyperbolic discounting by committing their earnings before they actually received them, such as in a retirement plan. A farsighted planner could mitigate the effects of myopic behavior in future periods. Laibson's farsighted planners implicitly imply superior cognitive ability for those escaping hyperbolic discounting. For this reason, we directly measure the cognitive ability of our study's participants while assessing their attitudes toward intertemporal choice, as in Frederick [7] and Dohmen et al. [8].

The cognitive reflection test (CRT) is a simple test that gauges how individuals differ in cognitive ability [7] in terms of the relative powers of their Systems 1 and 2. "System 1" refers to a large set of subsystems that operate autonomously in response to their own triggering stimuli and are not under control of the analytic processing system, which is called "System 2." Individuals scoring higher on the CRT show enhanced ability for using their System 2 to override System 1. The CRT is claimed to successfully predict intertemporal choice [7].

There is a large volume of literature linking analytic processing to inhibitory control [9]-[16]. This means an individual's ability to use his or her System 2 to override System 1 can be associated with his or her self-control [17]-[19]. System 2 is in charge of self-control, and self-control problems are sometimes related to time-inconsistent preferences [20] [21].

Here, we assess whether participants who scored lower on the CRT were also those who tended to hyperbolically discount the future. Our problem is then to find whether lower cognitive ability translates into hyperbolic discounting in our sample.

The rest of this paper is organized as follows. The next section presents the materials and methods used. Section 3 displays the results found. Section 4 discusses the results and Section 5 concludes this study.

2. Materials and methods

The cognitive reflection test is made up of three simple questions [7]. They are conceived to elicit automatic responses that are compelling but wrong. They are as follows.

CRT

1. 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

2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
   _____ minutes

3. In a lake, there is a patch of lilypads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take the patch to cover half the lake?
   _____ days

The correct answers are 5, 5, and 47, respectively, but the intuitive (wrong) answers are, respectively, 10, 100, and 24. We requested the participants to respond to the three questions above in less than 30 seconds. This was done to make sure an automatic choice was given. We also asked whether he or she already knew one or all of the three questions. If someone reported to know at least one of the questions, then we asked him or her to answer to an alternative CRT [22] as follows.

CRT (alternative questions)

4. If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take them to drink one barrel of water together?
   _____ days.
   [Correct answer: 4; intuitive answer: 9]

5. Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class?
   _____ students.
   [Correct answer: 29; intuitive answer: 30]

6. A man buys a pig for $60, sells it for $70, buys it back for $80 and sells it finally for $90. How much has he made?
   _____ dollars.
   [Correct answer: 20; intuitive answer: 10]

To gauge hyperbolic discounting we adapted a questionnaire from Sutter et al. [23]. Participants chose between two sure payoffs at two distinct points in time. One was an early payoff and the other was a larger, later payoff. In total, we presented the participants eight choice lists each containing 10 questions, where the early payoff remained the same and the later payoff was increased monotonically along a list (Figure 1). Rewards were hypothetical.

The lists differed by the stake size of the early payoff (either $100 or $250 Brazilian Real) and by the timing of the early and late payoffs. For example, List 1 presented a choice between receiving a payoff today (an upfront delay of zero) and receiving a larger payoff in three weeks (a delay of three weeks). List 2 maintained the delay of three weeks, but shifted it into the future (an upfront delay of three weeks). List 3 required choices between a payoff today and a payoff in one year, and List 4 shifted the latter list into the future by having an upfront delay of three weeks again. Figure 2 shows the four arrangements of these examples.

List 1
[1] receive $100 now ( ) or ( ) receive $100 in 3 weeks
[2] receive $100 now ( ) or ( ) receive $105 in 3 weeks
[3] receive $100 now ( ) or ( ) receive $110 in 3 weeks
.....
[10] receive $100 now ( ) or ( ) receive $145 in 3 weeks

List 5
[41] receive $250 now ( ) or ( ) receive $250 in 3 weeks
[42] receive $250 now ( ) or ( ) receive $275 in 3 weeks
[43] receive $250 now ( ) or ( ) receive $300 in 3 weeks
.....
[50] receive $250 now ( ) or ( ) receive $475 in 3 weeks

