Policies for Transactional De-Dollarization: A Laboratory Study

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Content

Motivation

- Partial **currency substitution** episodes (e.g. currency dollarization) occur typically due to **fiscal and monetary disequilibria** (local currency loses one or more of its functions).

- Typically, currency dollarization occurs in **small open economies**, whose currencies will not become international.

- Interestingly, in many countries, the **coexistence of two currencies persists** after macroeconomic stability is restored.

- The coexistence of two currencies (dollarization) poses **important challenges to monetary policy** and macroeconomic stability:
  - Currency substitution often leads to financial dollarization.
  - It limits the role of the central bank (CB) as a lender of last resort rendering it less effective.

- **Central Banks are interested** in implementing **de-dollarization policies** (for both transactions and liabilities) but there is **insufficient research** on the effectiveness of the different policy options.

This Paper

- We study the **impact of three policies** on the acceptance rate of foreign currency in transactions:
    1. Taxes on transactions in foreign currency among domestic agents.
    2. Storage costs for foreign currency.
    3. Information on the acceptability of the foreign currency.

- We use the environment based on **Matsuyama et al. (1993, henceforth MKM)** to study these policies, both theoretically and experimentally.

- **We contribute to the theoretical literature** by extending the model to characterize a new equilibrium (circulation regime): agents accept the foreign currency in international transactions but reject it in domestic transactions.

- We develop an evolutionary model to refine theoretical predictions in a context of multiple equilibria.

- Our experimental evidence suggest that **both taxes and storage cost reduce acceptability of FC**. Information treatment does not have a significant impact relative to baseline.

Related Literature

- **Kiyotaki and Wright (1989, 1993)**: search and matching model in which money emerges endogenously as a medium of exchange. Thet highlight the welfare implications in a barter economy.
- **Matsuyama et al. (1993)**: search and matching model in a context of two economies - two currencies. Currency circulation regimes emerge endogenously and depend on fundamentals (degree of integration and relative sizes of the economies).

Related Literature

- **Jiang and Zhang (2018)** conducted an experiment based on the model of MKM (1993) to study the impact of fundamental parameters on the acceptance rate of currencies. Moreover, they introduce a government purchase policy which acts as a coordination device in favour of local currency circulation.

- **Rietz (2019)** studied an experiment based on the acceptance rate of a secondary currency (cryptocurrency) circulating alongside the official currency. The experiment suggests there is an equilibrium with partial acceptance of the *cryptocurrency*, given the trade frictions.

- **Ding and Puzzello (2020)** tested the effect of two international trade policies on the emergence of a international currency probability. Even though there was no evidence to support a change of circulation regime, the policies do increase the number and volume of transactions among agents.

Baseline Model: Matsuyama et al. (1993, MKM)

- **Random matching model** of two currencies and two economies, Blue (B) and Red (R).
- **Each period, agents are paired randomly** with a matching technology that depends on sizes of the economies, n_i, and the degree of economic integration, ρ. More.
- There are **three types of indivisible objects:** a consumption good and two intrinsically worthless tokens. The red (blue) token is the local currency of economy R (B) and is used as medium of exchange.
- Each agent can costlessly produce a variety of the consumption good, but **consumes only the varieties other agents produce**, which provides an utility flow u. After consumption, agents engage in production to restore their inventories.

Baseline Model: Matsuyama et al. (1993, MKM)

- Each economy, i, has a fraction $M_i \in (0,1)$ of agents (buyers) initially endowed with an unit of local currency. The remaining fraction of agents (sellers), $1 - M_i$, are endowed with one unit of the consumption good.

- The market generates a **trade opportunity**. whenever a token-holder (buyer) is matched with a good-holder (seller). In this case, each agent must decide, simultaneously, whether to trade.

- Trade occurs only when there is mutual agreement, in which case agents swap inventories and roles are reversed.

Baseline Model: Policy instruments

We assume that the Red economy is smaller than the Blue economy (low *n*). Therefore, the Red is a small open economy which trades with a big economy.

