KU LEUVEN

DEPARTMENT OF ECONOMICS

Do heuristics matter for financial literacy? The impact of better heuristics awareness to financial literacy.

Francisco Pitthan, Kristof De Witte

FACULTY OF ECONOMICS AND BUSINESS



DISCUSSION PAPER SERIES DPS 24.10

July 2024

Do heuristics matter for financial literacy? The impact of better heuristics awareness to financial literacy.*

Francisco Pitthan[a,*], Kristof De Witte[a,b]

[a] *Leuven Economics of Education Research, Faculty of Economics and Business, KU Leuven*
[b] *UNU-Merit, Maastricht University*

Abstract

Policymakers are increasingly focused on improving citizens' financial well-being through better financial literacy. Traditional strategies emphasize financial education to boost financial knowledge, while recently behavioural-based education focus on issues like behavioural biases and emotional influences. This paper suggests a randomized controlled-study to assess if financial education including lessons on heuristics (availability and gambler's fallacy) enhances financial literacy. Results showed that traditional financial education significantly improved financial literacy, while adding heuristics had effect close to zero. This suggests expanding curricula to address rules-of-thumb may not necessarily improve financial literacy, challenging the notion that more complex financial education is always beneficial.

Keywords: Financial literacy, Financial education, Behavioural finance, Availability heuristics, Gambler's fallacy, Decision support systems

*This work was supported by the Research Foundation Flanders (FWO) (through fundamental research fellowship under grant 11K4621N), and by the 'Baloise Insurance Research chair to financial well-being'. Kristof De Witte acknowledges financial support from the Horizon Europe project EFFEct (grant 101129146). Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them. This experiment was registered in the American Economic Association's registry for randomized controlled trials on September 30, 2021 (AEA-0007956).

*Corresponding author.
Email addresses: francisco.donascimentopitthan@kuleuven.be (Francisco Pitthan), kristof.dewitte@kuleuven.be (Kristof De Witte)

1. Introduction

Insufficient financial literacy renders individuals susceptible to make poor financial choices, resulting in adverse consequences, including an accumulation of excessive debt, bankruptcy, and financial instability, perpetuating the cycle of poverty by the absence of knowledge and aptitude required to effectively manage personal finances (Mitchell and Lusardi, 2015). In the absence of financial literacy, individuals may become susceptible to exploitative lending practices, high-interest loans, and fraud, thereby trapping them in a recurring pattern of indebtedness and restraining their financial autonomy (Khan, Siddiqui, and Imtiaz, 2022). By lacking the proper financial knowledge in a realm of complex and in-numerous financial instruments, consumers rely on heuristics or rules of thumb, which are mental shortcuts that help them make fast financial decisions, but can also result in errors (Bernheim, 1995; Lusardi and Mitchell, 2014). However, given the increasing complexity of financial products and the amplified attention to provide costumers all relevant information, it becomes fundamental to find effective methods to improve financial literacy and to examine whether pointing individuals to heuristics changes their financial literacy (Lusardi, 2019; Shefrin and Nicols, 2014).

Financial education has emerged as the most effective approach thus far in enhancing financial literacy. Extensive research indicates its positive impact on financial knowledge, and to a lesser extent, on financial behavior, facilitating financial inclusion (Atkinson and Messy, 2013; Kaiser, Lusardi, Menkhoff, and Urban, 2022). However, the long-term effects of financial education on financial outcomes and overall well-being remain uncertain. Existing findings are inconclusive and lack sufficient evidence to establish causal relationships (Kaiser, Lusardi, Menkhoff, and Urban, 2022; Willis, 2011), except for recent evidence from Germany and Brazil (Bruhn, Garber, Koyama, and Zia, 2022; Sutter, Weyland, Untertrifaller, Froitzheim, and Schneider, 2023). While alternative interventions like financial advisory services have been proposed, their effectiveness is mixed, and empirical evidence is scarce (Chalmers and Reuter, 2020). A major policy concern is related on which content should be included in financial education curricula to improve the financial competences of the youth, especially considering complex themes such as sustainable finance and investments (European Union/OECD, 2023).

Recent advancements in the literature highlight the significant role of behavioral and cognitive factors in shaping financial literacy and decision-making processes (Compen, Pitthan, Schelfhout, and De Witte, 2022; Jonsson, Söderberg, and Wilhelmsson, 2017; Pitthan and De Witte, 2021). Building upon this understanding, behavioral-based financial education programs, i.e. when financial education also teaches *how* to make good financial decision and about *which factors* could be in the way to make good decisions, show that learning about biases can improve financial literacy (Pitthan and De Witte, 2023). Although often centred in behavioural or cognitive biases, it is important to acknowledge that other factors, such as heuristics, can also lead to suboptimal outcomes. Heuristics serve as simplifications of reality that facilitate decision-making in complex

scenarios (Tversky and Kahneman, 1973). However, there is ambivalence regarding the usefulness of heuristics in decision-making processes. Although heuristics can streamline decision-making, they may lead to inconsistent behavior when evaluated under von Neumann-Morgenstern utility functions (Gigerenzer and Gaissmaier, 2011; Tversky, 1996). While fast and frugal heuristics can be beneficial in complex situations with time constraints (Drexler, Fischer, and Schoar, 2014; Forbes, Hudson, Skerratt, and Soufian, 2015; OECD/INFE, 2019), they can prove considerably detrimental in financial decisions with long-term consequences, such as purchasing a house or choosing a pension plan (Dhami, Al-Nowaihi, and Sunstein, 2019; Quddus and Banerjee, 2021).

Given the increasing financial complexity, this paper examines the impact of financial education courses supplemented with heuristic materials on improving financial literacy. Moreover, it explores if education can counteract the negative influence of heuristics. To test this, we conducted a randomized controlled trial (RCT) with Belgian secondary school students. We compared traditional financial education materials to modified versions including content on the availability heuristic and the gambler's fallacy (Kahneman et al., 1971; Tversky and Kahneman, 1973). We assess whether the effect of behavioral-based financial education on financial literacy can be mediated by increased awareness of heuristic behavior. Contrary to assumptions, only traditional financial education courses improved financial literacy, while behavioral courses with heuristic content did not. We did not observe a similar indirect effect to financial literacy mediated by heuristics, as seen with the myopic bias (Pitthan and De Witte, 2023). These findings can be attributed to the dual nature of heuristics, which can both simplify reality and undermine decision-making in complex scenarios. Consequently, teaching about heuristics may not be the optimal delivery method, as it can potentially confuse students by emphasizing both the usefulness and the detrimental effects of heuristics on decision-making skills. This makes decisions more complex, since the simplifications from heuristics now are no longer unconscious, which worsens financial literacy outcomes.