List 2
[11] receive $100 in 3 weeks ( ) or ( ) receive $100 in 6 weeks
[12] receive $100 in 3 weeks ( ) or ( ) receive $105 in 6 weeks
[13] receive $100 in 3 weeks ( ) or ( ) receive $110 in 6 weeks
.....
[20] receive $100 in 3 weeks ( ) or ( ) receive $145 in 6 weeks

List 6
[51] receive $250 in 3 weeks ( ) or ( ) receive $250 in 6 weeks
[52] receive $250 in 3 weeks ( ) or ( ) receive $275 in 6 weeks
[53] receive $250 in 3 weeks ( ) or ( ) receive $300 in 6 weeks
.....
[60] receive $250 in 3 weeks ( ) or ( ) receive $475 in 6 weeks

List 3
[21] receive $100 now ( ) or ( ) receive $100 in 1 year
[22] receive $100 now ( ) or ( ) receive $105 in 1 year
[23] receive $100 now ( ) or ( ) receive $110 in 1 year
.....
[30] receive $100 now ( ) or ( ) receive $145 in 1 year

List 7
[61] receive $250 now ( ) or ( ) receive $250 in 1 year
[62] receive $250 now ( ) or ( ) receive $275 in 1 year
[63] receive $250 now ( ) or ( ) receive $300 in 1 year
.....
[70] receive $250 now ( ) or ( ) receive $475 in 1 year

List 4
[31] receive $100 in 3 weeks ( ) or ( ) receive $100 in 1 year and 3 weeks
[32] receive $100 in 3 weeks ( ) or ( ) receive $105 in 1 year and 3 weeks
[33] receive $100 in 3 weeks ( ) or ( ) receive $110 in 1 year and 3 weeks
.....
[40] receive $100 in 3 weeks ( ) or ( ) receive $145 in 1 year and 3 weeks

List 8
[71] receive $250 in 3 weeks ( ) or ( ) receive $250 in 1 year and 3 weeks
[72] receive $250 in 3 weeks ( ) or ( ) receive $275 in 1 year and 3 weeks
[73] receive $250 in 3 weeks ( ) or ( ) receive $300 in 1 year and 3 weeks
.....
[80] receive $250 in 3 weeks ( ) or ( ) receive $475 in 1 year and 3 weeks

Figure 1. Gauging hyperbolic discounting (present bias) using choice lists
Adapted from Sutter et al. [23]

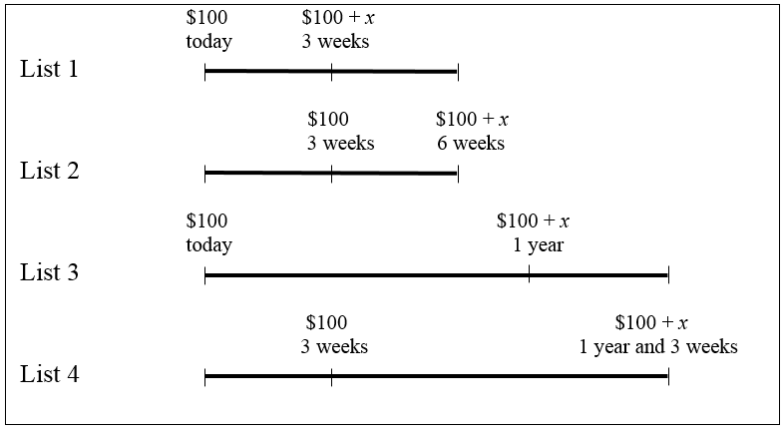

Figure 2. Combinations of early and late payoff (four choice lists for sure payoff $100)
Adapted from Sutter et al. [23]

From the eight choice lists, we calculated the “future equivalent" of the (fixed) early payoff as the midpoint between the two later payoffs, where a participant switched from the earlier to the later payoff. Figure 3 illustrates the computation of the future equivalent for List 1. The participant chose the payoff today twice (left-side option) and then switched to the right-side option. This means her future equivalent was $107.50, that is, $(\$105.00+\$110.00)/2$. The larger the future equivalent, the stronger the delay aversion. In other words, a larger future equivalent indicates stronger impatience.