The Red government can use the following policy instruments:

1. **Taxes on using FC domestically**:
   - Lump-sum tax on sellers for accepting a blue token in a domestic transaction (τ_r^0).
   - Lump-sum tax on buyers for handing over a foreign token in a domestic transaction (τ_r^b).
2. **FC Storage Costs**: Per-period storage cost on foreign currency (c_r^b).
3. **Information**: Disclose information on the acceptability of the blue token between red agents.

Baseline Model: Monetary Equilibria

- We focus on **symmetric and stationary equilibria in pure strategies**, where agents from the same country follow the same trading rule and the distribution of tokens remains constant over time. More.

- We focus on **candidate equilibria** where buyers always attempt to trade **and** sellers always accept the local currency.

- Furthermore, we make an emphasis on equilibria where Blue sellers **always reject** red currency.

- The central issue is whether sellers from the Red economy accept to trade and receive Blue currency.

Baseline Model: Circulation Regimes

Red currency is a **national currency** because it is only accepted in its economy. From the Red economy's perspective, three circulation regimes may emerge:

1. **National currency regime (N)**: the Blue currency is always rejected by domestic agents.

2. **International currency regime (I)**: the Blue currency is always accepted by domestic agents.

3. **Conditional acceptance regime (C)**: the Blue currency is accepted in foreign transactions, but rejected in transactions between domestic agents.

Baseline Model: Circulation Regimes
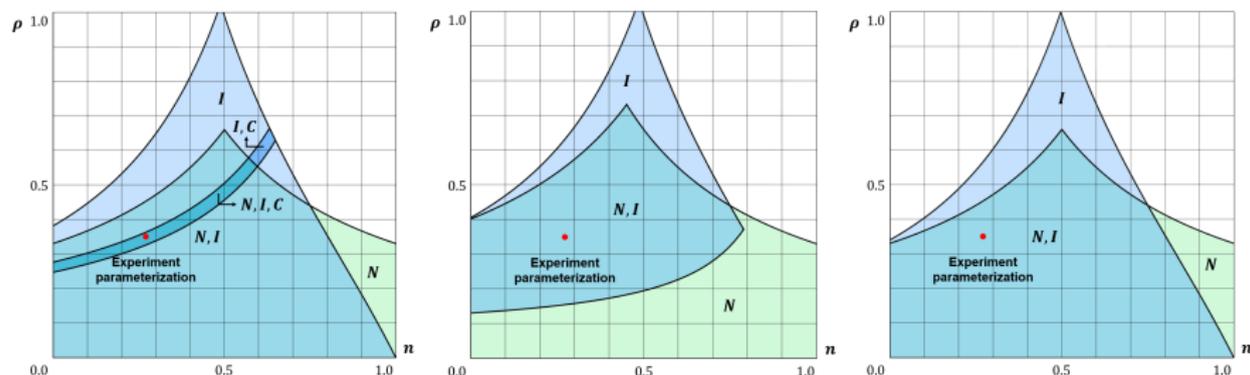
(a) Taxes on trade in foreign currency (b) Costly storage of foreign currency (c) Info on acceptance of foreign currency

Figure: **Typology of equilibria**. These graphs represent the regions of fundamentals (relative size, n, and degree of integration, ρ) that support the three different equilibria we study: international circulation of Blue token (I); National circulation of Blue token (N); and conditional acceptance of Blue token (C). These diagrams also show the parameterization utilized in the experiment (red dot).

Evolutionary Model

- This is a modified version of the **Baseline Model**.

- Agents from each economy conform a generation. There are three type of individuals in the Red economy: those who always reject FC (p_N), those who always accept FC (p_I), and those who only accept FC on foreign transactions (p_C); hence $p_N + p_I + p_C = 1$. These proportions determine a distribution $\mathbf{p} := (p_N, p_I, p_C)$.

- The economy's value function depends on the distribution $\mathbf{p}$,
  $W(\mathbf{p}) := p_N W_N(\mathbf{p}) + p_I W_I(\mathbf{p}) + p_C W_C(\mathbf{p})$.

