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Do smart consumers regonise a good deal when they see one? Quasi-experimental evidence from the online horse betting market

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ABSTRACT

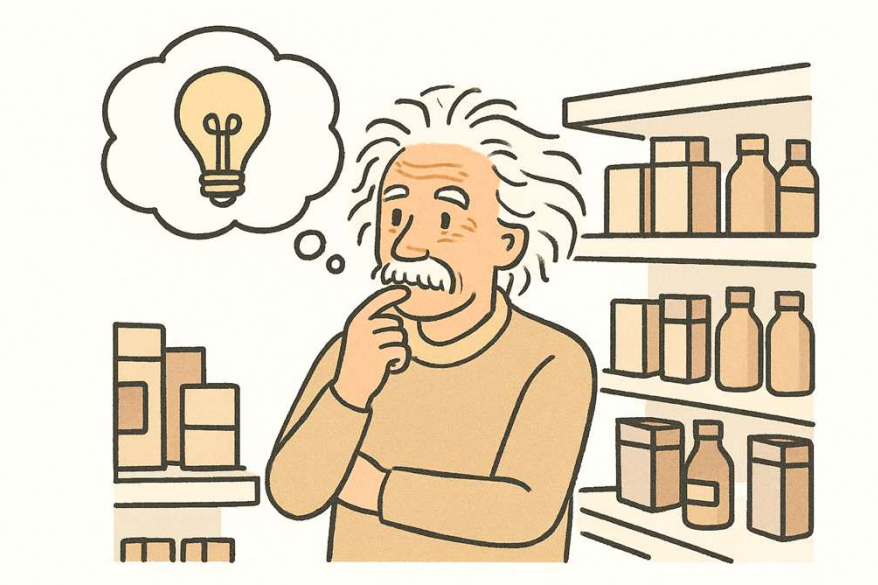
We use a large-scale data set from Finland to examine how individual differences in IQ predict consumer responses to temporary price discounts in a quasi-experimental setting. Our data set amalgamates all horse wagering product purchases made by all consumers in a monopolistic market over a one-year period, IQ test scores from the Finnish Defence Forces, and administrative registry data on the socioeconomic characteristics of those consumers. Our results indicate that high-IQ individuals respond to price discounts by increasing their participation in and consumption of horse betting products whose price has fallen.

Theoretical background

- Neoclassical microeconomic theory predicts that consumers increase their spending on a normal good whose price falls to maximise their utility
- Economic decision-making is a complex task because it involves choosing between consumption options, each of which has value to the consumer, and processing the information relevant to the choice (Rustichini, 2015).
- Differences in consumer choices may not result solely from preferences but also from individual differences in decision-making ability (Payne et al., 1992; Choi et al., 2014)
- The theory of bounded rationality argues that limitations in information processing capabilities can hinder utility maximisation (Simon, 1955; Conlisk, 1996).

Intelligence and economic decision-making

- Intelligence facilitates processing complex information from one's surroundings (Gottfredson, 1997)
- Intelligence plays a crucial role in how a consumer processes information into economic decisions (Gaston-Breton & Raghubir, 2013; D'Acunto et al., 2023)
- Even though rational choice is not directly equivalent to intelligence (Stanovich, 2016), cognitive ability appears to correlate positively with utility maximisation (West and Stanovich, 2003; Cappelen et al., 2023), a key tenet of rationality in economic theory



Empirical evidence on the role of IQ in economic decisions

- Prior studies suggest that IQ correlates positively with economic decisions that can be regarded as beneficial to the consumer
  - High-IQ investors participate more in the stock market (Grinblatt et al., 2011) and are more skilled traders (Grinblatt et al., 2012)
  - Cognitive ability is positively associated with debt-management skills (Agarwal and Mazumder, 2013)
  - High-IQ investors buy mutual funds with lower management fees, which indicates higher price sensitivity (Grinblatt et al., 2016)
  - Consumers with higher IQ were able to take advantage of a tax break for environment-friendly cars (Aspara et al., 2017)
  - High-IQ consumers increase their consumption when inflation is low (and vice versa) (D'Acunto et al., 2023)

Price and value of gambling products

- In addition to potential for financial gains, gambling provides entertainment value (Conlisk, 1993; Mao et al., 2015)
- The price of gambling is the cost of purchasing a probability distribution of prizes with some expected value (Clotfelter and Cook, 1987)
- The effective price of a gambling product is the amount staked minus the expected value of a gamble (Forrest et al., 2000)
- Example of the effective price:
  - Suppose that the probability of winning €100,000 in a lottery is one in a million
  - Expected value of the lottery: 10^{-6} x €100,000 = €0.1
  - If the amount staked on the lottery is €1, the effective price of the gamble is

