

Is Money Essential? An Experimental Approach

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Introduction

Motivation: Essentiality of Money

Why is money valued when it is intrinsically worthless? Why is it essential?

- Money is called **essential** when **superior** outcomes are **incentive feasible** with money than without it (Hahn 1973)

Mechanism design approach to monetary theory:

- *“is the search for fruitful settings or environments in which something that resembles monetary trade actually accomplishes something”* (Wallace, 2010)

Three frictions are typically considered necessary for essentiality

- Lack of double coincidence DC SC
- Limited commitment
- Information frictions

Motivation: Experimental Approach

Why the experimental approach?

- Does it matter that money is essential?

Money can help when it is not essential. For example, subjects

- Use money for reasons that are not strategic
- Find easier to coordinate on a monetary equilibrium than to coordinate on a gift-exchange one (e.g., Camera and Casari, 2014; Duffy and Puzzello, 2014)

And money can be essential but not help

- People may not coordinate on the monetary equilibrium

Motivation: Experimental Design

Consider finite-horizon model with info frictions (Kovenock and de Vries, 2002; Davis et al. 2022)

- When position is known: apply backward induction → money cannot be valued
- When position is unknown: backward induction circumvented → money can be valued and is essential

Effect of suggestions on coordination

- Autarky coexists with monetary equilibrium when money is essential
- Mediator.... *“a person or machine that can help the players communicate and share information”* (Myerson, 1991)
- Compare with suggestion when following it is not incentive compatible

Use social value orientation and exit surveys to investigate anomalies

Main Findings

Money significantly increases output when essential

Use of money is significantly higher when incentive compatible

→ Evidence supporting theory on essentiality: subjects use money for strategic reasons

Recommendation helps more when following it is incentive compatible

Sometimes money is accepted when that is not incentive compatible; exit surveys suggest this is due to social preferences and confusion

Theoretical Framework

Theory – Meetings

Three agents, with equal chance of being player 1, 2, or 3 ex ante, and an indivisible good

Two sequential meetings: (1, 2) and (2, 3), where earlier player is consumer and the other producer

Utility from consumption u , disutility from production c

Two information structures

- Model **N**: Everyone knows their role (player 1, 2 or 3) at the time of decision
- Model **M**: Only player 1 knows his role; the other two only know they are not player 1.

With no money, autarky is the only equilibrium

Theory – Money

Player 1 endowed with an indivisible token (money) without intrinsic value

Action choice

- Meeting 1: Player 1 decides whether to offer token to Player 2 in exchange for production. Player 2 sees offer and decides whether to produce.
- Meeting 2: if Player 2 has token, he decides whether to offer it to Player 3. Player 3 sees offer and decides whether to produce.

Recall: Players 2/3 know their role in Model N but not in Model M

Equilibrium Allocation

- Model **N**: unique eqm is autarky (non-monetary)
- Model **M**: there is also a monetary eqm when $u > 2c$

Action set expands in both models, equilibrium outcomes only expand in Model M

Theory – Monetary Strategy in Model M

Player 1 offers the token, players 2/3 produce only if they are offered the token, and transfer it.

- Player 1: Weakly dominant strategy to offer token
- Player 2 and 3: $[1/2(u - c) + 1/2(-c)] > 0$. If $u > 2c$, no incentive to deviate.

Experimental Design

Experimental Design: Treatments

Treatment	Model	Money	Suggestion
1	M	0	0
2	M	1	0
3	M	0	1
4	M	1	1
5	N	1	0
6	N	1	1

Q1: Is there more production with **money** than without it in Model M?

Q2: With money, is there more production in Model **M** than in Model **N**?

Q3: Do **suggestions** have a bigger impact on production in Model M with money than without it?

Q4: Do **suggestions** have a bigger impact on production in Model M with money than Model N with money?