- The distribution $\mathbf{p}$ evolves according to standard **replicator dynamics**. Each type's proportion increases from one generation to another iff the type's payoff, $W_j(\mathbf{p})$, exceeds the economy's average payoff, $W(\mathbf{p})$.

$$\dot{p_j} = [W_j(\mathbf{p}) - W(\mathbf{p})] p_j$$

Evolutionary Model

(a) Taxes
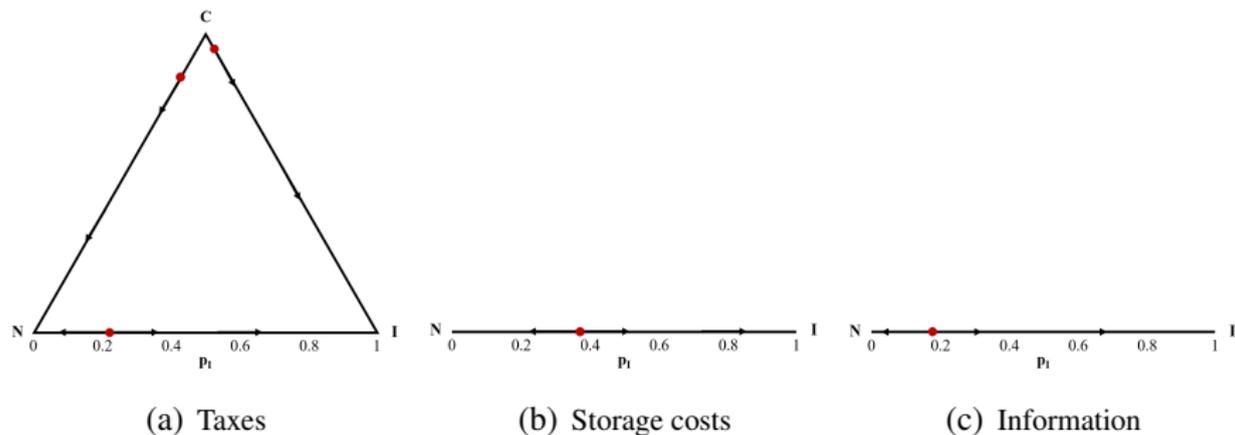
(b) Storage costs

(c) Information

Figure: **Evolutionary stable equilibria**. The figure shows the evolutionary dynamics towards each circulation regime: N, I y C. These diagrams are based on the experiment's parameterization.

Experiment Design: Groups and Interactions

- **Red Economy**: Random fixed group of 8 participants
- **Blue Economy**: Random fixed group of 20 automated agents (*robots*).
- Each session lasts 50 rounds.
- Human participants interact with each other and with robot agents from the (foreign) Blue country. At the beginning of each round, each red member is **randomly matched** with someone from their group or the Blue country.
- We calibrate the parameters, n and ρ, to obtain a matching probability between Red individuals of 75%.

Experiment Design: Endowment and Exchange Decision

- Each participant starts the session with 70 points and **an object**: a red token or a consumption good.
- **Red Economy**: in the first round, *four* participants have a Red token and *four* the consumption good.
- **Blue Economy**: in the first round, *ten* participants have a Blue token and *ten* the consumption good.
- In each round, the participant is **informed of the object** they currently have, and both their **partner's group and object**.
- If the encounter involves a token-holder and a good-holder, then **trade is possible**.
- If trade is possible, **each agent decides simultaneously** whether or not to attempt exchange. If **both agents respond positively, the objects are exchanged.**
- **Blue agents are automated** and only accept blue tokens in exchange for the consumption good.

Tú:

Grupo Rojo
Posees objeto:
Ficha roja

Tu socio:

Grupo Rojo
Posee objeto:
Bien de consumo

¿Quieres intercambiar tu ficha roja a cambio del bien de consumo de tu socio?