    €1 - €0.1 = €0.9
  - Hence, the effective price for a chance to win €100,000 is 90 cents

Price changes in gambling products

- Changes in effective prices operate through the expected value of the gamble (Forrest, 2000)
  - Increase in prize money tends to reduce the effective price (and vice versa)
  - The gambling operator can also adjust the 'takeout rate', which is the proportion of the total amount staked retained by the operator
- Rolling over previously undistributed wins or adding bonus money to the prize pool reduce the effective price
- This is similar to other consumer markets: price discounts or added value (e.g. "buy one get one free") enhance the value proposition to the consumer

Research hypotheses

- The utility-maximization principle of neoclassical microeconomic theory predicts that a reduction in the effective price of a product, ceteris paribus, increases demand
- The concept of bounded rationality (Simon, 1955) posits that consumers face cognitive constraints that limit their ability to process information optimally, leading to deviations from fully rational choice (Conlisk, 1996)
- We expect that consumers with higher cognitive ability — proxied by IQ — are better equipped to identify and act upon temporary price discounts — both in deciding whether to consume (extensive margin) and in how much to consume (intensive margin)

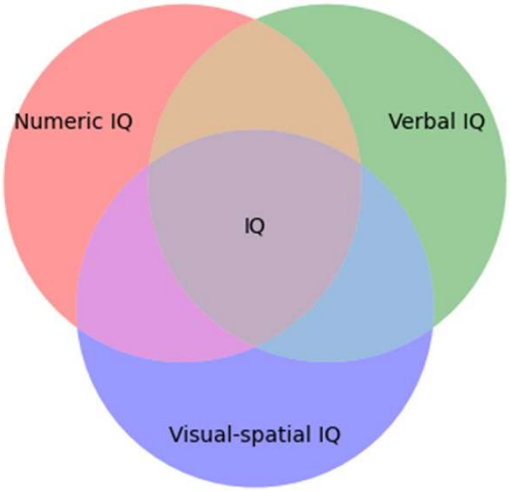
  H1: The effect of a price discount on the probability of consumption is stronger for consumers with higher IQ

  H2: The effect of a price discount on the level of consumption is stronger for consumers with higher IQ

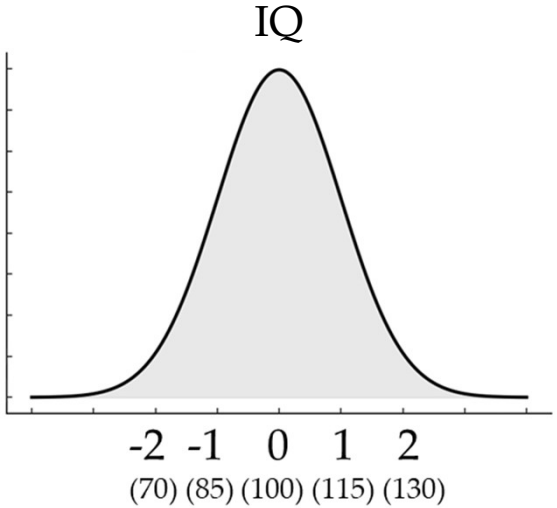
Data set (1): IQ test scores

- IQ test scores from the Finnish Defence Forces (FDF), N = 705,089 males born between 1962 and 1990
- Data on conscripts who undertook military service between 1982 and 2010
  - The IQ test remained unchanged
- Typical conscript is 19 to 20 year-old
- Mandatory for males (~ 70% completion rate)
- Voluntary for females (~ 2 % of conscripts) since 1995
  - We do no't use female test scores because there are so few of them in the data

- Three psychometric tests that measure visual-spatial, numeric, and verbal ability (M = 100, SD = 15)

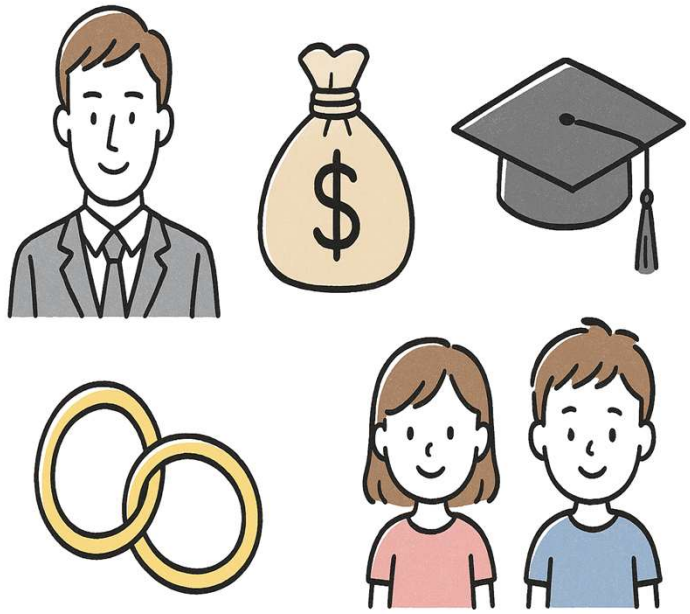


- We use the arithmetic mean of the three tests as the measure of IQ, which is yearly-standarised scores (M = 0, SD = 1) to mitigate the impact of the Flynn effect



