A note on financial scarcity and tunneling

Abstract

Scarcity theory suggests a novel lens to study poverty, putting forward that scarcity creates cognitive load which in turn influences real-world decision-making. Cognitive load, however, can have two consequences: 1) increased attentional focus on the scarcity issue (tunneling) and 2) neglect of all other issues (impaired cognitive functions). While empirical evidence is emerging, the question of how exactly scarcity impacts economic decision-making and behavior is still vague. We conducted a lab-in-the-field experiment with low-income individuals around Bangalore, India. The treatment group received artificial cognitive load (memory task). Both groups (treatment and control) took part in a cognitive capacity test and a directly incentivized productivity task where they were asked to sort beans (beans task). While most empirical work suggests a negative impact of cognitive load on economic performance - meaning they detect impaired cognitive capacity - we find the opposite: The treatment group performed better in the cognitive capacity test (yet not statistically significantly) and - controlling for socio-demographics - statistically significantly better in the productivity task. We interpret the results as evidence for scarcity theory's tunneling effect.

Keywords: Raven's Progressive Matrix; Tunnel; Memory Task; Beans Experiment
JEL codes: Q10, Q12, D91

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Introduction

Scarcity theory, put forward by Mullainathan and Shafir (2013), suggests that the lack of financial means forces an individual to constantly manage limited resources, which creates a cognitive load that temporarily taxes the individual's cognitive capacity. One central element of scarcity theory that needs careful empirical investigation is the channels through which cognitive load can alter economic decision-making, as shown in Figure 1. First, cognitive load can lead to tunneling, i.e. an individual focuses on her scarcity issue and pays very close attention to decisions made *inside of the tunnel*. Second, cognitive load will then lead to neglect of all other issues *outside of the tunnel*, i.e. all other areas of life. Thus, cognitive load might trigger various biases in economic decision-making and behavior of the poor (Schilbach et al., 2016)[1].

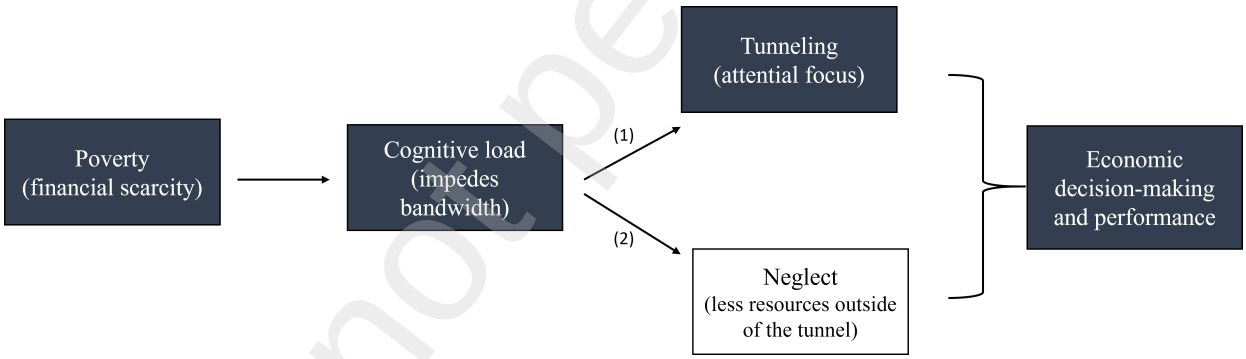

FIGURE 1: Scarcity framework, adapted from Shah et al. (2012); Mullainathan and Shafir (2013); Tomm et al. (2016); De Bruijn and Antonides (2022)

First empirical evidence shows that financial scarcity can tax the human mind (Shah et al., 2018) and tends to confirm the link between poverty and cognitive load (Mani et al., 2013) as well as the link between cognitive load and real-world economic behavior (Kaur et al., 2021). However, the empirical insights are still very limited and findings are mixed (de Almeida et al., 2024; Haushofer and Salicath, 2023; De Bruijn and Antonides, 2022). In

[1]We are aware about the existence of alternative approaches towards scarcity theory, e.g. by Dang et al. (2016) and de Almeida et al. (2024). However, we embed our work into the original and most broadly used framework proposed by Mullainathan and Shafir (2013).