Of note, Lists 1 and 2 measure the attitude toward an identical delay (of three weeks) with an upfront delay of zero and three weeks, respectively. Similarly, in Lists 3 and 4 the delay is one year and the upfront delay is zero and three weeks, respectively. Comparing the future equivalents between such lists allows us to learn whether discounting is constant or not [6] [24] [25]. If future equivalents are higher for List 1 than for List 2 and for List 3 than for List 4, the

early payoff receives more weight than the payoff in three weeks, and this is considered to provide evidence of hyperbolic discounting. Taking these four timing combinations for both high and low stakes (as in Figure 1) allows us to control for the effects of stake size [23].

List 1						
[1]	receive $100 now	( )	or	( )	receive $100 in 3 weeks
[2]	receive $100 now	( )	or	( )	receive $105 in 3 weeks
[3]	receive $100 now	( )	or	( )	receive $110 in 3 weeks

Figure 3. Example of calculation of the future equivalent for List 1
Adapted from Sutter et al. [23]

Participants from both sexes filled out the eight choice lists in Figure 1 in a random order and answered the CRT. All participants were asked whether their age was below 25, or 25 or older. This is claimed to be a useful sorting of age groups from a neural perspective [25]. We intentionally assembled a non-probabilistic sample of two distinct groups according to income. The first was made up of 216 high-income bank customers from a large Brazilian bank branch located in Florianopolis, Brazil. High-income customers in Brazil usually bank at separate branches that are designated for those who individually earn $10,000 a month or more. We ended up with a sample of 147 high-income individuals (93 males and 54 females; 96 percent were 25 or older). From the original bank customers we approached, 69 either failed to answer to the CRT in less than 30 seconds or made detectably sloppy choices in the intertemporal choice questionnaire. The second sample was made up of 796 undergraduates from the southern Brazilian cities of Florianopolis, Chapeco, Ibirama, Blumenau, Tubarao and Capivari De Baixo. As 334 answers to the intertemporal questionnaire were incomplete or the CRT was not answered in less than 30 seconds, in the end, the subsample of undergraduates was reduced to 462 participants (187 males and 275 females; 67.7 percent were below age 25). The students also reported their income, whether below $1,000 (35.3 percent); between $1,000 and $10,000 (64.3 percent); or above $10,000 (0.4 percent).

We capitalized on the advantages of applying the CRT and the intertemporal choice questionnaire online [26], and these were sent to the participants using the Eval&Go platform (http://www.evalandgo.com/) through e-mail, WhatsApp, Facebook or LinkedIn. Eval&Go allowed us to insert a chronometer to guarantee a CRT question flipped its screen after 30 seconds. For the first subsample of bank customers, we took advantage of the fact that author AC is also a manager at the branch where the experiment took place. Experimenter AC then collected the data from 4 April 2016 to 29 April 2016. As for the second subsample, experimenter DDF collected the data from 13 September 2016 to 31 October 2016. A higher rate of desistance from the part of the students (above 50 percent) casually suggests a higher rate of impatience for this group. The final subsample was then likely to produce conservative results. Indeed, an adverse selection occurred during the sampling due to the desistance of the most impatient undergrads. However, the bank customers were likely to be more cooperative due to the very fact that their manager was asking them to participate in the experiment. The experiment was registered at Plataforma Brasil under No. 64758617.2.0000.0121, a Brazilian government organization that assesses the ethical proceedings of experiments with human beings. The dataset is available at Figshare (https://doi.org/10.6084/m9.figshare.4983392.v2).

3. Results

Most participants responded to the CRT in the first format shown earlier. Only 13 bank customers and 22 undergrads took the alternative CRT. The bank customers outperformed the students (Figure 4). Though both groups were similar in correctly answering the three questions, the bank clients beat the students while answering one to two questions correctly. Moreover, more students than clients did not correctly answer all the three questions. The difference between the two groups was significant (p-value < 0.05, nonparametric Mann-Whitney U test = $29673.00, Z = -2.883$). Thus, the students showed relatively poorer cognitive ability than the bank customers.