○ No

○ Sí

[Siguiente]

Rondas anteriores

Pago acumulado:
70,0 puntos

Ronda	Tu Objeto	Objeto del Socio	Grupo del Socio	Intercambio Posible	Intento de Intercambio	Intercambio Exitoso	Pagos de la Ronda
3	Rojo	Azul	Azul	No	No	No	0,0 puntos
2	Rojo	Bien de Consumo	Azul	Sí	No	No	0,0 puntos
1	Rojo	Bien de Consumo	Rojo	Sí	No	No	0,0 puntos

Figure: Player interface

Experiment Design: Treatments

- **Baseline**: Receiving a token awards 0 points. **Obtaining a consumption good in an exchange awards 10 points** upon receipt ($u = 10$). The session's payment is the accumulated points at the end of the 50 rounds.

- **Treatment 1 - Taxes:** Same as baseline except receiving a Blue token from another Red agent is taxed with one point. Giving a Blue token to a Red good-holder is also taxed with one point.

- **Treatment 2 - Storage costs:** Same as baseline except Red agents are charged a storage cost of 0.7 points for each additional round in which they keep a Blue token.

- **Treatment 3 - Information:** Same as baseline except we provide round-by-round information on the rate of acceptance of Blue tokens in Red-Red encounters.

We calibrate the parameters τ_r^b, τ_r^0 and c_r^b to obtain the same theoretical welfare in regime I for treatments 1 and 2.

Experimental Procedure

- Online experiments using subject pool from ORSEE PUCP's LEEX Laboratory (Lima).
- Eight sessions of 16 participants (two groups in each session).
- Each group received a treatment (*between-group*).
- We included incentivized control questions and a post-interaction survey.
- We used an exchange rate of 1 point = S/ 0.05 (soles).
- S/ 5.00 of participation fee.
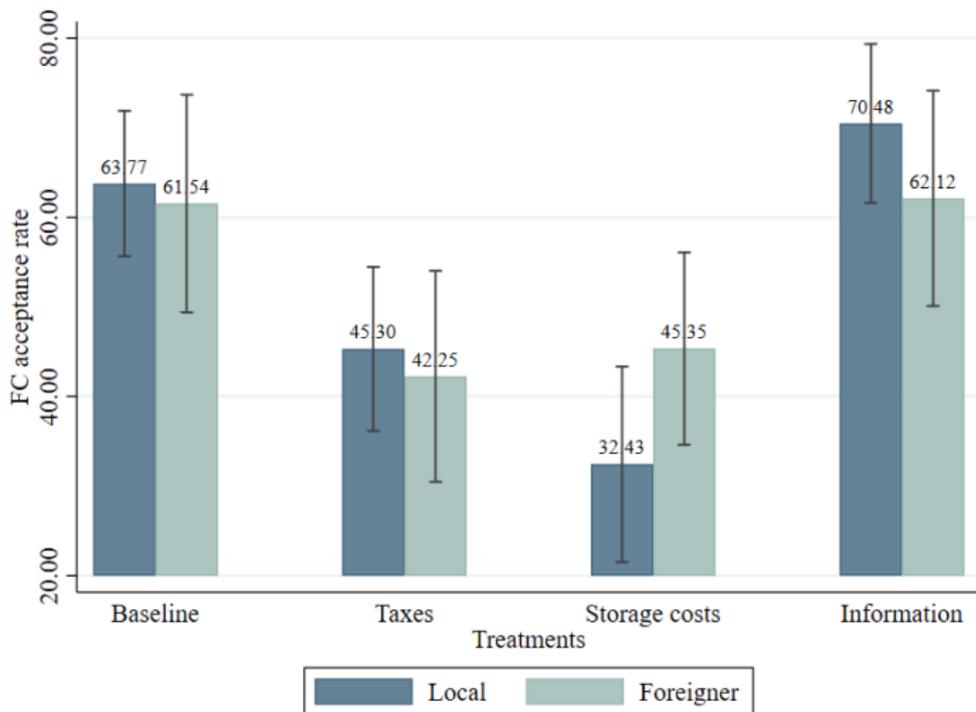- We applied electronic payments at the end of each session.