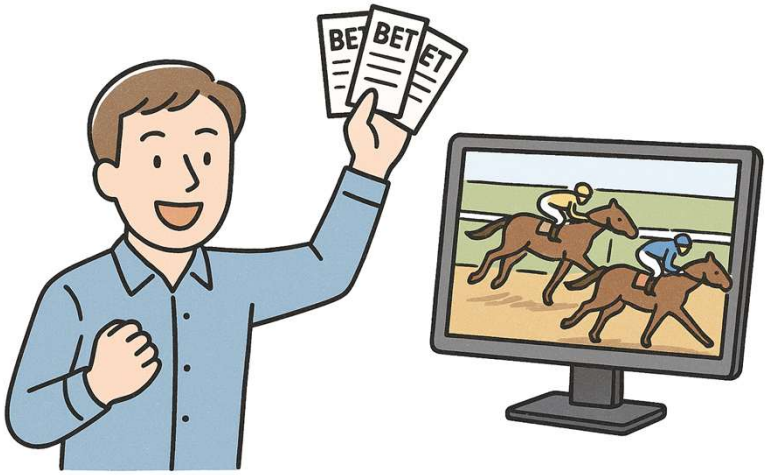
Data set (2): Socioeconomic background

- Administrative registry data on Finnish citizens, aged 15 and 70 (N = 4,414,248) from Statistics Finland
  - FOLK database
- Includes information on the individual's socioeconomic status (SES)
  - E.g. age, personal disposable income, marital status, educational attainment, employment, family relationship, place of residence



Data set (3): Horse betting market data

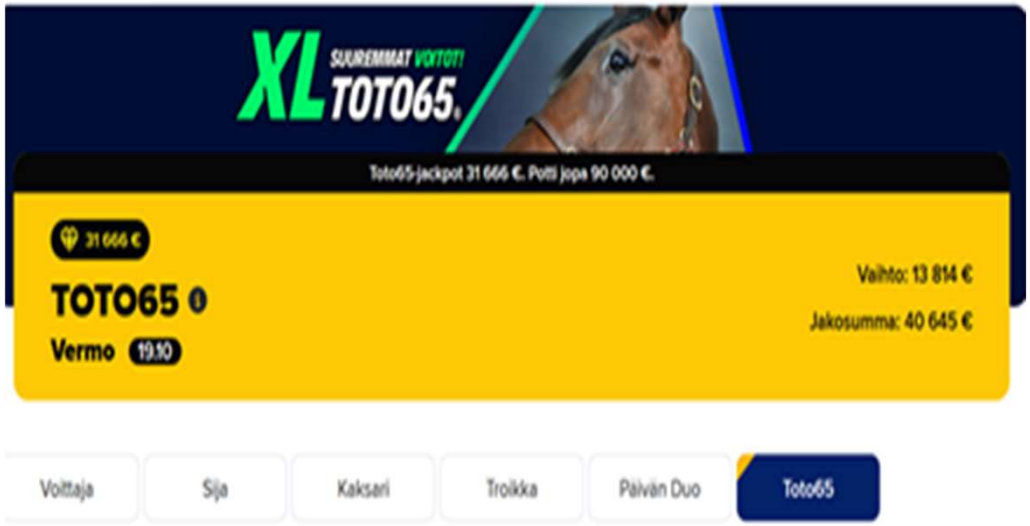
- Every online horse betting transaction by every bettor from the Finnish market over a one-year period (2015-2016)
  - A government-sanctioned monopoly operator
  - Wagers on Finnish and Swedish horse races
  - Parimutuel betting
- We focus on lottery-like betting products where the bettor picks winners of several races
  - Granular data
- Data on rollovers from the same period, hand-collected from the operator's online platform
- Daily panel data set (364 days)
- We use male bettors (N = 11,427) who wagered on lottery-like betting formats



Identification strategy

- Rollovers as a source of exogenous variation because they are random
  - The rules of lottery-like betting formats stipulate that if no one wins, the prize is rolled over to the next round of the game
- Effective price discounts resulting from the rollover money added to the prize pool
  - Occurred 119 times across five betting formats
- There are also endogenous price discount resulting from the operator's promotions in the form of bonus money added to the prize pool and a lowered takeout rate
  - We use dummy variables to control for their effects
- In our empirical context, rollovers (and other price discounts) were saliently displayed at the online betting platform and in the betting company's advertising
  - This mitigates other concerns that salience (Bordalo et al., 2013; 2022) or search costs (Stigler, 1961) might influence consumer choice