2. Theory and methods

The literature presents causal frameworks that propose connections among financial education, financial literacy, and financial outcomes (Carpena and Zia, 2020; Pitthan and De Witte, 2023). Since heuristics can play a role on financial decisions (Strough, Karns, and Schlosnagle, 2011), we hypothesize that such causal frameworks could be augmented in order to also consider the role of heuristics in financial literacy and financial decisions. We propose the following mechanism: behavioural-based financial education courses that teach about heuristics would make individuals more aware of such rules of thumb. In turn, this could make them more conscious of their financial decisions, improving their financial literacy and financial outcomes.

Our hypothesized framework is shown in the Direct Acyclic Graph (DAG) of Figure 1.

The experiment is centred in financial education courses offered to secondary schools in the

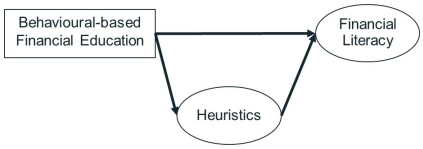

Figure 1. Direct acyclic graphs with estimated causal links of behavioural-based financial education mechanisms.

Dutch-speaking part of Belgium, with students aged between 14 and 19 years.[1] Although our target group has a restrictive sample of individuals, teenagers and young-adults are a perfect target group for financial education interventions, since they are already making daily financial-decisions and consuming financial products starting from a young age (OECD/PISA, 2020). Earlier research from Flanders shows indeed that findings in the studied age group of 14-19 years old provides reliable conclusions (De Beckker, De Witte, and Van Campenhout, 2021; Iterbeke, De Witte, Declercq, and Schelfhout, 2020; Iterbeke, De Witte, and Schelfhout, 2021). Moreover, starting financial education at an early age is fundamental to cultivate healthy financial habits that can otherwise be uncorrectable as adults (Whitebread and Bingham, 2013), having potential to bring improvements to the whole financial life of such individuals (Compen, De Witte, and Schelfhout, 2021). Finally, given the similarity in the findings from the OECD PISA studies, which measures financial literacy at age 15, and the OECD INFE studies, which measures financial litearcy among adults, the experimental findings from the study at hand are likely to be externally valid towards older age populations

The courses are in the format of computer-assisted games (i.e. based on an online interactive platform), covering the main financial literacy objectives from the Flemish curriculum. Students make financial decisions in close to real life examples, receiving feedback on their mistakes. Using a mix of text, interactive elements, games, and videos, students explore key financial concepts like investment and insurance. The curriculum brings them face-to-face with the kind of financial choices they'll encounter in real life, emphasizing the importance of budgeting, long-term planning, and coping with the risk and reward trade-off. The experiment has three different experimental arms, which were randomized at the school level to avoid contamination and peer effects. (i) A control group that does not receive any course until the end of the experiment. (ii) A treatment group that receives traditional financial education (TFE), i.e. a version of the game focusing only on financial knowledge concepts. (iii) A treatment group that receives heuristics financial education (HFE), i.e. a modified version of the game, including behavioural-based material about the heuristics of availability and gambler's fallacy, in addition to the core financial knowledge content of the previous treatment arm. The only absence of the material in the HFE course (when compared to the TFE course) were a couple of examples about financial products specific to the Belgian context (e.g. mandatory third-party risk insurance), which

[1]The experiment was conducted between September 2021 and January 2022.

have no direct relationship to the general questions used to estimate the financial literacy score about financial knowledge, attitude and behaviour. An overview of the treatment arms and corresponding course material interventions is seen in Table 1. Students in one experimental arm only follow the course from their respective treatment (if any).

All participants fill out both pre and post-tests, which include socioeconomic questions; financial literacy tests with questions inspired on OECD/INFE (2011); and heuristics tests, partially based on Camerer and Kunreuther (1989). An overview of a few examples seen in the course is given in Appendix A.The timeline of the experiment was divided as follows: (i) the course was built between May and August 2021; (ii) an open-call to interested schools was made in August 2021, with registration made until September 2021; (iii) schools completed pre-tests from September to mid October 2021; (iv) stratified randomization was made with eligible schools that completed pre-tests; (v) schools completed the course between October and December 2021; (vi) post-tests were filled after the completion of the course between November 2021 and January 2022. For ethical reasons, schools in the control condition were eligible to receive the course after the end of the examination and post-test period, so that no school was left behind.

Table 1. Schematic representation of the experimental conditions

	Control	**Treat. Tradit. Fin. Educ.**	**Treat. Heurist. Fin. Educ.**
Traditional financial education course about insurance, pensions and investments	No	Yes	Yes
Heuristics-based materials about Availability and Gambler's Fallacy	No	No	Yes

We estimate the average treatment effects (ATE) and average direct effect (ADE) of our treatment variables (i.e. receiving either the TFE or HFE courses) to our main outcome variable (i.e. financial literacy) and to our mediating variable (i.e. better heuristics awareness) using OLS estimates, clustering standard errors by school. The treatments are constructed as two dummy variables, with a value of 1 assigned to indicate if participated in a certain treatment, while utilizing the control group as the baseline when both dummy variables are set to 0. The causal mediation analysis follows the approach of Imai, Keele, and Tingley (2010), in order to estimate average causal mediated effects (ACME).[2] The ATE and ADE are identified by the statistical independence of the treatment status with both the mediation and outcome variables, which is given by the random attribution of treatments from our RCT design. The statistical independence of the mediation and outcome variables (that identifies the ACME) is indirectly tested by sensitivity analysis and proxy tests for endogeneity.

[2]For similar causal mediation applications in the financial education literature, see Carpena and Zia (2020) and Pitthan and De Witte (2023).

3. Results

Table 2 shows the ATEs for the main variables of our study, financial literacy and heuristics scores. Although the treatment achieved full compliance following exogenous allocation, we still observe sample imbalance due to attrition in the post-tests. To address this issue, we use both Mahalanobis distance matching (MDM) and Lee (2009)'s bounds techniques, in addition to controlling for any balancing differences.[3] The set of controlling variables is seen in Appendix B, in which, among others, relevant family-related factors and background characteristics are included, such as language spoken at home, socioeconomic status questions, family composition, and family education. In Panel A, we observe that all ATEs to financial literacy are positive, although only the traditional financial education has a significant effect of 0.36 standard deviations (sd).