Results I: General foreign currency acceptance

Figure: **Foreign currency acceptance rates**

Figure: **Foreign currency acceptance rate by partner's origin**
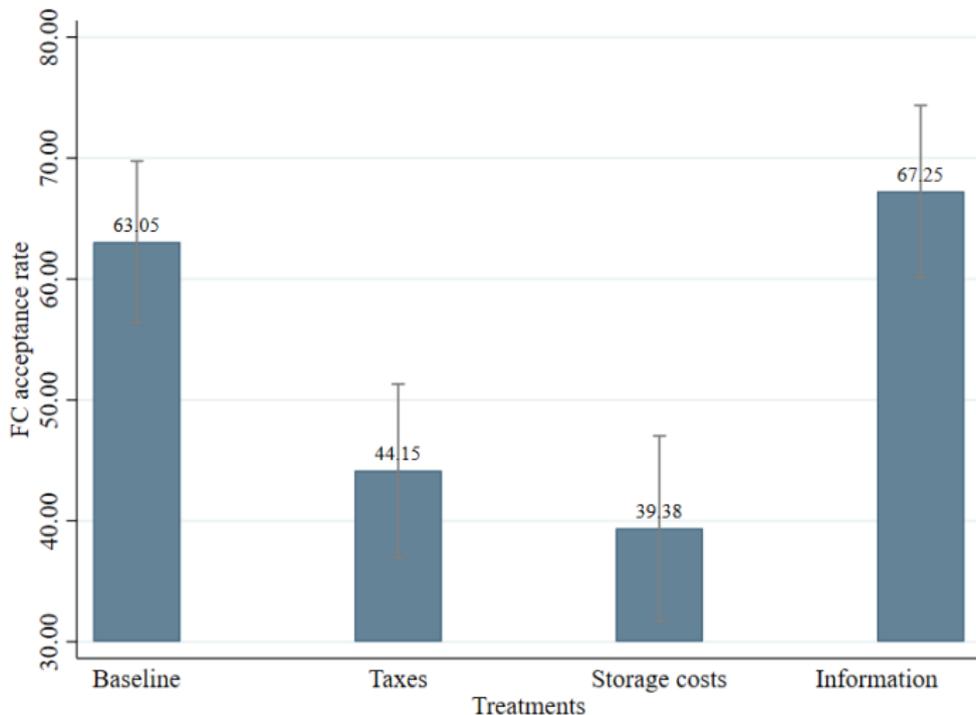
Results I: Foreign currency acceptance

Table 1: Marginal effects on foreign currency acceptance rate (Probit)

Variables	(1) Full sample	(2) FC held by local	(3) FC held by foreigner
Taxes [T1]	-0.168**	-0.146**	-0.193*
	(0.018)	(0.053)	(0.085)
	[0.009]	[0.0351]	[0.0987]
Storage costs [T2]	-0.204**	-0.253*	-0.178**
	(0.038)	(0.078)	(0.040)
	[0.0266]	[0.0567]	[0.0374]
Information [T3]	0.0565	0.0962	-0.0063
	(0.458)	(0.352)	(0.948)
	[0.4187]	[0.2974]	[0.9471]
Controls	✓	✓	✓
N	722	434	288