Examples of how consumers are informed about rollovers



Black box with a diamond indicates the amount of rollover money (€31,666) added to the pool of Toto65 product

The advert informs that the amount of rollover money distributed to the winner(s) in Toto75 product in a racing event in Årjäng, Sweden, is €2,430,025

Methodology

- Panel data probit (extensive margin) / OLS (intesive margin) models:

$$DV_{i,t} = \beta_{i,0} + \beta_1 FV_{i,t} + \beta_2 IQ_i + \beta_3 FV \times IQ_i + \sum_j \beta_j OtherFormats_{i,t} + \sum_k \beta_k DayOfWeek_{i,t} + \sum_l \beta_l Month_{i,t} + \sum_m \beta_m SpecialEvents_{i,t} + \sum_n \beta_n SES_i + u_{i,t}. \quad (1)$$

  - DV: Participation (dummy) or spending (log euros) on a lottery-like betting format (T64, T65, T75, T76, T86)
  - FV: Rollover in a lottery-like betting format in log euros, i.e. : ln(rollover+1)
  - IQ: Standaridzed IQ (M=0, SD = 1)
  - Other formats: dummy variables for rollovers in other lottery-like betting formats or the operator's other promotions (bonus money, reduced takeout rate)
  - SES: Control variables for the individual's socioeconomic status
  - DayOfWeek, Month, SpecialEvents: Control variables for daily and monthly variation in betting volume and special racing events

Descriptive statistics

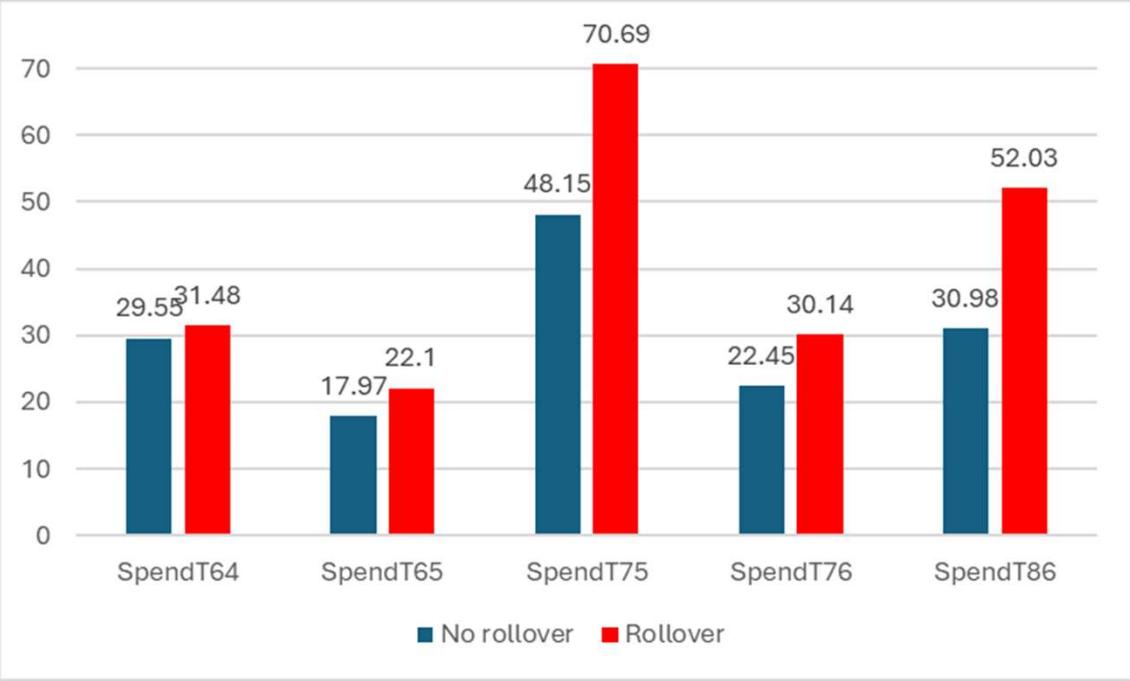
- Descriptive statistics of DVs (PartTxx indicating participation; SpendTxx indicating spending (€), FVs (RoTxx indicating the amount rolled over (€)), and standardised IQ

Dependent variables	Mean	Median	SD
PartT64	.020	0	.139
PartT65	.022	0	.147
PartT75	.011	0	.105
PartT76	.021	0	.143
PartT86	.001	0	.034
SpendT64	29.12	9.60	197.28
SpendT65	18.48	10.80	36.56
SpendT75	51.11	14.05	553.99
SpendT76	24.27	13.50	85.24
SpendT86	42.18	13.14	251.10