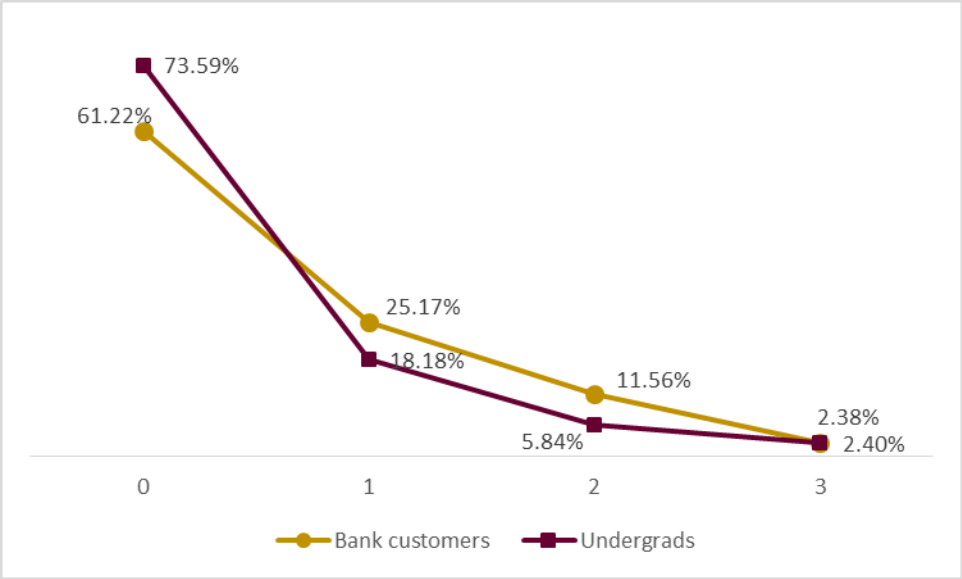

Figure 4. CRT scores: the high-income consumers beat the students

It is well established that males score higher than females do on the CRT [7] [27]. Our sample replicated this finding for both bank clients (Table 1) and undergrads (Table 2).

Table 1. Bank clients' CRT scores, by sex

	Percentage scoring 0, 1, 2 or 3			
Sex	0	1	2	3
Male_{93}	53.77_{50}	30.11_{28}	12.90_{12}	3.22_{3}
Female_{54}	74.07_{40}	16.67_{9}	9.26_{5}	0.00_{0}

Notes:

1) subscripts show the number of respondents

2) $\chi^2(3) = 6.997$, p-value = 0.072 ; Fisher's exact p-value = 0.076

3) Spearman's correlation $\rho = -0.19$, p-value = 0.017

After computing the future equivalents of each list in Figure 1, the lists were compared in pairs. Considering the delays (three weeks or one year) and stakes ($100 or $250), four types of hyperbolic discounting could be measured, as in Table 3. For example, if a future equivalent in List 1 was greater than that in List 2, the early payoff is weighted more than the payoff in three

weeks, thus revealing a "present bias," in this case a hyperbolic discounting of Type 1. Comparing Lists 3 and 4 produced a gauge of Type-2 hyperbolic discounting, and so on.

Table 2. Students' CRT scores, by sex

	Percentage scoring 0, 1, 2 or 3			
Sex	0	1	2	3
Male_{187}	61.00_{114}	23.50_{44}	11.20_{21}	4.30_{8}
Female_{275}	82.20_{226}	14.50_{40}	2.20_{6}	1.10_{3}

Notes:
1) subscripts show the number of respondents
2) $\chi^2(3) = 32.093,\ p\text{-value} = 0.000$
3) Spearman's correlation $\rho = -0.25,\ p\text{-value} = 0.000$

Table 3. Four types of hyperbolic discounting measured by the future equivalents, considering delays and stakes

	Delay	
Stake	Three weeks	One year
Low	Type-1 hyperbolic discounting	Type-2 hyperbolic discounting
High	Type-3 hyperbolic discounting	Type-4 hyperbolic discounting

Whenever a participant chose the early payoff in all the choice lists, we kept the greater future equivalent, which meant \$147 for Lists 1 to 4, and \$487 for Lists 5 to 8.

Most participants did not show hyperbolic discounting (Figure 5). This is not unexpected and is in line with the literature [4]. However, for those affected by the present bias, Figure 5 suggests a payoff delay mattered for the bank customers, who displayed hyperbolic discounting when high stakes were involved (Type-4 measure). A payoff delay also mattered for the students, regardless of whether stakes were low or high (Type-2 and Type-4 measures). Considering these together, such results for both groups make sense, as high-income individuals are expected to be more insensitive to lower stakes.