Experimental Design: Matching and Roles

Game repeats 15 times (rounds) to allow subjects to gain experience

To mitigate repeated game effects

- Random grouping in each game (3 to 5 groups in each session)
- Fixed roles
 - In Model N treatments, role fixed for all 15 rounds.
 - In Model M treatments, Player 1s keep their role, and the rest are randomly assigned as Player 2 or 3 in each round

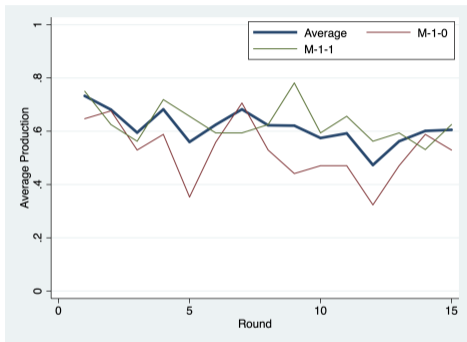
Suggestion

Procedures

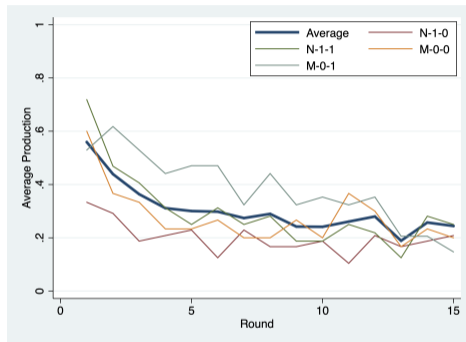
Procedures

Experimental Results

Results Overview: All Treatments



(a) Monetary equilibrium exists

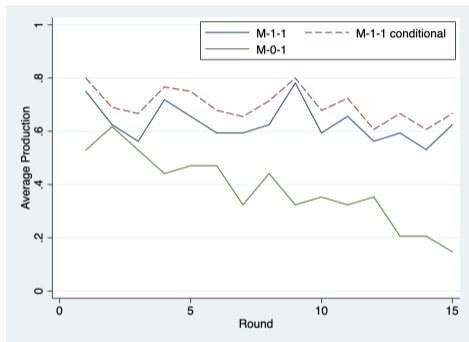
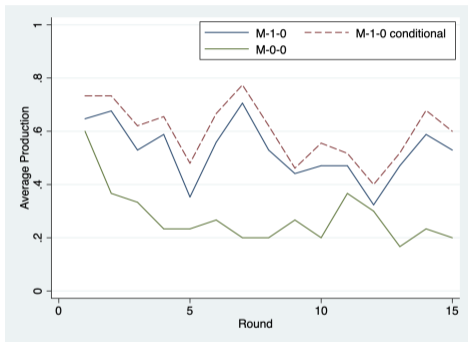


(b) Only equilibrium is autarky

Dark line: average over treatments; First digit: money; Second digit: suggestion

Question 1: Effect of Money in Model M

Is there more production with money than without it in Model M? **YES**

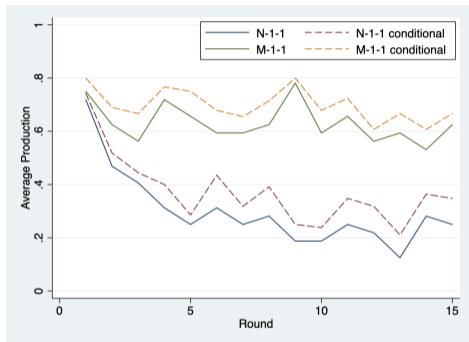
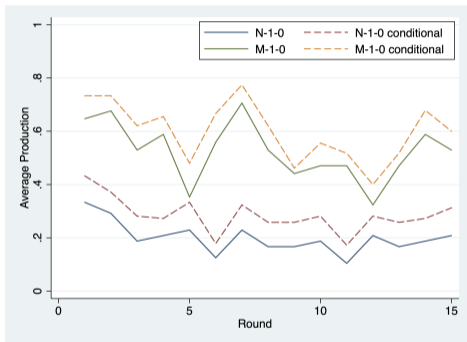


On average, money increases production by more than 20%, and persists across rounds WMW

Consistent with Camera and Casari (2014), Duffy and Puzzello (2014) but not with Davis et al. (2022)