One possibility is that the inclusion of heuristics education may make decision-making more complex, provoking heuristics to become conscious and acting as a distraction for students in relation to the main financial literacy outcomes. Alternatively, it is plausible that the explanation of heuristics could cause confusion among students as they become suddenly aware of the complexity involved in making decisions. Besides, we note in Appendix B that the financial literacy pre-test score of students that participated in the heuristics education treatment is significantly higher in comparison to the other treatment arms. Although we control for this difference in the analysis, we do not exclude the hypothesis that this could undermine the total effect of the course.

From Panel B, we observe that students in the traditional financial education treatment experienced a significant increase in their heuristics behaviour by 0.93 sd when compared to the control group.[4] The observed effect size is notably substantial and may be associated with the hypothesis that improving financial literacy in the absence of exposure to heuristics could lead students to develop increased confidence in their decision-making, thereby exhibiting a greater inclination towards relying on heuristics. In the case of heuristics education as the treatment, the ATE remains positive, although it is not statistically significant.

In Table 3, we directly examine the hypothesis presented in Figure 1, which explores whether education that enhances awareness of heuristics can lead to an indirect improvement in financial literacy. Our findings indicate that we have evidence to reject this hypothesis. Neither of the two treatments exhibited a significant average causal mediation effect (ACME) in enhancing financial literacy scores, although the ACME is positive for the heuristics education treatment. Notably, the ACME for the traditional financial education case is even negative, although it is not statistically significant. This observation may be associated with the notable rise in heuristics-based

[3] A post-hoc power analysis found a minimum detectable effect-size of 0.31, considering a power of 80%, sample of 427, significance level of 5%, 42 clusters and the estimated intraclass correlation of clusters of 0.01. An overview about the data and sample is seen in Appendix B.

[4] From Appendix C, this seems to be driven mostly by the availability heuristics type of behaviour.

Table 2. Estimated ATEs and Lee bounds of main variables.

Specification	Mahalanobis Matching	Lower Bound	Upper Bound	Trimming proportion
Panel A: Financial literacy post-test score as outcome				
Treat. Trad. Fin. Educ.	0.359**	-0.311	0.697	22.3%
	(0.138)	$[-0.580, -0.042]$	$[0.414, 0.980]$	
Treat. Heuristics Educ.	0.127	-0.329	0.220	11.6%
	(0.151)	$[-0.592, -0.070]$	$[-0.059, 0.499]$	
N	427			
R^2	0.364			
F	76.37			
Panel B: Heuristics post-test score as outcome				
Treat. Trad. Fin. Educ.	0.931**	-0.406	0.963	22.3%
	(0.297)	$[-0.785, -0.028]$	$[0.537, 1.388]$	
Treat. Heuristics Educ.	0.363	-0.778	0.313	11.6%
	(0.224)	$[-1.221, -0.334]$	$[-0.071, 0.696]$	
N	427			
R^2	0.168			
F	147.1			

Note: Lower and upper bounds coefficients are the Lee (2009)'s bounds estimations for the required trimming rate in comparison with control conditions. Treatments are constructed as dummy variables, indicating 1 if followed a certain treatment, and 0 otherwise. Numbers in brackets are the 95% confidence intervals. The Mahalanobis Distance Matching estimated coefficients are in terms of standard deviations of the outcome variable. Clustered standard errors in parentheses. * p ≤ .05 ** p ≤ .01 *** p ≤ .001. Estimation controls for all pre-test observed characteristics presented at Appendix B.

behavior observed in Table 2. Furthermore, both the average direct effect (ADE) and the average treatment effect (ATE) are only statistically significant for the traditional financial education case, aligning with the findings presented in Table 2. To provide further support, Appendix C replicates the results of both tables for each of the two individual heuristics (availability and gambler's fallacy). Additionally, Appendix D discusses the sensitivity analysis and endogeneity tests conducted to assess the robustness of our mediation analysis.

Table 3. Mediation analysis for financial literacy post-test as outcome with effect mediated by heuristics.

	Treatment Trad. Fin. Educ.	Treatment Heuristics Educ.
Average Causal Mediated Effect (ACME)	-0.009	0.008
	(0.020)	(0.013)
Average Direct Effect (ADE)	0.476***	0.132
	(0.150)	(0.116)
Average Treatment Effect (ATE)	0.466***	0.140
	(0.136)	(0.116)
% of ATE Mediated	−2.00%	3.92%
N	249	283
R^2	0.356	0.300
F	166.21	21.86

Note: The results show direct and indirect effects estimated by mediation analysis using the algorithm proposed by Imai, Keele, and Tingley (2010). Standard errors obtained by quasi-Bayesian Monte Carlo simulations. * p ≤ .05 ** p ≤ .01 *** p ≤ .001. Estimation controls for all pre-test observed characteristics presented at Table 2.

4. Discussion

In this paper, we examined the potential role of heuristics in enhancing financial literacy. To investigate this, we conducted a randomized controlled trial in Belgium involving 427 secondary school students. The results revealed that students who participated in traditional financial education courses experienced a significant improvement in their financial literacy scores. However,

this improvement was not observed among students who received instruction on heuristics. Additionally, our mediation analysis indicated that increased awareness of heuristics does not serve as a significant mediator in improving financial literacy.

The findings presented in Panel A of Table 2 demonstrate that the incorporation of heuristics content rendered financial education ineffective in improving financial literacy. This provides evidence of the dual nature of heuristics' influence on financial decision-making. On the one hand, heuristics can be beneficial by simplifying complex situations. On the other hand, they can be detrimental by making individuals more prone to making mistakes. In essence, teaching about heuristics can be too complicated for students, leaving them uncertain about the benefits and drawbacks, while potentially diverting their attention away from the main course content, causing information loading when too much information is present (Huang, Hsu, and Ku, 2012). The results presented in Panel B of Table 2 indicate that traditional financial education may contribute to an increase in heuristics-based behavior among students. This may be attributed to the confidence gained from the course. However, despite this shift in behavior, it does not appear to have a negative impact on students' financial literacy, as evidenced by the absence of any mediation effect of heuristics, as shown in Table 3.