The difference between the groups of bank customers and undergrads was not significant (Table 4). This means their attitudes toward intertemporal discounting did not differ too much (p-value > 0.05).

Next, we considered the future equivalents computed for the eight choice lists and then calculated "implicit annual discount rates" [23] as

$$i = \ln\left(\frac{\text{future equivalent}}{\text{early payoff}}\right) \tag{1}$$

for a one-year delay (assuming continuous discounting), and

$$i = \ln\left(\frac{\text{future equivalent}}{\text{early payoff}}\right)\frac{52}{3} \tag{2}$$

for the delays of three weeks, as one year has 52 weeks. After considering the early payoffs of \$100 and \$250, we found the median annual discount rates for the bank customers, as in Table 5. Such implicit discount rates were larger for short delays of three weeks with an upfront delay of

zero and three weeks (Lists 1, 2, 5 and 6) than for long delays of one year with an upfront delay of zero and three weeks (Lists 3, 4, 7 and 8). This replicated Sutter et al. [23].

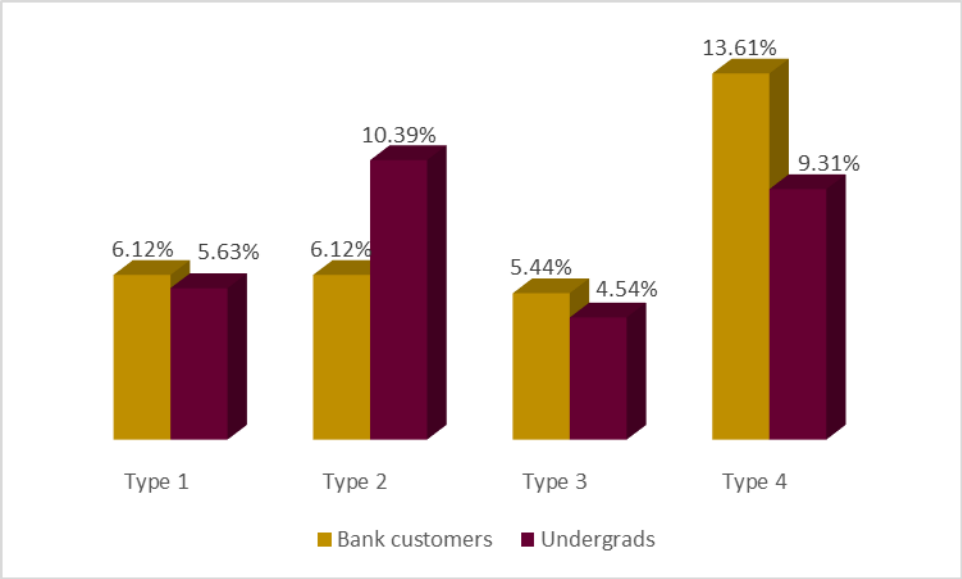

Figure 5. Incidence of hyperbolic discounting among bank customers and undergrads, by type

Table 4. Bank customers and students did not differ in their attitudes toward intertemporal choice

	Hyperbolic discounting			
	Type 1	Type 2	Type 3	Type 4
Mann-Whitney	33789.00	32508.00	33652.50	32497.50
Z	−0.224	−1.546	−0.444	−1.489
p-value	0.823	0.122	0.657	0.136

Table 5. Median annual discount rates for the bank customers, %

Delay	Three weeks Upfront delay = 0	Three weeks Upfront delay = 3 weeks	One year Upfront delay = 0	One year Upfront delay = 3 weeks
Stake				
	List 1	List 2	List 3	List 4
Low	133.39	133.39	20.70	24.68
	List 5	List 6	List 7	List 8
High	87.86	245.26	22.47	22.47

Table 6 shows the students adopted the same pattern as the bank customers did, but the students had higher implicit discount rates for both low stakes and long delays with high stakes. This is in line with the literature, too, where higher rates of discount are expected for lower-income individuals [28].