Focus variables	Mean	Median	SD
IQ	.079	.131	.953
RoT64	164,000	132,000	226,000
RoT65	76,324.7	82,817	26,050.05
RoT75	2 038,732	2 230,000	1 100,000
RoT76	152,000	127,945	86,445.66
RoT86	584,000	616,325	131,000

Model-free evidence

- Consumers in the horse wagering market respond to price discounts
- Bettors increase their spending on lottery like products if there is a rollover prize available
- Relative increases in spending vary from 7% (T64) to 68% (T86)
- The analysis based on raw means is consistent with neoclassical microeconomic theory



Extensive margin: Probit estimates

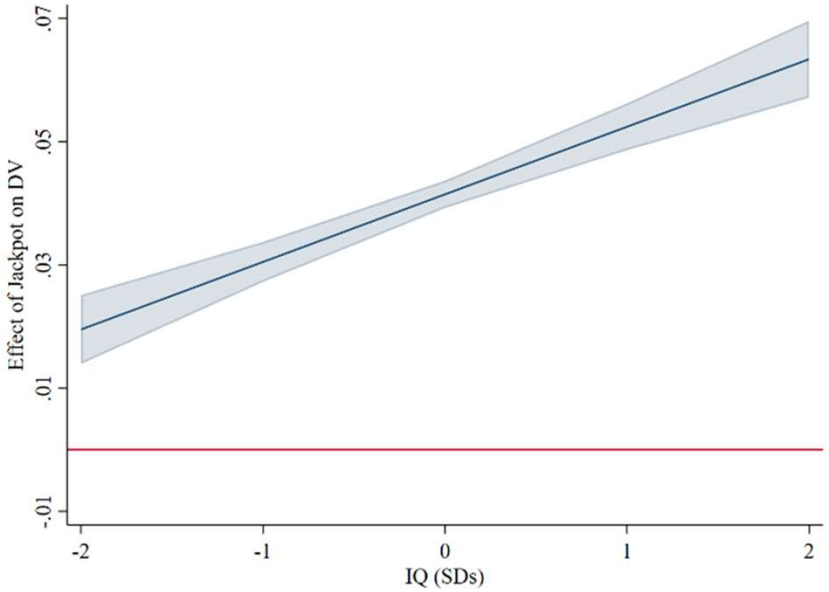
	PartT64	PartT65	PartT75	PartT76	PartT86
Focus variables					
IQ	0.0028^{***}	0.0015^{***}	0.0009^{***}	0.0007^{***}	-6.7×10^{-7}
	(0.0005)	(0.0003)	(0.0002)	(0.0002)	(2.14×10^{-5})
LnRoT64	0.0011^{***}				
	(3.23×10^{-5})				
LnRoT64 × IQ	0.0003^{***}				
	(4.27×10^{-5})				
LnRoT65		0.0036^{***}			
		(6.93×10^{-5})			
LnRoT65 × IQ		0.0012^{***}			
		(0.0001)			
LnRoT75			0.0019^{***}		
			(4.72×10^{-5})		
LnRoT75 × IQ			0.0009^{***}		
			(0.0001)		
LnRoT76				0.0026^{***}	
				(0.0001)	
LnRoT76 × IQ				0.0013^{***}	
				(0.0002)	
LnRoT86					0.0031^{***}
					(0.0001)
LnRoT86 × IQ					0.0008^{***}
					(0.0001)