Question 2: Money in Model M vs Model N

With money, is there more production in Model M than in Model N? **YES**



On average, production is more than 30% higher in model M, and persists across rounds

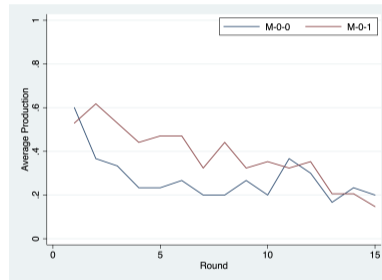
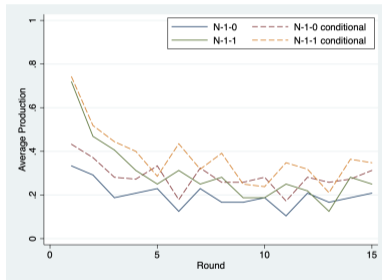
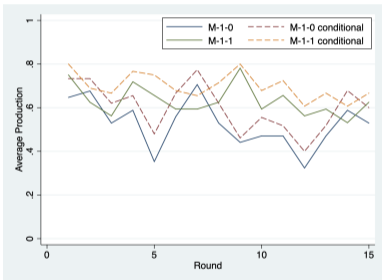
WMW

Novel comparison: Strategic considerations important

Questions 3 and 4: Effect of Suggestions

Do suggestions have a bigger impact in Model M with money than without it? **YES**

Do suggestions have a bigger impact in Model M with money than Model N with money? **YES**



Suggestions boost production in all models, but it persists across rounds only in Model M with money

Subjects learn to ignore suggestions when not incentive compatible WMW

Additional Results–Deviations from Theory

Positive production by

- Player 3 in Model N with money
- Players 2 and 3 in Model M without money

Note: Production by player 2 is rationalizable by the belief that player 3 accepts money

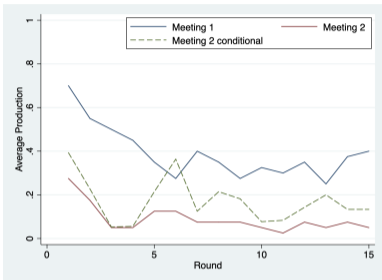
Coefficients on SVO tend to be insignificant; sometimes have the “wrong” sign

Exit surveys

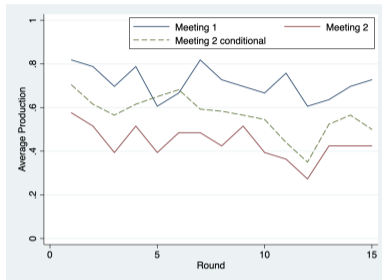
- Strategic considerations dominate
- Social preferences, confusion and repeated-game considerations contribute to deviations from theory

See survey results: N M M0

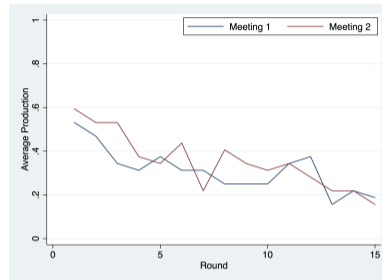
Additional Result—Production in Meeting 1 vs. Meeting 2



pooling data from N-1-0 and N-1-1



pooling data from M-1-0 and M-1-1



pooling data from M-0-0 and M-0-1

In Model N subjects have incentive to condition production on meeting

Same in Model M with money... subjects try to predict the meeting (possibly using waiting times)

But no incentive in Model M without money → production rates are about the same

Conclusion

Conclusion

We designed an experiment to study whether money is essential

Evidence that introducing money significantly increases output in treatments where money is essential

- Use of money is significantly higher when incentive compatible than when it is not
→ subjects use money for strategic reasons

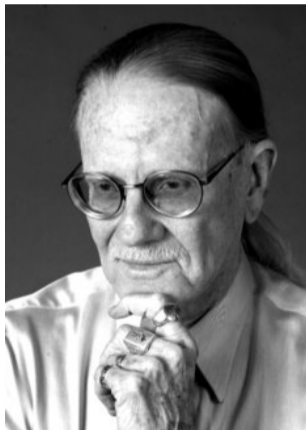
Recommendations help when incentive compatible, not otherwise

Sometimes money is accepted when not incentive compatible due to social preferences and confusion;

Framework can be extended: communication, chain length, memory, fragility of monetary equilibrium, etc.