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this study, we set out to investigate the yet little explored tunneling effect of scarcity on economic performance - the colored path in Figure 1 - in a lab-in-the-field experiment. We contribute to the overall scarcity theory literature by providing further evidence to the still very limited empirical knowledge. More precisely, we are the first to provide empirical evidence from the Global South and a non-WEIRD subject pool showing that cognitive load improves productivity, i.e. we present evidence for tunneling.

Materials and Methods

We collected data in 2022 with low-income individuals surrounding the city of Bengaluru, India. We utilize a randomly drawn sub-sample derived from the Survey Stratification Index from Hoffmann et al. (2017). For the experiment, we divided our sample into one treatment and one control group, see Figure 2. The treatment induced cognitive load in the form of a memory task[2]. Participants had to remember a sequence of four items in an incentivized design, i.e. the participants received 50 INR per correctly remembered item. The participants were reminded throughout the experimental session that they should keep the items in mind to increase their payout[3].

In the following step (first step for the control group), we tested cognitive capacity. We use the well-established Raven's Progressive Matrix (RPM) test (Schilbach et al., 2016; Raven, 1938). The RPM test involves a sequence of shapes with one shape missing. Participants must choose which of several alternatives best fits in the missing space. As commonly done in lab-in-the-field settings (Mani et al., 2013), we use a carefully tested comprised version of the RPM-test, where the least possible score is 0 (no puzzle solved correctly) and the best possible score is 12 (all puzzles scored correctly).

[2]Memory tasks serve well as artificial cognitive load (Shiv and Fedorikhin, 1999; Schofield and Venkataramani, 2021).

[3]See *experiment instructions* in Appendix B.

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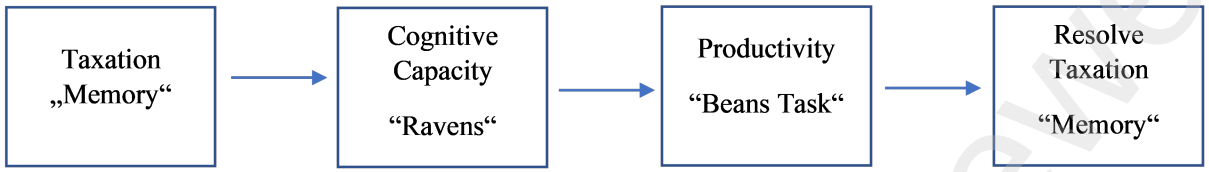
Treatment Group (N=109):



Control Group (N=115):

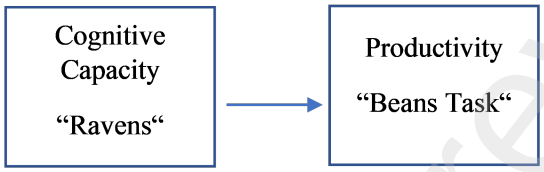


FIGURE 2: Experimental sessions for treatment and control group

As a next step, we asked participants to sort beans under time pressure *bean's task*, a task proposed by Bulte et al. (2021). In our setting, participants could earn up to 400 INR[4] depending on their performance in the task. The participants received a container with 4 types of beans (kidney beans, peas, chickpeas, and lentils). The task was to sort as many kidney beans as possible into a new container within five minutes, see Figure A1 for an illustration. The new container had eight markings, each of them indicating a unit[5]. Once a unit was complete, the participant earned 50 INR. As a final step, the treatment group participants were asked to recall their items memorized at the beginning of the session, receiving an additional payout according to the number of correctly remembered items.

[4] About 5.00 USD, according to Ranganathan (2015), farmers in Karnataka have an average daily household income of 3.50 USD.

[5] One unit was about 73 beans. We determined the units carefully in multiple pilots.

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Results

Our sample encompasses a treatment (N=104) and control (N=114)[6] group. On average and in comparison to the control group[7], participants in the treatment group are relatively younger (41.31 years), slightly more educated (7.37 years), and more likely to be female (71%). Household size and literacy level are rather similar between the groups. Concerning the test scores, on average, the treatment group scored higher on the cognitive RPM test (6.95), performed better in the bean's task (4.56 units sorted), and made less mistakes (0.20 mistakes).