One lingering question remains: why does the improved awareness of heuristics not have a statistically significant indirect effect on enhancing financial literacy, unlike the positive impact observed with the learning of behavioral biases such as myopia (Pitthan and De Witte, 2023)? First, heuristics should not be viewed solely as a negative influence on financial decisions. This is especially evident when individuals are faced with time constraints, as heuristics can offer a practical solution. Second, some behavioural biases like myopia can have a more direct link to low financial literacy (e.g. short-term preference), which is not always seen in the case of heuristics. Finally, the realization of exactly when heuristics are useful or dangerous might be more beneficial to individuals, instead of better awareness to different types of heuristic behaviour.

In terms of policy implications, our findings suggest that the inclusion of heuristics in financial education programs may not be advisable, as it appears to diminish the effectiveness of such courses, making decisions more complex than they should be. Although recent national strategies (US Treasury, 2020) are built given a very complex financial system, the answer to effective education programs is not to make decisions more difficult than they should be. Furthermore, considering the dual nature of heuristics, policies aimed at mitigating their negative effects should prioritize interactive approaches, such as "learning by doing," rather than traditional teaching methods. By engaging in practical exercises and experiencing firsthand both the advantages and disadvantages of heuristics, individuals can develop a more comprehensive understanding of their implications.

Our analysis has some limitations. First, the limited sample size resulted in a power that was small. Second, although we tested our hypothesis with both the availability and gambler's fallacy

heuristics, many other heuristics were not analysed (e.g. framing effect, affection, representativeness), which might have a similar or different effect, depending on how closely linked with financial literacy they are. Third, the analysis was realized in a time span of 4 months, which does not allow to draw conclusions about long lasting outcomes of financial education courses. Finally, the hypothesis of causal mediation analysis are not directly testable, although they were still indirectly tested here with proxy measures and sensitivity analysis. Future research should focus on these aspects by conducting experiments across various locations, employing diverse heuristics and biases, and extending the observational period to assess long-term financial outcomes and well-being. Additionally, it is valuable to analyse the implications of our findings on behavioural and heuristics-based financial education in other contexts, such as mindful household energy decisions and the heterogeneity in households' risk sensitivity, as these factors may lead to different results (Korkmaz, Yin, Yue, and Zhou, 2021; Ye and Yue, 2023).

References

Atkinson, A., & Messy, F. A. (2013). Promoting financial inclusion through financial education. oecd/infe evidence, policies and practice [Unpublished. OECD Working Paper series].

Bernheim, D. (1995). Do households appreciate their financial vulnerabilities? an analysis of actions, perceptions, and public policy. *Tax policy and economic growth*, *3*, 11–13.

Bruhn, M., Garber, G., Koyama, S., & Zia, B. (2022). The long-term impact of high school financial education [Unpublished. Banco Central do Brazil & World Bank Working Paper Series].

Camerer, C. F., & Kunreuther, H. (1989). Decision processes for low probability events: Policy implications. *Journal of policy analysis and management*, *8*(4), 565–592.

Carpena, F., & Zia, B. (2020). The causal mechanism of financial education: Evidence from mediation analysis. *Journal of Economic Behavior & Organization*, *177*, 143–184.

Chalmers, J., & Reuter, J. (2020). Is conflicted investment advice better than no advice? *Journal of Financial Economics*, *138*(2), 366–387.

Compen, B., De Witte, K., & Schelfhout, W. (2021). The impact of teacher engagement in an interactive webinar series on the effectiveness of financial literacy education. *British Journal of Educational Technology*, *52*(1), 411–425.

Compen, B., Pitthan, F., Schelfhout, W., & De Witte, K. (2022). How to elicit and cease herding behaviour? on the effectiveness of a warning message as a debiasing decision support system. *Decision support systems*, *152*, 113652.

De Beckker, K., De Witte, K., & Van Campenhout, G. (2021). The effect of financial education on students' consumer choices: Evidence from a randomized experiment. *Journal of Economic Behavior & Organization*, *188*, 962–976.

Dhami, S., Al-Nowaihi, A., & Sunstein, C. R. (2019). Heuristics and public policy: Decision-making under bounded rationality. *Studies in Microeconomics*, *7*(1), 7–58.

Drexler, A., Fischer, G., & Schoar, A. (2014). Keeping it simple: Financial literacy and rules of thumb. *American Economic Journal: Applied Economics*, *6*(2), 1–31.

European Union/OECD, C. (2023). *Financial competence framework for children and youth in the european union*. EU Commission & OECD Publishing.

Forbes, W., Hudson, R., Skerratt, L., & Soufian, M. (2015). Which heuristics can aid financial-decision-making? *International review of Financial analysis*, *42*, 199–210.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual review of psychology*, *62*, 451–482.

Huang, H.-H., Hsu, J. S.-C., & Ku, C.-Y. (2012). Understanding the role of computer-mediated counter-argument in countering confirmation bias. *Decision Support Systems*, *53*(3), 438–447.

Imai, K., Keele, L., & Tingley, D. (2010). A general approach to causal mediation analysis. *Psychological methods*, *15*(4), 309.

Iterbeke, K., De Witte, K., Declercq, K., & Schelfhout, W. (2020). The effect of ability matching and differentiated instruction in financial literacy education. evidence from two randomised control trials. *Economics of Education Review*, *78*, 101949.

Iterbeke, K., De Witte, K., & Schelfhout, W. (2021). The effects of computer-assisted adaptive instruction and elaborated feedback on learning outcomes. a randomized control trial. *Computers in Human Behavior*, *120*, 106666.

Jonsson, S., Söderberg, I.-L., & Wilhelmsson, M. (2017). An investigation of the impact of financial literacy, risk attitude, and saving motives on the attenuation of mutual fund investors' disposition bias. *Managerial Finance*, *43*(3), 282–298.

Kahneman, D., et al. (1971). Belief in the law of small numbers. *Psychological bulletin*, *76*(2).

Kaiser, T., Lusardi, A., Menkhoff, L., & Urban, C. (2022). Financial education affects financial knowledge and downstream behaviors. *Journal of Financial Economics*, *145*(2).

Khan, F., Siddiqui, M. A., & Imtiaz, S. (2022). Role of financial literacy in achieving financial inclusion: A review, synthesis and research agenda. *Cogent Business & Management*, *9*(1), 2034236.