Nobel Prize in 2002

- Vernon Smith (2002): “for the use of laboratory experiments as a **tool** in empirical economic analysis, in particular, for the study of different **market mechanisms**”



Experimental Design: Suggestion

- Suggestion in monetary treatments: produce only for money

“A suggestion: Each player in a group may consider making the following choices:

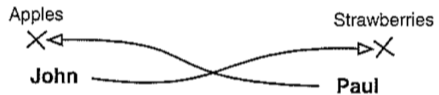
1. Whenever you have the token, transfer it to the next player (if there is one).
2. Produce ONLY if you are offered the token.

This is simply a suggestion. Feel free to follow it or not.”

- Suggestion in treatment without money: “A suggestion: If you are not player 1, you may consider choosing to produce. This is simply a suggestion. Feel free to follow it or not.”

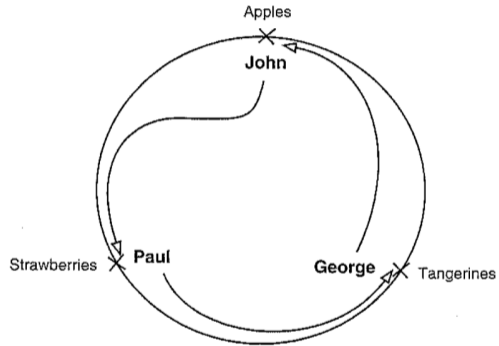
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Double Coincidence



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Single Coincidence



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Experimental Procedures: Tasks

- Main experiment (Model M or Model N)
- Exit survey: reasons to produce
- Demographic survey: gender, age, major, English proficiency
- Social value orientation: prosocial/altruistic

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Experimental Procedures

- Subjects: Indiana University students
- Feb 2020 (before pandemic) to Feb 2022
- Use z-tree or oTree software
- 6 sessions for treatment N-1-0 (4 z-tree); 4 sessions for others; (315 subjects in total)
- 45-60 minutes per session
- Earnings
 - $u = +3$ points from consumption and $c = -1$ point from production
 - Initial endowment: 3 points; 3 rounds randomly selected for payment.
 - 1 point = \$2; \$5 show-up payment; average earnings \$19

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Exit Survey—Reasons for Monetary Exchange in Model N

	Player 3		Player 2	
	N-1-0	N-1-1	N-1-0	N-1-1
a Not applicable:				
I was never in this situation	70.8	37.5	12.5	0.00
b To increase the chance of trading it for the good with another player	4.20	6.30	75.0	87.5
c I made a mistake	8.30	12.5	4.20	6.30
d To help the other player	8.30	31.3	33.3	43.8
e I wanted the token for the sake of it	16.7	25.0	8.30	0.00
f To follow the suggestion	-	25.0	-	43.8
g Other reason. Please explain:	0.00	6.30	12.5	6.30

NOTE.—This table shows the percentages of responses to the question: “If you were offered the token and you produced in exchange for the token, why did you do it? Check all that apply.” Option (f) applies only to N-1-1. The total number of subjects is 24 for treatment N-1-0, and 16 for treatment N-1-1. Back to [main](#)

Exit Survey—Reasons for Monetary Exchange in Model M

	M-1-0	M-1-1
a Not applicable: I was never in this situation.	2.90	3.10
b To increase the chance of trading it for the good with player 3 in case I turn out to be player 2	91.2	90.6
c I made a mistake	0.00	3.10
d To help the other player	20.6	25.0
e I wanted the token for the sake of it.	2.90	6.30
f To follow the suggestion.	-	15.6
g Other reason. Please explain:	2.90	18.8