We thus employ two strategies to account for the socioeconomic differences between the groups: ordinary least square (OLS) regression analysis and propensity score matching (PSM). In Table 1 we conduct an OLS analysis with *beans performance* as the dependent variable. The coefficient for *artificial load* is 0.349, and it is statistically significant at the 5 percent level. This suggests that, on average, being in the treatment group is associated with a 0.349 unit increase in performance in the bean's task, holding all other variables constant. Also, *gender* is statistically significant at the 1 percent level, suggesting that being female is associated with a 0.572 unit increase in performance in the bean's task, ceteris paribus. de Almeida et al. (2024) point out the importance to control for education, as effect sizes tend to shrink once education is included. Education, as all other variables, is not statistically significant and has no effect sizes in this analysis.

The PSM confirms the OLS results, with the effect of artificial load on performance in the bean's task being even slightly higher. The Average Treatment Effect of the Treated (ATT) is 0.494 (t=2.635) using the Nearest Neighbor Matching method and ATT=0.375 (t=2.390) when using the Radius Matching method (radius 0.1).

[6] We cleaned the data for outliers prior to conducting the analyses.

[7] Average values control group: Age = 47.32; Education = 6.27; Female = 58%; RPM score = 6.50; Beans Performance = 4.13 units sorted; Bean' Task Mistakes = 0.39; See Table A1 in the appendix.

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We interpret the statistically significantly higher performance in the productivity task of the treatment group as evidence for the tunneling effect in scarcity theory. In other words, the treatment group is more engaged with our task because it aligns with problems where scarcity is salient.

TABLE 1: OLS regression on performance in beans task, N=214

Variables	Definition	Coef.	Std. Err.
artificial load	dummy (1=treatment)	0.349**	0.149
age	in years	-0.004	0.007
education	in years	-0.025	0.025
gender	dummy (1=female)	0.572***	0.159
hhsize	members	-0.030	0.0403
literacy	dummy (1= yes)	0.295	0.241
cons		4.057***	0.478
Prob > F		0.0005	
R-squared		0.1083	

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Concluding remarks

Scarcity theory presents a novel way of understanding poverty, yet empirical evidence is limited and results are mixed. Existing evidence from the Global South on the economic consequences of temporarily impaired cognitive capacity is rare and suggests productivity-diminishing behavior (Kaur et al., 2021; Bruns et al., 2022). In this study, we present new evidence on scarcity leading to productivity-enhancing behavior. While this is also predicted by scarcity theory, it nevertheless is surprising to find. The reason is that the given activity has to fall 'within the tunnel' of an individual's reality. However, it is difficult to predict where this tunnel is and what it covers, and thus presents an important and interesting avenue for future research and an entry point for policy makers dealing with poor individuals.

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Appendix A



FIGURE A1: Example of container of beans

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TABLE A1: Descriptive overview per group

	(Treatment N=104)				(Control N=114)			
Variables	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
age[a]	41.308	13.828	18	80	47.316	14.258	19	76
education[a]	7.369	4.963	0	16	6.272	4.943	0	16
gender[b]	0.712	0.455	0	1	0.5790	0.496	0	1
hhsize[c]	4.670	1.784	2	10	4.628	1.987	1	12
literacy[d]	0.721	0.451	0	1	0.720	0.451	0	1
ravens score[e]	6.952	2.721	1	12	6.500	2.508	2	12
beans performance[f]	4.558	1.173	1	7	4.127	0.982	2	7.5
beans mistakes[e]	0.202	1.028	0	8	0.386	1.782	0	15

[a]in years; [b]dummy, 1=female, 0= male [c]members; [d]dummy, 1=yes; [e] score in cognitive capacity test (RPM test); [f] performance in productivity (bean's) task; [e]mistakes made in the bean's task

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Appendix B

Step 0: We explain the entire session to the participant

Dear Joe,

We will now start with our first session. For this session it is important that you concentrate and that you do not talk to anyone.