Korkmaz, A. G., Yin, Z., Yue, P., & Zhou, H. (2021). Does financial literacy alleviate risk attitude and risk behavior inconsistency? *International Review of Economics & Finance*, *74*, 293–310.

Lee, D. S. (2009). Training, wages, and sample selection: Estimating sharp bounds on treatment effects. *The Review of Economic Studies*, *76*(3), 1071–1102.

Lusardi, A. (2019). Financial literacy and the need for financial education: Evidence and implications. *Swiss Journal of Economics and Statistics*, *155*(1), 1–8.

Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *American Economic Journal: Journal of Economic Literature*, *52*(1), 5–44.

Mitchell, O. S., & Lusardi, A. (2015). Financial literacy and economic outcomes: Evidence and policy implications. *The journal of retirement*, *3*(1), 107–114.

OECD/INFE. (2011). *Measuring financial literacy: Core questionnaire in measuring financial literacy: Questionnaire and guidance notes for conducting an internationally comparable survey of financial literacy*. OECD Publishing, Paris.

OECD/INFE. (2019). *Tools and ethics for applied behavioural insights: The basic toolkit*. OECD Publishing, Paris.

OECD/PISA. (2020). *Results (volume iv): Are students smart about money?* PISA, OECD Publishing, Paris.

Pitthan, F., & De Witte, K. (2021). Puzzles of insurance demand and its biases: A survey on the role of behavioural biases and financial literacy on insurance demand. *Journal of Behavioral and Experimental Finance*, *30*, 100471.

Pitthan, F., & De Witte, K. (2023). How learning about behavioural biases improves financial literacy [Unpublished. G53 Network Working Paper series].

Quddus, K., & Banerjee, A. (2021). Understanding heuristics-based financial decision-making using behavioral portfolio strategies. *Review of Behavioral Finance*.

Shefrin, H., & Nicols, C. M. (2014). Credit card behavior, financial styles, and heuristics. *Journal of Business Research*, *67*(8), 1679–1687.

Strough, J., Karns, T. E., & Schlosnagle, L. (2011). Decision-making heuristics and biases across the life span. *Annals of the New York Academy of Sciences*, *1235*(1), 57–74.

Sutter, M., Weyland, M., Untertrifaller, A., Froitzheim, M., & Schneider, S. O. (2023). Financial literacy, experimental preference measures and field behavior–a randomized educational intervention [Unpublished. IZA Working Paper Series].

Tversky, A. (1996). On the reality of cognitive illusions. *Psychological Review*, *103*(3), 582–591.

Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive psychology*, *5*(2), 207–232.

US Treasury, D. o. (2020). *U.s. national strategy for financial literacy*. US Financial Literacy & Education Commission, Washington, DC.

Whitebread, D., & Bingham, S. (2013). Habit formation and learning in young children. *London: Money Advice Service*.

Willis, L. E. (2011). The financial education fallacy. *American Economic Review*, *101*(3).

Ye, X., & Yue, P. (2023). Financial literacy and household energy efficiency: An analysis of credit market and supply chain. *Finance Research Letters*, *52*, 103563.

Appendix A. Course material examples

This section shows some examples of what students learned in the financial education courses. Figure A.1 shows a small explanation to a type of compulsory insurance available in Belgium, which is part of the traditional financial education course. Similar topics were covered in both versions of the courses. After introduction on topics related to insurance, pensions, investment and so forth, students are asked questions and apply such knowledge in interactive games with close to real life situations. Students get feedback on their answers and can review articles or videos if they are unsure. Other topics are also covered, such as travel and health insurance; how to estimate and save for retirement; and different types of investment products.

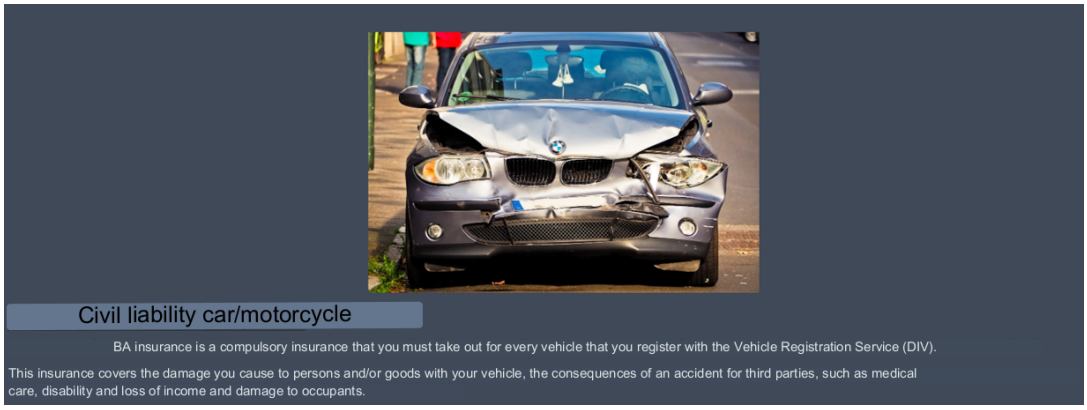

Figure A.1. Example of traditional course.

Figure A.2 and Figure A.3 show examples only available in the heuristics financial education courses. Although the heuristics course also covered similar topics to the traditional financial education program, it also coverred exclusive content related to what heuristics are, and how they can affect our decision making. Figure A.2 gives an heuristics-inducing example, in which students might incur in heuristics behaviour (e.g. availability heuristics by thinking their next bike is more susceptible of being stolen a second time). In Figure A.3, students get a summary from previous examples about heuristics.

After learning about financial literacy related topics (for both courses) and heuristics (only for the heuristics course), students use their knowledge in portfolio choice investment games, and in a "game of life" type of simulation, in which students decide about investment and insurance products, and as they get older they receive the outcome of their choices. Students can then play the games a second time, using different choices in order to achieve a better outcome.