Intensive margin: OLS estimates

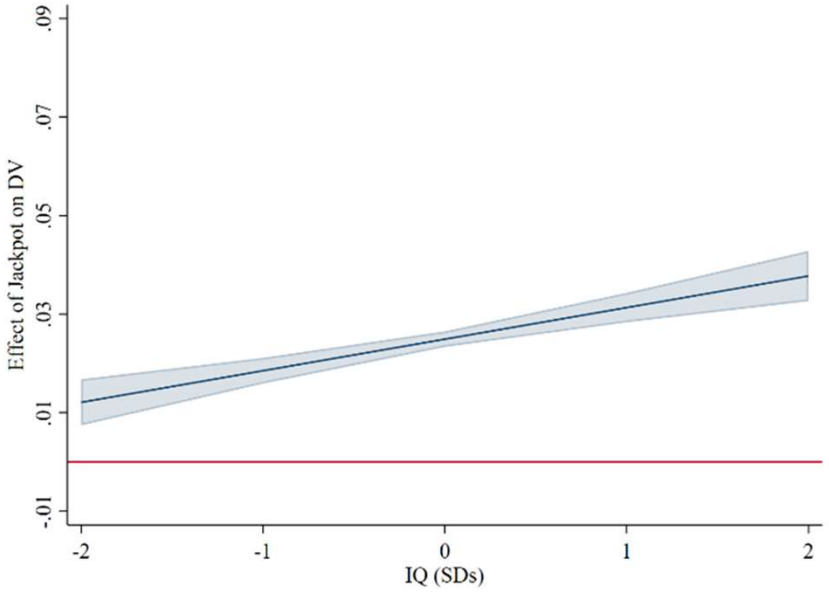
	(1) LnSpendT64	(2) LnSpendT65	(3) LnSpendT75	(4) LnSpendT76	(5) LnSpendT86
Focus variables					
IQ	0.0383***	0.0211***	0.0175***	0.0226***	0.0011*
	(0.0087)	(0.0031)	(0.0037)	(0.0037)	(0.0005)
LnRoT64	0.0249***				
	(0.0008)				
LnRoT64 × IQ	0.0064***				
	(0.0012)				
LnRoT65		0.0298***			
		(0.0008)			
LnRoT65 × IQ		0.0054***			
		(0.0012)			
LnRoT75			0.0248***		
			(0.0007)		
LnRoT75 × IQ			0.0096***		
			(0.0012)		
LnRoT76				0.0107***	
				(0.0009)	
LnRoT76 × IQ				0.0065***	
				(0.0012)	
LnRoT86					0.0519***
					(0.0015)
LnRoT86 × IQ					0.0100***
					(0.0018)

Marginal effects and 95% CIs at the extensive and intensive margin

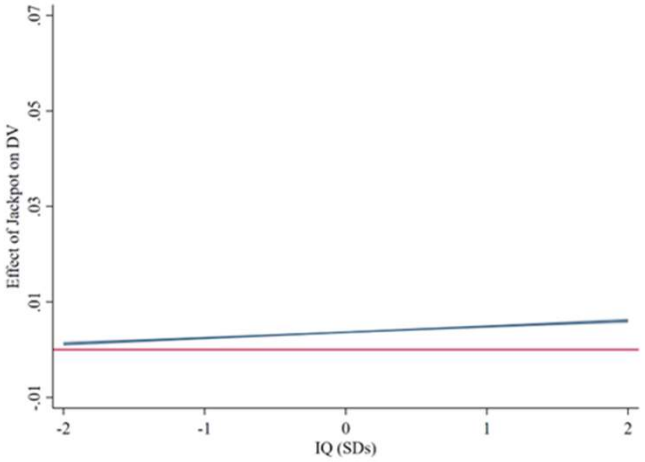
- Marginal effects of rollovers on participation and spending evaluated at different values of IQ indicate that higher IQ predicts a positive response to price discounts