Of note, because of the design of the fixed choice list in Figure 1, the step size implies by design a larger discount rate if calculated for a delay of three weeks as compared to a delay of one year. Thus, a participant may have a higher future equivalent in a choice list with a one-year delay in comparison to an equivalent list with a three-week delay, but a lower discount rate in the list with a one-year delay. For this reason, comparisons across delays in Table 5 and 6 should be avoided and an analysis should be conducted separately for the delays of three weeks and one year [23].

We then turned to the possible relationship between cognitive ability and intertemporal discounting. As for the bank customers, Figure 6 suggests at first glance a negative correlation between cognitive ability and impatience because those individuals who scored two or three correct answers escaped more from discounting the future hyperbolically. However, this was not significant for any type of present bias (p-value > 0.05, Pearson's χ^2 test). Importantly, Spearman's correlations between CRT and hyperbolic discounting were ambiguous and not significant for all types of discounting (p-value > 0.05).

Table 6. Median annual discount rates for the undergraduates, %

Delay	Three weeks Upfront delay = 0	Three weeks Upfront delay = 3 weeks	One year Upfront delay = 0	One year Upfront delay = 3 weeks
Stake				
	List 1	List 2	List 3	List 4
Low	196.43	272.13	35.06	38.52
	List 5	List 6	List 7	List 8
High	81.26	239.23	29.86	37.01

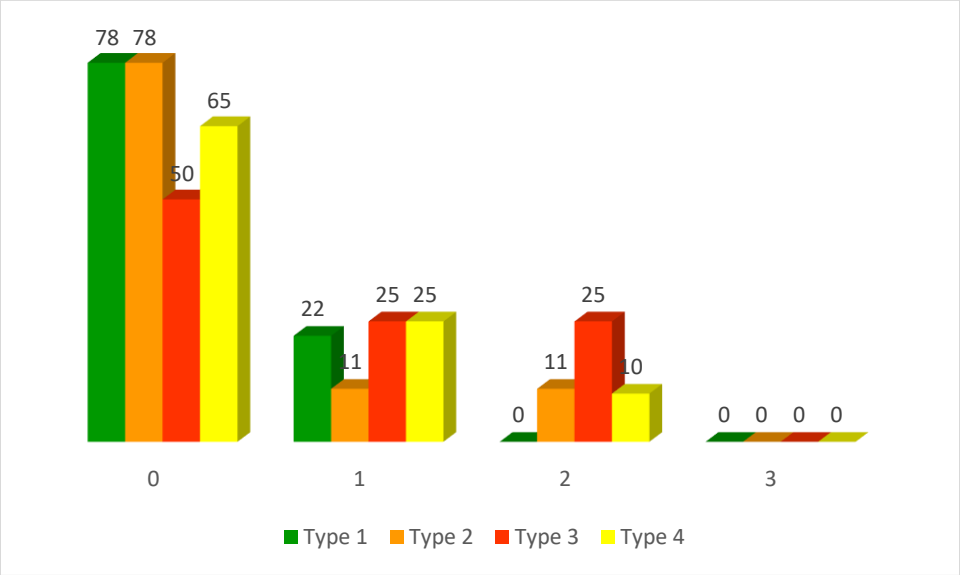

Figure 6. Percentage of bank customers showing hyperbolic discounting while scoring 0, 1, 2 or 3 on the CRT

Notes:

1) Type 1: Spearman $\rho = -0.100$, p-value = 0.229

2) Type 2: Spearman $\rho = -0.079$, p-value = 0.342

3) Type 3: Spearman $\rho = 0.065$, p-value = 0.433

4) Type 4: Spearman $\rho = -0.039$, p-value = 0.643

A different picture emerged for the undergraduates, at least as far as the hyperbolic discounting of Type 4 was concerned (Figure 7). The negative relationship between cognitive ability and impatience did emerge and was significant (Spearman's correlation $\rho = -0.094$, p-value < 0.05; Pearson's $\chi^2(3) = 9.105$, p-value < 0.05).

Taking together, the results for both groups suggested intertemporal choice was related to cognitive ability for the students, but not for the bank customers.