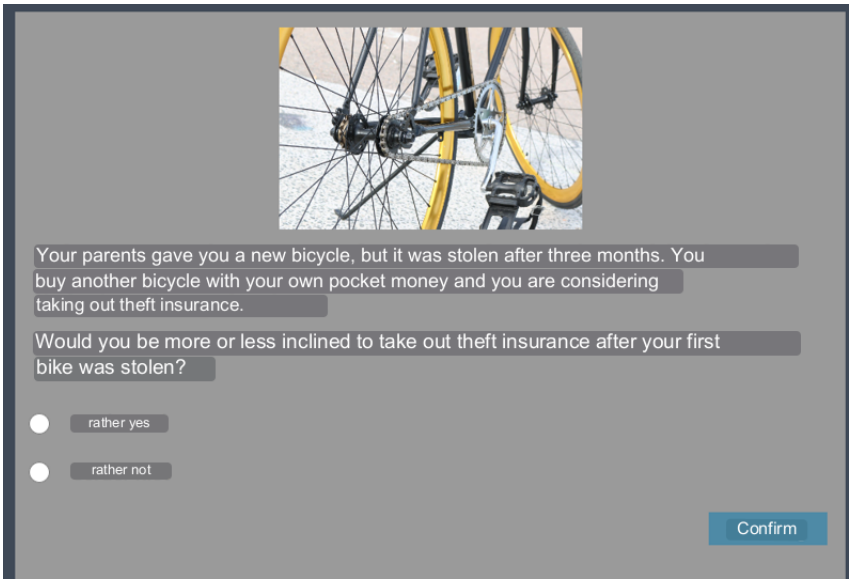

Figure A.2. Example of heuristics course.

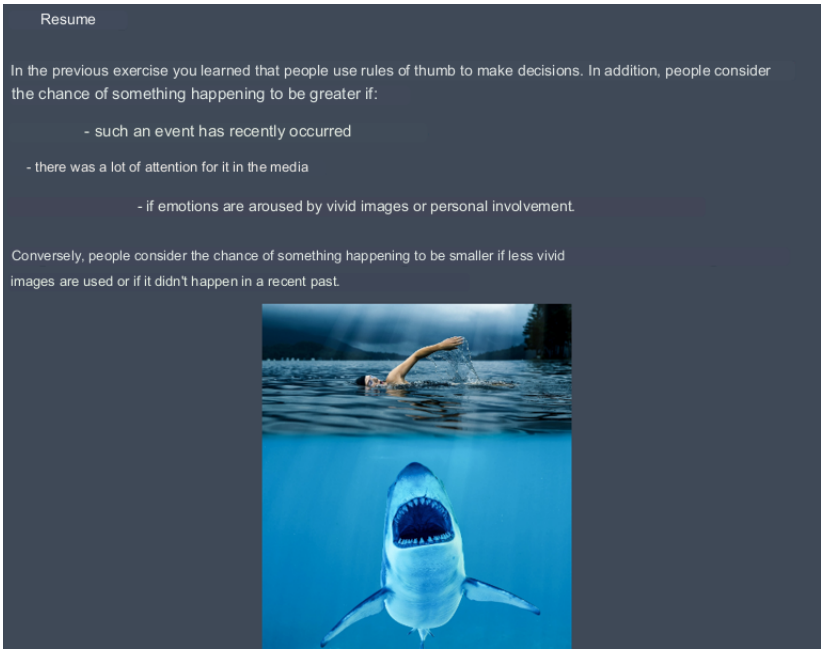

Figure A.3. Example of heuristics course.

Appendix B. Data balance and sample representativeness

In this section, we discuss the data collected in the experiment, and the balance of the variables across experimental arms. Table A.1 shows the main background characteristics of our sample, including variables related to the education track, language, gender, education background, age, and socioeconomic status. To the exception of language, age, gender, and travel frequency, all other variables were fairly balanced. Considering sample imbalances, such variables are used as controls and matching variables in the main analysis.

Table A.1. Characteristics across experimental groups.

	(1)	(2)	(3)	(4)	(5)
Variable	Control	Traditional Education	Heuristics Education	(2) vs (1)	(3) vs (1)
Academic track	0.732	0.689	0.678	-0.043	-0.055
	(0.446)	(0.464)	(0.469)	(0.064)	(0.063)
Dutch spoken at home	0.620	0.949	0.818	0.329***	0.198***
	(0.489)	(0.220)	(0.387)	(0.045)	(0.057)
Sex (male)	0.549	0.395	0.556	-0.154*	0.007
	(0.501)	(0.490)	(0.498)	(0.069)	(0.068)
Age (17-19)	0.296	0.124	0.561	-0.171**	0.265***
	(0.460)	(0.331)	(0.497)	(0.052)	(0.067)
School scores					
Dutch below 50%	0.056	0.023	0.019	-0.034	-0.038
	(0.232)	(0.149)	(0.136)	(0.025)	(0.023)
Dutch above 70%	0.493	0.621	0.481	0.129	-0.012
	(0.504)	(0.486)	(0.501)	(0.069)	(0.069)
Math below 50%	0.141	0.102	0.121	-0.039	-0.019
	(0.350)	(0.303)	(0.327)	(0.045)	(0.046)
Math bove 70%	0.352	0.373	0.411	0.021	0.059
	(0.481)	(0.485)	(0.493)	(0.068)	(0.067)
Financial Independence	0.071	-0.013	-0.012	-0.084	-0.083
	(0.991)	(0.989)	(1.016)	(0.139)	(0.138)
Travel frequency (>2)	0.197	0.356	0.271	0.159*	0.074
	(0.401)	(0.480)	(0.446)	(0.064)	(0.060)
Books at home (> 40)	0.465	0.452	0.393	-0.013	-0.072
	(0.502)	(0.499)	(0.489)	(0.070)	(0.067)
Siblings (>2)	0.394	0.407	0.435	0.012	0.040
	(0.492)	(0.493)	(0.497)	(0.069)	(0.068)
Education of mother (low)	0.352	0.441	0.430	0.089	0.078
	(0.481)	(0.498)	(0.496)	(0.069)	(0.067)

Note: values for each of the experimental groups in the columns, with p-values being derived from t-tests of mean-differences between each of the treatment arms (i.e. Traditional Education and Heuristics Education) in comparison with the control group.