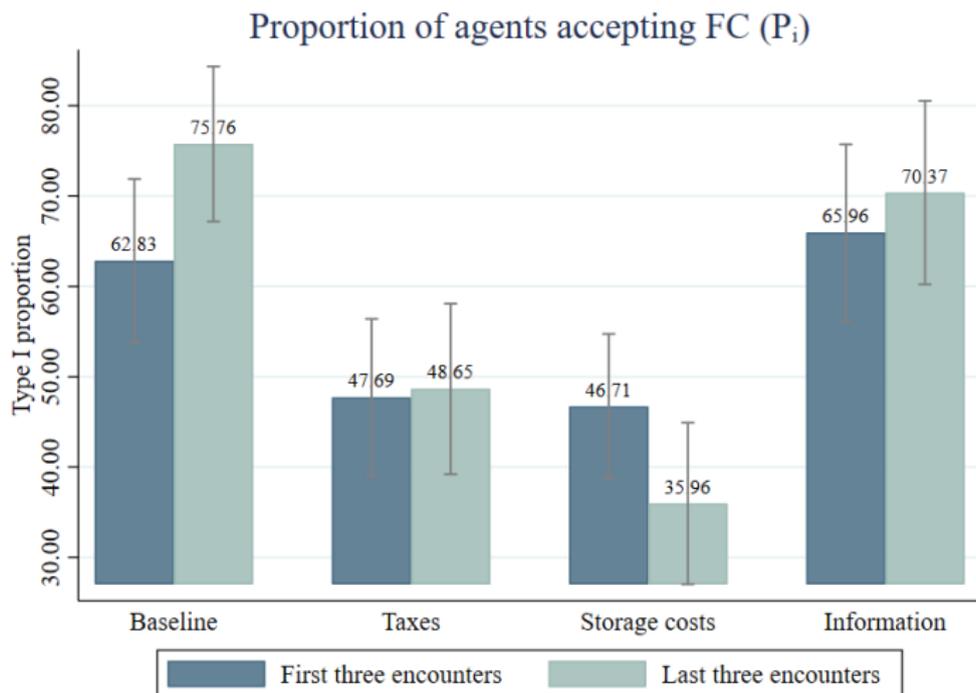p-values clustered at group level in parentheses, bootstrapped p-values in brackets

We control at a group level and the number of rounds.

*** p<0.01, ** p<0.05, * p<0.1

Results I: Descriptive and Regression Analysis

- Foreign currency acceptance rates are statistically equivalent in the Baseline and Information (T3) conditions.

- **Taxes (T1) and storage costs (T2)** discourage foreign currency circulation at the domestic level. Both treatments diminish acceptance rates by around 20 percentage points.

- Taxes (T1) do not induce an heterogeneous response based on the nature of the transaction (domestic vs foreign).

Proportion of agents accepting FC (P_i)

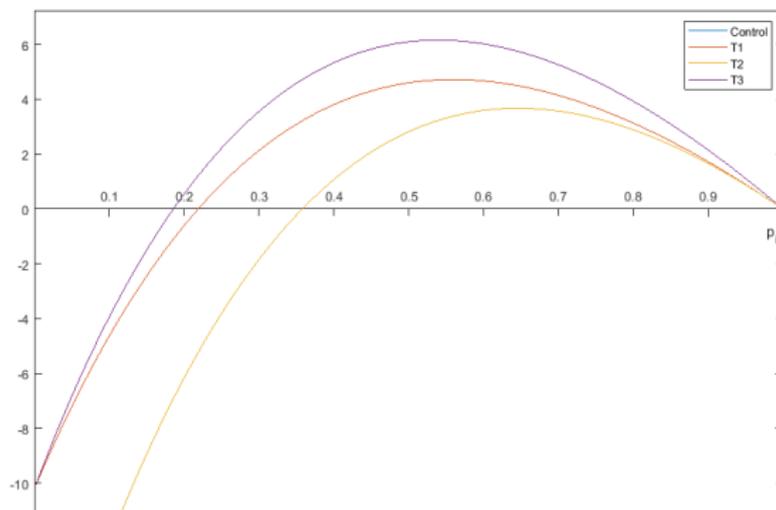Figure: Evolution pattern of $p_I (W_I - W)$

Figure: **Equilibrium Selection**. Red economy is comprised by agents of type N and I. The distribution **p** evolves according to standard replicator dynamics. Type I proportion, p_I, increases (decreases) when the corresponding payoff, W_I, is higher (lower) than the economy's average payoff, W.

Results II: Evolutionary Dynamics

- Both regimes, *I* and *N*, are evolutionarily stable in all treatments, but under different initial conditions.

- Baseline and Information treatments support a gradual convergence towards the **international circulation regime**.

- Storage costs on FC induce a gradual convergence towards the **national circulation regime**.

- In contrast with theory, the Tax condition shows a persistent level of transactional dollarization.

Conclusions

- We study the **impact of three policies** on the acceptance rate of foreign currency in transactions in the lab.