To evaluate whether income is what really drives differences in inferred discount rates, we considered the group of undergraduates alone because age affects discounting [29], and thus can be an important confounding factor. Table 7 shows the results for the subsample of students by discriminating against them in terms of income. As can be seen from the statistically significant results, students with incomes above $1,000 were relatively less hyperbolic.

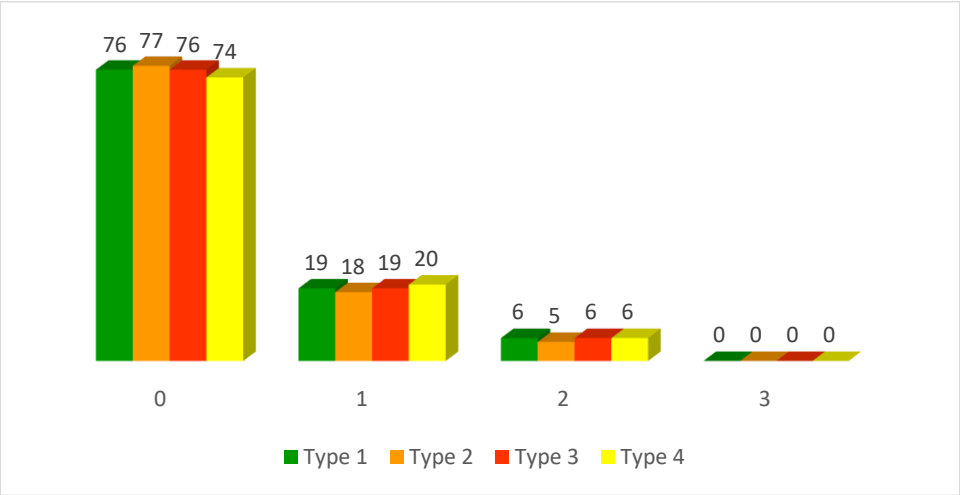

Figure 7. Percentage of students showing hyperbolic discounting while scoring 0, 1, 2 or 3 on the CRT

Notes:

1) Type 1: Spearman $\rho = 0.056$, p-value $= 0.226$

2) Type 2: Spearman $\rho = 0.109$, p-value $= 0.019$; $\chi^2(3) = 6.702$, p-value $= 0.082$

3) Type 3: Spearman $\rho = 0.047$, p-value $= 0.316$

4) Type 4: Spearman $\rho = -0.094$, p-value $= 0.043$; $\chi^2(3) = 9.105$, p-value $= 0.028$

Table 7. Spearman correlations ρ for the students showing hyperbolic discounting while scoring 0, 1, 2 or 3 on the CRT, by income

Income	Low	High
Hyperbolic discounting		
Type 1	$\rho = 0.074$, p-value $= 0.345$	$\rho = 0.047$, p-value $= 0.415$
Type 2	$\rho = 0.200$, p-value $= 0.010$ * $\chi^2(3) = 7.681$, p-value $= 0.053$	$\rho = 0.063$, p-value $= 0.274$
Type 3	$\rho = 0.188$, p-value $= 0.016$ * $\chi^2(3) = 13.434$, p-value $= 0.004$	$\rho = -0.022$, p-value $= 0.708$
Type 4	$\rho = -0.030$, p-value $= 0.706$	$\rho = -0.128$, p-value $= 0.027$ * $\chi^2(3) = 7.307$, p-value $= 0.063$

Notes:

1) * significant at 5 percent

2) Low income means < $1,000; High income means > $1,000

4. Discussion

The vast majority of our sample's participants from both groups did not show hyperbolic discounting. In this regard, bank customers and students did not differ too much. However, for those who did not escape hyperbolic discounting, there was a clear difference in the pattern for the emergence of the phenomenon of high-income consumers relative to students. The undergraduates tended to be hyperbolic regardless of stake size, whereas the bank customers tended to be hyperbolic only when high stakes were involved. This makes sense, as one expects high-income consumers to be less sensitive to low stakes. We observed a "magnitude effect" [5] for bank customers (but not for the students) regarding the delay of one year (Figure 5). This result is compatible with hyperbolic discounting, but it can also be alternatively explained by a "fixed-cost present bias" [30]-[35].