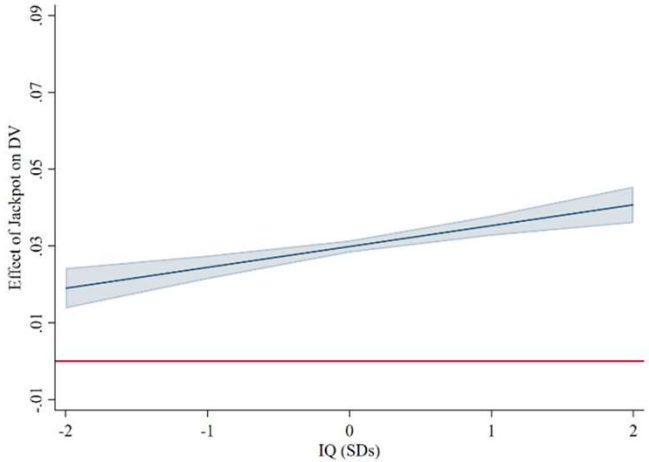
Panel (1a) Participation in T64



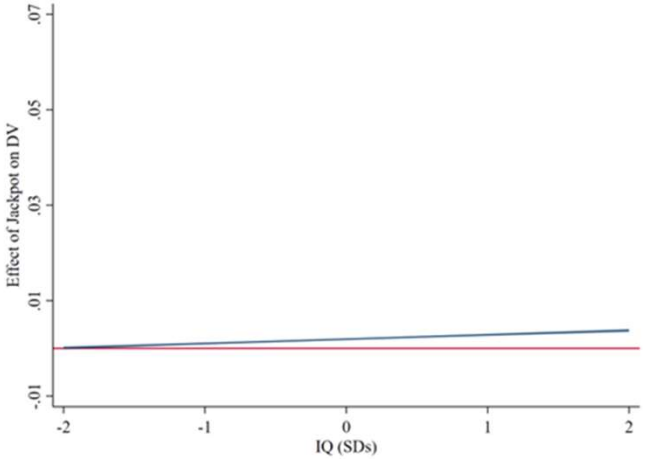
Panel (1b) Spending on T64



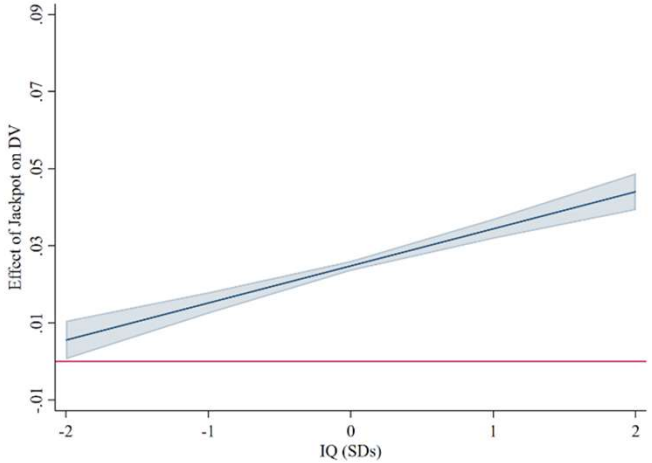
Panel (2a) Participation in T65



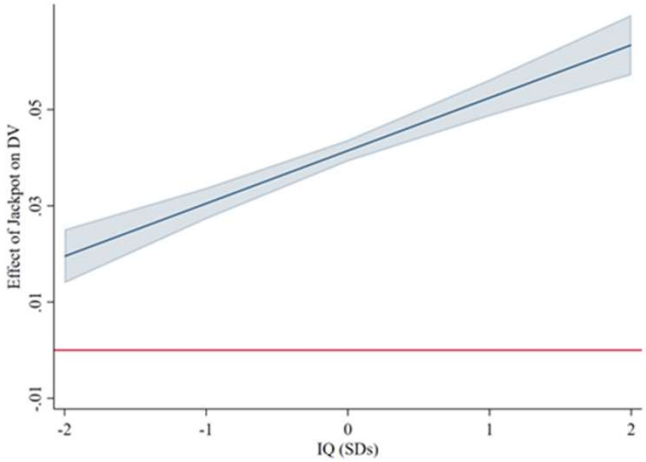
Panel (2b) Spending on T65



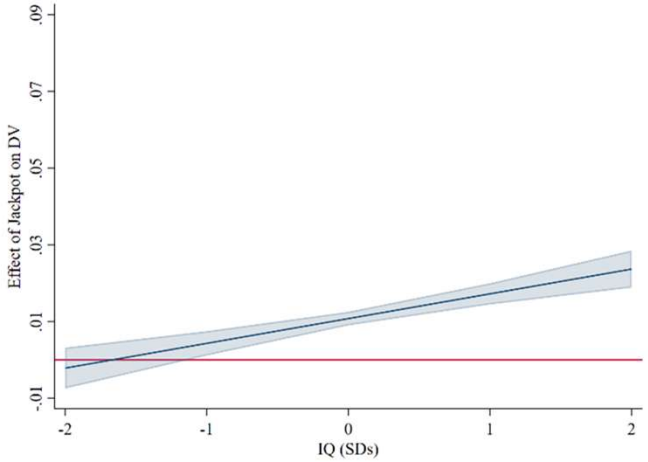
Panel (3a) Participation in T75



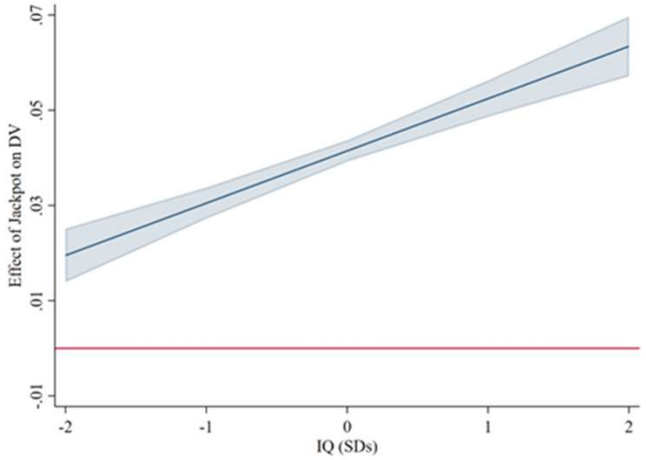
Panel (3b) Spending on T75



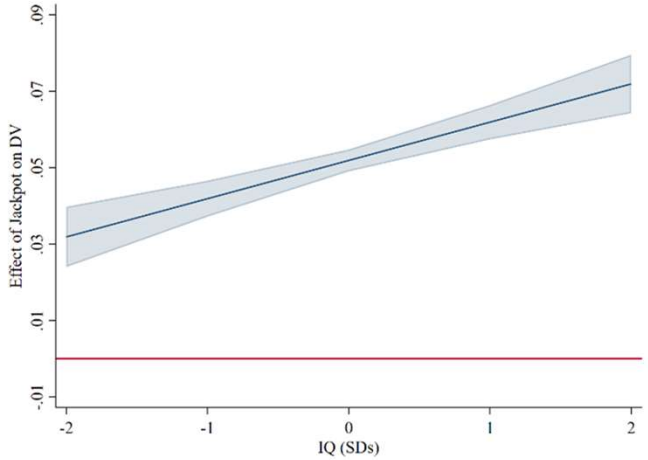
Panel (4a) Participation in T76



Panel (4b) Spending on T76



Panel (5a) Participation in T86



Panel (5b) Spending on T86

Effect sizes

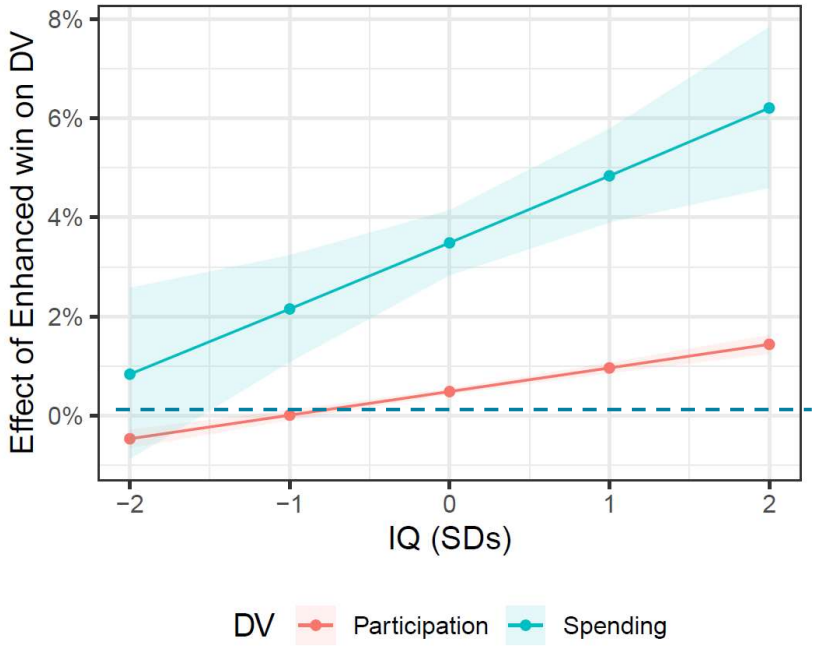
- The effect size of the mean rollover in each product category shows that higher IQ individuals increase their participation and spending in a substantial manner

	Participation (in percentage points)					Spending (in percent)				
IQ	-2	-1	0	1	2	-2	-1	0	1	2
T64	0.60	0.96	1.32	1.68	2.04	15.64	24.87	34.85	45.62	57.25
T65	1.35	2.70	4.05	5.51	6.86	23.81	31.56	39.80	48.72	58.02
T75	0.15	1.45	2.76	4.07	5.38	8.32	24.53	43.37	64.83	79.84
T76	0.00	1.55	3.10	4.77	6.32	-2.59	5.26	13.62	22.78	32.68
T86	1.99	3.05	4.12	5.31	6.37	52.74	74.43	99.19	127.48	159.78

Notes: The mean values of rollovers in each betting product obtained from Table 1. Background colours indicate statistical significance at 0.1% level (dark grey), 1 % level (medium grey), 5% level (light grey), and no statistical significance (white).

Additional analysis: all effective price reductions in all betting formats

- Figure depicts MEs on participation in any betting format on a day (turquoise line) and on aggregate spending on all betting formats per day (red line)
- N = 15,488 male bettors
- Price reductions include any price discounts available on a day, including rollovers, a reduced take-out rate, and the operator's promotions in the form of bonus money
- We used dummy variables for price discounts due to data limitations
- Results are consistent with the baseline model, confirming the finding that IQ moderates the individual's response to price discounts



Conclusion

- Since high IQ individuals respond more strongly to price reductions at both extensive and intensive margins, we cannot reject H1 and H2
- As a theoretical contribution, our findings integrate insights from the neoclassical microeconomic theory of consumer behaviour with bounded rationality (Simon, 1955) to explain variation in consumer responses to price changes
- Thus, the cost of taking decisions is lower for those with higher capacity, which allows them to find solutions to decision problems that are closer to those regarded as optimal (Conlisk, 1996)
- Our results are consistent with prior empirical literature, which indicates that cognitive ability is positively associated with decisions that are economically beneficial to the individual (e.g., Grinblatt et al., 2011; 2016; 2016; Agarwal and Mazumder, 2013; Aspara and Wittkowski, 2017; D'Acunto et al., 2023)

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