- We extend the MKM model to study the theoretical impact of each policy instrument. We characterize a new equilibrium (circulation regime) and develop an evolutionary model to refine our predictions in a context of multiple equilibria.

- Experimental evidence indicate both storage costs and taxes reduce the acceptability of FC in around 20 percentage points.

- The Taxes condition does not induce an heterogeneous response based on the nature of the transaction (domestic vs international).

- Information treatment does not have a significant impact relative to baseline. Average acceptance rates remain at around 60%.

Appendix: Table on consumption and local token

Variables	(1) Local currency	(2) Consumption good
Taxes [T1]	0.121***	-0.0582*
	(0.004)	(0.109)
	[0.0158]	[0.0917]
Storage costs [T2]	0.164***	-0.0823
	(0.000)	(0.197)
	[0.0152]	[0.3103]
Information [T3]	0.0239	-0.0256
	(0.601)	(0.504)
	[0.6039]	[0.4523]
Controls	✓	✓
N	621	1,396

p-values clustered at group level in parentheses, bootstrapped p-values in bracke
We control at a group level and the number of rounds.
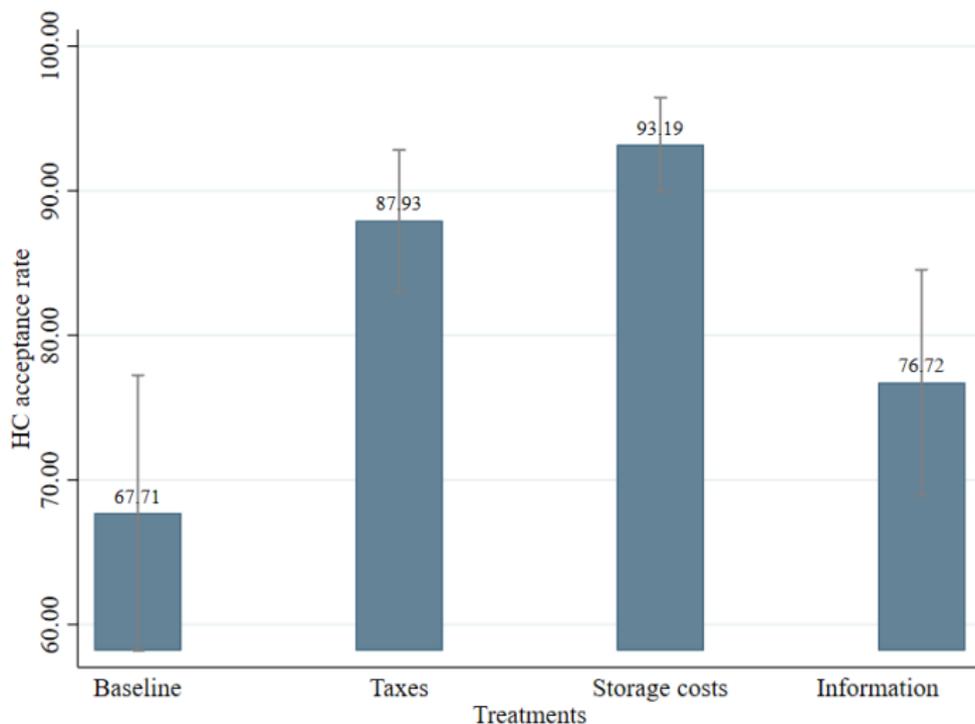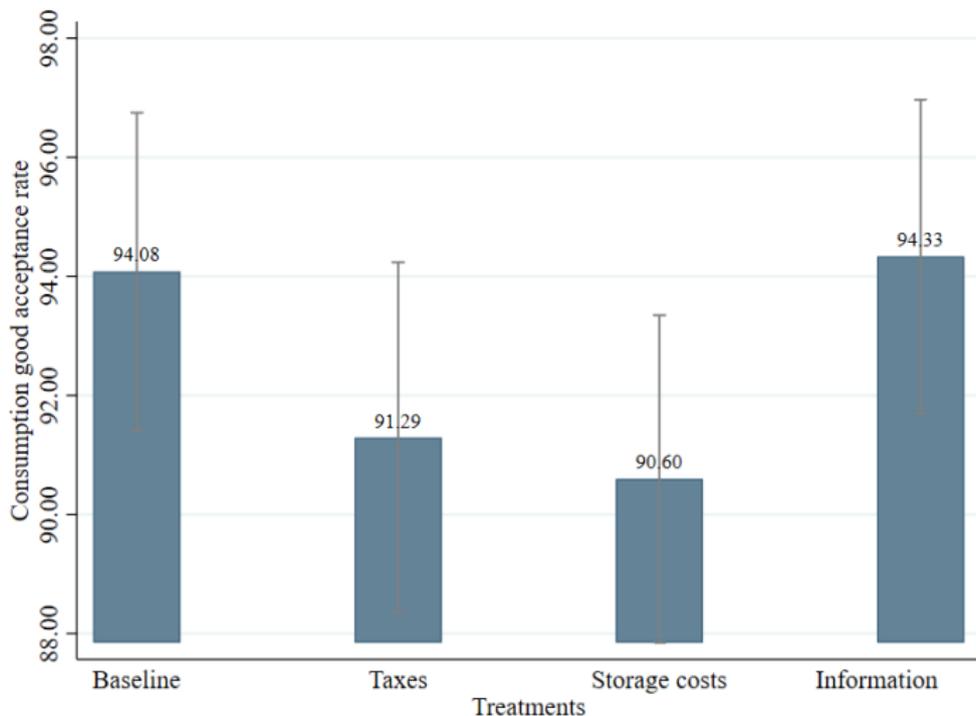*** p<0.01, ** p<0.05, * p<0.1