[Treatment group:]

We will start with a short task where I will ask you to remember something. It is important that you remember this well until the very end of the session because you can make a lot more money if you remember it. Then, we will play a short game where you will solve a few puzzles. After that I will show you a box of beans and ask you to sort them as fast and perfectly as you can. Finally, after the bean sorting I will ask you what you remember from what I told you at the very beginning. So remember it until after the bean sorting task! You can earn up to Rs. 550 in a very short time. But this depends on your performance in the bean task and how well you remember what I told you at the beginning. Do you have any questions?

[Control group:]

We will start with a short game where you will solve a few puzzles. After that I will show you a box of beans and ask you to sort them as fast and perfectly as you can. You can earn an additional payout of up to Rs. 350 in a very short time. But this depends on your performance in the bean task. Do you have any questions?

Step 1: Taxation "Memory"

Same concept as in the Digital Span Test. We read FOUR items out to the participant

TV, Car, Tea, Cow

We ask the participant to keep these items in mind, in the same order, until the end of the session and explain: *The greater the number of correct items – which includes correct order – the higher the pay at the end of the session!*

Step 2: Cognitive Capacity "Ravens"

Same as usual; Treatment group should be reminded before starting the Ravens Matrix: *Remember you can significantly increase your pay-out by repeating the sequence of items we discussed at the beginning of the session, so keep them in mind!*

Step 3: Productivity "Beans Task"

What we do [Instructions]:

[Give a one of the *kidney beans* to each participant before you start the instructions for the task.]

We now proceed to the *Beans Task*. For this task you will be paid up to Rs. 350, depending on your performance. [ONLY FOR TREATMENT GROUP: And remember you can significantly increase your pay-out by repeating the sequence of items we discussed at the beginning of the session! So do not forget them!]

This task will last 5 minutes, and consists of sorting beans. Please do not communicate with other participants during the instructions, and also not when you implement the task.

In a moment you will all receive a container that contains four types of beans that need to be sorted. [Show one such bag to the participants while raising it above your head]. The bean types are *kidney*

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beans, *peas*, *chickpeas*, and *lentils*. We want you to pick only the kidney beans. That is the species that is presented in front of you on your table. But also, please have a look at how all four species look like. Make sure that you are able to tell the *kidney beans* apart from the other three species.

[Go by all participants with, in one hand, a bunch of *kidney beans*, and in the other a handful of the mixture of all four beans. Ask each participant to have a look at the beans in both your hands, and also ask them to pick a kidney bean from the mix. Verify it is correct, and have the participant place it back in your hand.]

In a moment you are requested to pick *kidney beans* from the mixture of beans that are in the container on your desk. For this task, you receive up to Rs. 350, depending on your performance! The payment will depend on how many beans you were able to sort (show the cup) and how correctly you sorted them! So be fast, but please make sure the pile of selected *kidney beans* is perfect; there should be NO beans of the other three species in the pile. So please carefully select the beans. We want you to pick only *kidney beans*. Place your output in the cup in front of you. After 5 minutes the time is up and you will have to hand the cup to me when I come over to your table to collect the it.

So, you will get more money when you are faster and you sorted the beans correctly (up to Rs. 350)! Also, don't forget the items! You can get even more if you can repeat them correctly! All together up to Rs. 550!

Are there any questions?

If there no (other) questions, we will now start the timer.

[Please watch the participant for the entire 5 minutes, please make sure he does not talk to other participants; please watch the time and say "3 minutes left", "2 minutes left", "1 minute left", "30 seconds left"].

Step 4: Resolve Taxation "Memory"

Participant is now asked to repeat the sequence of items. He needs to repeat the items at the correct spot within the sequence in order for it to count.

Payout Beans Task (1 Unit = c.a. 73 beans)

Unit	Rs.	Euro
1	50	0,60
2	100	1,20
3	150	1,80
4	200	2,40
5	250	3,00
6	300	3,60
7	350	4,20
8	400	4,80

Payout Cognitive Load (Memory)

Per item Rs. 50 [up to Rs. 200 =2,40 EUR]

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