The implicit discount rates were greater for short delays of three weeks (with an upfront delay of zero and three weeks). In this regard, bank customers and students did not differ too much, either. While this result may be interpreted as suggesting a sort of hyperbolic discounting [4], it is not unambiguous because it can be alternatively accommodated by "subadditive discounting" [36]. According to this competing theory, discounting occurring in short delays and long delays may differ due to the very fact that it is more finely partitioned, and not because discount rates actually declined with time.

To measure intertemporal choice, we considered multiple price lists with monetary payments where an interest rate increased monotonically in a choice list (Figure 1), and thus the point where a participant switched from preferring an early payment to a later payment carried interval information about his or her intertemporal preferences. Hyperbolic discounting was thus viewed in the sense of "present bias," as in Thaler [5]. The technique of multiple price lists implicitly assumes time-separable stationary preferences and linear utility [37], and leads to upward-biased discount rate estimates if utility is concave [37] [38]. Thus, we expect this method exaggerated the results we found. However, for our purposes in this study this makes no difference because the method exaggerates equally for both groups (high and low-income participants). Despite this upward bias, the high-income participants showed relatively lower discount rates. And the latter result is still likely to be conservative because the subsample of students was biased toward the more impatient, in light of the fact that such low-income participants showed a higher rate of desistance from the onset of the experiment.

Regardless of the explanation for the evidence of implicit discount rates that are higher for shorter delays, our study showed a difference in pattern for each group. The students had higher implicit discount rates for both low stakes and high stakes when long delays were involved. This is in line with the literature, where higher rates of discount are expected for lower-income individuals [28].

The students showed relatively poorer cognitive ability than the bank customers did. For high stakes and long delays at least, hyperbolic discounting was negatively related to cognitive ability for the group of undergraduates. This result is in line with the literature, too [7] [8] [39]. However, and importantly, intertemporal choice for the high-income individuals in our sample was not related to cognitive ability, thus suggesting other subjective mechanisms of choice were at play for the bank customers.

As for cognitive ability, the bank customers were superior to the undergrads in our sample. Individuals with higher cognitive ability may control their automatic impulse for instant gratification and immediate payoffs [40]. This may explain why the high-income consumers where not affected by the present bias while discounting the future. Moreover, on a daily basis bank customers are under the influence of "nudgers" (their personal managers), who influence their money decisions using a "choice architecture" [41]. Such choice architects are responsible for improving the environment where these individuals make decisions. Indeed, high-income bank clients usually decide using real-time information and after considering the input provided by their personal bank managers. An extra mechanism of reinforced learning after such a nudge thus suffices to justify why bank clients were less hyperbolic in our study.

It has to be said that differences in discounting behavior between the two groups may be due to transaction costs and liquidity constraints [42]. Our choice lists (Figure 1) were not specific about how the hypothetical payments would be made. So, a participant could assume that while choosing the early payment he or she would leave with cash, and when choosing later he or she would have to return to receive the cash with some risk of a broken promise, which is a type of transaction cost [43]. We did not contextualize our choice lists to assess the impact of liquidity constraints, either, for example, by asking a participant to choose between two days before Christmas (now) and in late summer [42] [43]. Students with limited cash liquidity have a higher fixed cost component of discounting. Thus, only when the offered future reward is large enough to overcome the present bias will a student accept the later payment [43]. Moreover, students have less access to credit and this liquidity constraint makes problematic the elicitation of the present bias through lack of intertemporal stationarity or time inconsistency [44].

5. Conclusion

Are high-income consumers less hyperbolic when discounting the future? This study considered high-income bank customers and low-income undergraduates to partially answer this question. And the answer is a qualified "yes." The bank customers unambiguously showed more cognitive ability than the students did on a cognitive reflection test. Moreover, those students presenting hyperbolic discounting were also those scoring lower on the cognitive reflection test. For this group, lower cognitive ability translated into hyperbolic discounting. The students had higher implicit discount rates (were more hyperbolic) for both low stakes and high stakes when long delays were involved. For high stakes and long delays at least, hyperbolic discounting was negatively related to cognitive ability for the group of undergraduates. However, while intertemporal choice was related to cognitive ability for the students, this could not be shown for the bank customers. Because the bank clients had superior cognitive ability, their System 2 was possibly more capable of overriding the cognitive bias of hyperbolic discounting.

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