We present the pre and post-test scores of our main interest variables in Table A.2. Both availability heuristics and financial literacy pre-test scores do have differences across experimental arms significant at 5%, for this reason they are also included as controls and matching variables. The main differences in the post-test scores compared to the control group are observed in the heuristics variables (i.e. both availability heuristics and total heuristics) and financial literacy, but only when compared to the traditional financial education group. This goes in line with the results from Table 2. Comparing between pre and post-test scores, we note that the financial literacy score of all experimental arms' distributions were shifted to the right, which can be due to the treatment received by the groups traditional education and heuristics education, and to the students' individual reflection and research after completing the pre-test. Regarding heuristics, both control and heuristics education students increased their awareness to availability, while students in the traditional education group became more prone to it. As discussed in the results

section, this can be linked to the additional confidence from a traditional financial education course leading to more systematic errors (e.g. heuristics behaviour). This change is closer to zero, due to either a lack of training at all (i.e. control group), or to a type of financial education which increases the awareness to heuristics (i.e. heuristics education).

Table A.2. Test scores across experimental groups.

	(1)	(2)	(3)	(4)	(5)
Variable	Control	Traditional Education	Heuristics Education	(2) vs (1)	(3) vs (1)
Pre-test scores					
Availability heuristics	0.125	0.144	-0.160	0.019	-0.285*
	(0.984)	(0.991)	(0.993)	(0.139)	(0.136)
Gambler's fallacy	-0.089	-0.050	0.071	0.039	0.160
	(1.083)	(1.015)	(0.958)	(0.145)	(0.136)
Total heuristics	0.065	0.106	-0.110	0.041	-0.175
	(1.126)	(1.009)	(0.940)	(0.147)	(0.136)
Financial literacy	-0.164	-0.074	0.115	0.091	0.280*
	(1.054)	(1.024)	(0.951)	(0.145)	(0.134)
Post-test scores					
Availability heuristics	-0.194	1.146	-0.416	1.340***	-0.221
	(3.187)	(2.630)	(3.110)	(0.393)	(0.429)
Gambler's fallacy	-2.261	-1.944	-1.831	0.316	0.429
	(2.712)	(2.544)	(2.723)	(0.364)	(0.373)
Total heuristics	-1.227	-0.399	-1.123	0.828**	0.104
	(2.148)	(1.742)	(1.963)	(0.262)	(0.275)
Financial literacy	1.060	1.564	1.304	0.504**	0.244
	(1.210)	(1.051)	(1.301)	(0.154)	(0.175)

Note: values for each of the experimental groups in the columns, with p-values being derived from t-tests of mean-differences between each of the treatment arms (i.e. Traditional Education and Heuristics Education) in comparison with the control group. Standardization was made using pre-tests' distributions.

We checked how our sample matches the Flemish schools using the official data from the Flemish Ministry of Education and Training (2021). They report that 289,000 students are in the second and third cycles of regular secondary education. Most of them (72.1%) are in private schools, which is similar to what observed in our data. About 42% of students are in general academic tracks, which is smaller than what found in our sample from Table A.1. Since the course was distributed through an open call to schools, it is possible that it was more interesting for schools offering academic tracks. Our controlling and matching procedures also accounted for differences in education tracks.

Appendix C. Causal analysis for availability heuristics and gambler's fallacy separately

In this section, we replicate the results from Table 2 and Table 3 for the two heuristics (i.e. availability and gambler's fallacy) separately. The findings from Panel A of Table A.3 align closely with those observed in Panel B of Table 2. This leads us to conclude that the primary

result obtained from the combination of both heuristics is primarily influenced by the availability heuristic. Notably, we observe a larger effect size of 1.46 standard deviations in this case. With respect to the gambler's fallacy, no course had a significant impact of changing this type of heuristics behaviour, even though both courses appeared to have positive but insignificant changes (i.e. on average this type of behaviour became more common). For the traditional financial education, the same possible explanation given in the main text is valid here: students get more confident after a financial education course, which can lead them to heuristics behaviour, which can occur for both types of heuristics (but stronger for availability). Students in the heuristics course seemed to have learned better about availability heuristics then gambler's fallacy, as such, the 'opposite' type of behaviour (i.e. gambler's fallacy) might become more common (although insignificant here due to high variance).

Table A.3. Estimated ATEs and Lee bounds of main variables.

Specification	Mahalanobis Matching	Lower Bound	Upper Bound	Trimming proportion
Panel A: Availability heuristics post-test score as outcome				
Treat. Trad. Fin. Educ.	1.457***	-0.429	2.104	22.3%
	(0.274)	$[-1.031, 0.174]$	$[1.323, 2.886]$	
Treat. Heuristics Educ.	0.0152	-1.642	0.368	11.6%
	(0.414)	$[-2.309, -0.974]$	$[-0.268, 1.004]$	
N	427			
R^2	0.284			
F	87.88			
Panel B: Gambler's fallacy post-test score as outcome				
Treatment	0.532	-1.071	1.669	22.3%
Trad. Fin. Educ.	(0.372)	$[-1.643, -0.498]$	$[-0.525, 0.623]$	
Treatment	0.702	-0.590	0.674	11.6%
Heuristics Educ.	(0.414)	$[-1.184, 0.004]$	$[0.200, 1.148]$	
N	427			
R^2	0.145			
F	52.45			

Note: Lower and upper bounds coefficients are the Lee (2009)'s bounds estimations for the required trimming rate in comparison with control conditions. Numbers in brackets are the 95% confidence intervals. Treatments are constructed as dummy variables, indicating 1 if followed a certain treatment, and 0 otherwise. The Mahalanobis Distance Matching estimated coefficients are in terms of standard deviations of the outcome variable. Clustered standard errors in parentheses. * p $\leq$ .05 ** p $\leq$ .01 *** p $\leq$ .001. Estimation controls for all pre-test observed characteristics presented at Appendix B.

Table A.4 and Table A.5 replicate the results from Table 3. The standard errors are obtained by quasi-Bayesian Monte Carlusing Hicks and Tingley (2011) implementation. In both instances, we note striking similarities in the interpretations when compared to the observations presented in Table 3. Specifically, none of the courses exhibited a significant indirect effect (i.e., ACME) in enhancing financial literacy through increased awareness of heuristics. Once again, it is only the traditional financial education courses that demonstrated significant ADEs and ATEs in improving financial literacy, albeit with slight variations depending on the mediators employed.

Table A.4. Mediation analysis for financial literacy post-test as outcome with effect mediated by availability heuristics.