NOTE.—This table shows the percentages of responses to the question: “If you were offered the token and you produced in exchange for the token, why did you do it? Check all that apply.” Option (f) applies only to M-1-1. The total number of subjects is 34 for treatment M-1-0, and 32 for treatment M-1-1. Back to [main](#)

Exit Survey—Reasons for Production in Model M without Money

	M-0-0	M-0-1
a Not applicable: I never produced	20.0	14.7
b To increase the chance of others producing for me in this game	50.0	44.1
c To increase the chance of others producing for me in a following game	53.3	70.6
d I made a mistake	3.30	2.90
e To help the other player	33.3	52.9
f To follow the suggestion	-	11.8
g Other reason. Please explain:	3.30	8.80

NOTE.—This table shows the percentages of responses to the question: “If you produced in a game, why did you do it? Check all that apply.” Option (f) applies only to M-0-1. The total number of subjects is 30 for treatment M-0-0, and 34 for treatment M-0-1. Back to [main](#)

- Allow communication among subjects
- Chain length
- Effect of suggestions in the role identification treatment of Davis et al.: money game + continuation game; money serves as a coordination device for the latter

- Multiple equilibria, equilibrium selection is ultimately an empirical question

“The issue involves a question concerning how collections of people behave in a specific situation. Economic theory does not resolve the question. One can imagine other principles that would, but this cannot rule out the possibility that still other principles might resolve it quite differently. It is hard to see what can advance the discussion short of assembling a collection of people, putting them in the situation of interest, and observing what they do.” Lucas (1986)

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Question 1: Effect of Money in Model M

Is there more production with **money** than without it in Model M? Yes

Rounds	Average Production				WMW p -values	
	M-1-0	M-0-0	M-1-1	M-0-1	M-1-0 v M-0-0	M-1-1 v M-0-1
All	0.52	0.28	0.62	0.39	0.029	0.114
1-5	0.55	0.37	0.64	0.52	0.114	0.343
6-15	0.51	0.24	0.61	0.32	0.029	0.057
11-15	0.48	0.25	0.59	0.25	0.057	0.057

NOTE.—The p -values from the WMW test are exact and two-sided. There are 4 observations per treatment.

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Question 2: Money in Model M v Model N

With money, is there more production in Model M than in Model N? Yes

Rounds	Average				WMW p -values	
	N-1-0	M-1-0	N-1-1	M-1-1	N-1-0 v M-1-0	N-1-1 v M-1-1
All	0.20	0.52	0.30	0.62	0.009	0.029
1-5	0.25	0.55	0.43	0.64	0.019	0.086
6-15	0.18	0.51	0.23	0.61	0.009	0.029
11-15	0.18	0.48	0.22	0.59	0.009	0.029

NOTE.—The p -values from the WMW test are exact and two-sided. There are 6 observations in N-1-0, and 4 observations for other treatments.

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Questions 3 and 4: Effect of Suggestions

Do suggestions impact more production in Model M with money than without it? **YES**

Do suggestions impact more production in Model M with money than Model N with money? **YES**

Average						
	N-1-0	N-1-1	M-1-0	M-1-1	M-0-0	M-0-1
All Rounds	0.20	0.30	0.52	0.62	0.28	0.39
Rounds 1-5	0.25	0.43	0.55	0.64	0.37	0.52
Rounds 6-15	0.18	0.23	0.51	0.61	0.24	0.32
Rounds 11-15	0.18	0.22	0.48	0.59	0.25	0.25

WMW p -value			
	N-1-0 v N-1-1	M-1-0 v M-1-1	M-0-0 v M-0-1
All Rounds	0.114	0.086	0.400
Rounds 1-5	0.076	0.400	0.114
Rounds 6-15	0.457	0.057	0.571
Rounds 11-15	0.609	0.057	1.000

NOTE.—The p -values from the WMW test are exact and two-sided, and there are 6 observations in treatment N-1-0 and 4 in the other treatments.