Figure: **Home currency acceptance rate**

Figure: **Home currency acceptance rate**

This technology determines the probability, α_{ij}, that an agent of economy i matches with an agent of economy j. We present the matching probabilities as functions of parameters (n, ρ):

Table: Matching Probabilities

	Red Agent	Blue Agent
Red Agent	$\alpha_{rr} = 1 - \rho(1-n)$	$\alpha_{rb} = \rho(1-n)$
Blue Agent	$\alpha_{br} = \rho n$	$\alpha_{bb} = 1 - \rho n$

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Appendix: Monetary Equilibria I

- Let λ_{ij} be a dummy variable defined as $\lambda_{ij} = 1$ if sellers from country i accept the foreign currency when paired with buyers from country j, and 0 otherwise. The regimes we study are completely characterized by $\lambda = (\lambda_{rr}, \lambda_{rb}, \lambda_{br}, \lambda_{bb})$.

- When two agents of different nationalities are matched, $i \neq j$, the stationarity conditions of currency holdings are given by:

$$\underbrace{m_{i0} m_{ji}}_{\text{outflow of currency } i \text{ from country } j} = \underbrace{m_{ii} m_{j0} \lambda_{ji}}_{\text{inflow of currency } i \text{ to country } j}$$

$$\underbrace{m_{i0} m_{jj} \lambda_{ij}}_{\text{inflow of currency } j \text{ to country } i} = \underbrace{m_{ij} m_{j0}}_{\text{outflow of currency } j \text{ from country } i}$$

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Appendix: Monetary Equilibria II

- Let V_{i0} represent the expected lifetime utility of a seller from economy i and V_{ik} the lifetime utility of a buyer from economy i with the currency $k \in \{r, b\}$.

- Foreign currency acceptance can vary among circulation regimes and is defined, endogenously, by the following **incentive compatibility restriction** for a seller of economy i who matches with a buyer of economy $k\{i, j\}$.

$$\lambda_{ik} = \begin{cases} 1 & \text{if } V_{ij} - \tau_i^0 \mathbf{1}_{\{k=i\}} > V_{i0} \\ 0 & \text{if } V_{ij} - \tau_i^0 \mathbf{1}_{\{k=i\}} \leq V_{i0}, \end{cases}$$

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