	Treatment Trad. Fin. Educ.	Treatment Heuristics Educ.
Average Causal Mediated Effect (ACME)	0.035	0.006
	(0.034)	(0.011)
Average Direct Effect (ADE)	0.431**	0.129
	(0.150)	(0.116)
Average Treatment Effect (ATE)	0.466***	0.135
	(0.125)	(0.111)
% of ATE Mediated	7.43%	2.96%
N	249	283
R^2	0.356	0.294
F	166.21	18.17

Note: The results show direct and indirect effects estimated by mediation analysis using the algorithm proposed by Imai, Keele, and Tingley (2010). Standard errors obtained by quasi-Bayesian Monte Carlo simulations. * p $\leq$ .05 ** p $\leq$ .01 *** p $\leq$ .001. Estimation controls for all pre-test observed characteristics presented at table 2.

Table A.5. Mediation analysis for financial literacy post-test as outcome with effect mediated by gambler's fallacy.

	Treatment Trad. Fin. Educ.	Treatment Heuristics Educ.
Average Causal Mediated Effect (ACME)	-0.005	0.004
	(0.016)	(0.014)
Average Direct Effect (ADE)	0.479**	0.163
	(0.145)	(0.109)
Average Treatment Effect (ATE)	0.474**	0.167
	(0.144)	(0.101)
% of ATE Mediated	−0.95%	1.82%
N	249	283
R^2	0.361	0.300
F	364.83	14.66

Note: The results show direct and indirect effects estimated by mediation analysis using the algorithm proposed by Imai, Keele, and Tingley (2010). Standard errors obtained by quasi-Bayesian Monte Carlo simulations. * p $\leq$ .05 ** p $\leq$ .01 *** p $\leq$ .001. Estimation controls for all pre-test observed characteristics presented at table 2.

Appendix D. Endogeneity and sensitiveness of causal claims

The causal mediation analysis framework (Pearl, 2001) differs mostly from Baron and Kenny (1986)'s common mediation due to the more strict causal hypothesis centred in counterfactuals. Although this incurs in more believable causal claims, the strict hypothesis are unfortunately not directly testable in most cases. As such, in this section we present indirect endogeneity tests (using residuals as proxy for errors), and sensitiveness analysis on how sensible our results are to changes in the exogeneity assumption.

Table A.4 presents the results of three common approaches to indirectly test endogeneity based on Cox (2008), Antonakis, Bendahan, Jacquart, Lalive, et al. (2014) and Wooldridge

Table A.6. Endogeneity tests to check identification of the indirect effect.

	Z-test for correlation between residuals	Heuristics residuals as coefficient in Augmented Regression	Wooldridge (1995) Endogeneity test
Treatment	-0.092	0.019	0.742
Heuristics Educ.	$[-0.034, 0.215]$	(0.040)	(p-value = 0.399)

Note: The first column tests the 0 correlation between the residuals of the estimated heuristics and estimated financial literacy using Z-tests with bootstrapped confidence intervals at 95% confidence level (Cox, 2008); the next column tests the significance of the residual of the estimated heuristics as a variable in the augmented regression for financial literacy (Antonakis, Bendahan, Jacquart, Lalive, et al., 2014), the non-significance of this coefficient in the augmented regression indicates that the unexplained factors of the estimated myopia are not correlated with the unexplained factors of the estimated financial literacy; the last column refers to the Wooldridge (1995)'s endogeneity test in a two stage least squares estimation with robust standard errors, where the first stage is the estimation of heuristics and the second stage the estimation of financial literacy.

(1995). In the three cases, we do not reject the exogenity assumption, since the correlations between residuals is close to zero, the coefficient of the residuals in the augmented regression is close to zero, and we do not reject the null exogenity hypothesis in Wooldridge (1995)'s test.

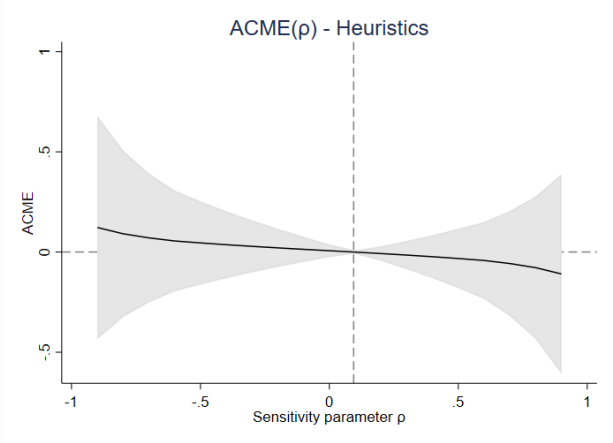

Figure A.4. Sensitivity analysis changing different violation of SI2 assumption for financial literacy as outcome.

Although our ACME results presented in Table 3 are close to zero, we still perform a sensitiveness analysis, to see if our results change depending on the degree of violation to exogenity from the ρ sensitivity parameter. We observe that from most cases of violation in the exogenity assumption, our ACME results are still not significantly different from zero. This points in the direction to support the null result of heuristics as a mediator to improve financial literacy.

Appendix References

Antonakis, J., Bendahan, S., Jacquart, P., Lalive, R., et al. (2014). Causality and endogeneity: Problems and solutions. In *The oxford handbook of leadership and organizations* (pp. 93–117, Vol. 1).

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology*, *51*(6), 1173.

Cox, N. J. (2008). Speaking stata: Correlation with confidence, or fisher's z revisited. *The Stata Journal*, *8*(3), 413–439.

Flemish Ministry of Education and Training. (2021). *Vlaams onderwijs in cijfers 2019-2020*. Het Vlaams Ministerie van Onderwijs en Vorming.

Hicks, R., & Tingley, D. (2011). Causal mediation analysis. *The Stata Journal*, *11*(4), 605–619.

Imai, K., Keele, L., & Tingley, D. (2010). A general approach to causal mediation analysis. *Psychological methods*, *15*(4), 309.

Lee, D. S. (2009). Training, wages, and sample selection: Estimating sharp bounds on treatment effects. *The Review of Economic Studies*, *76*(3), 1071–1102.

Pearl, J. (2001). Direct and indirect effects. *Proceedings of the Seventeenth Conference on Uncertainty and Artificial Intelligence, 2001*, 411–420.

Wooldridge, J. M. (1995). Score diagnostics for linear models estimated by two stage least squares. *Advances in econometrics and quantitative economics: Essays in honor of Professor CR Rao*, 66–87.

Copyright © 2024 @ the author(s). Discussion papers are in draft form. This discussion paper is distributed for purposes of comment and discussion only. It may not be reproduced without permission of the copyright holder. Copies of working papers are available from the author.