On the Emergence of International Currencies: An Experimental Approach*

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Abstract

We integrate theory and experimental evidence to study the emergence of different international monetary arrangements based on the circulation of two intrinsically worthless fiat currencies as media of exchange. Our framework is based on a two-country, two-currency search model where the value of each currency is jointly determined by private agents' decisions and monetary policy formalized as changes in a country's money growth rate. Results from the experiments indicate subjects coordinate on a regime where both currencies are accepted even when other regimes are theoretically possible. At the same time, we find the acceptance of foreign currency depends on relative inflation rates where sellers tend to reject payment with a more inflationary foreign currency. We also document the presence of learning in shaping acceptance patterns over time.

Keywords: international currency, monetary policy, inflation, experimental macroeconomics
JEL Classification: C92, D83, E40

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1 Introduction

The study of international currencies as media of exchange is a fundamental aspect of international economics with a long and diverse history. Prominent international currencies such as the gold coin of the Byzantine Empire, pound sterling in the 1900s, and more recently, the U.S. dollar, have risen and fallen in prominence over time (Eichengreen, 2020). It is important to emphasize that a currency's standing as an international medium of exchange is influenced by both choices made by private citizens and governments. In particular, monetary policy plays a crucial role in policymakers' ability to impact the global status of their currency. For instance, by lowering domestic inflation, monetary policy reduces the opportunity cost of using the domestic currency, providing both domestic and foreign citizens with more incentives to adopt and use it. In an open economy, citizens may opt to substitute to a less inflationary foreign currency such as the U.S. dollar, which is considered a more stable store of value. Understanding the factors influencing currency substitution is also of recent interest given the emergence of multiple cryptocurrencies that may compete with local currencies as a means of payment.

The objective of this study is to contribute to a more comprehensive understanding of currency preferences of buyers and sellers and the conditions under which different international currency regimes arise. In particular, we focus on how fundamentals like a country's money growth rate affect coordination on the use of one or more currencies as media of exchange. Our main contribution is to integrate monetary theory with experimental evidence to study the conditions under which different international transaction patterns arise and investigate the dynamics of currency acceptance and use. Specifically, we design a laboratory experiment that implements an open-economy search model with microfoundations on the circulation of multiple currencies and a role for inflation in order to answer the following questions: First, how do fundamentals and policies affecting relative money growth rates affect the emergence of different monetary regimes? Second, what are the dynamics of currency adoption and use? Finally, given the presence of multiple equilibria, how does coordination on different currency regimes evolve over time?

We rely on experimental methods in this study for several important reasons. First, the model we are working with features microfoundations on the use of multiple currencies which means there are certain assumptions – e.g., random matching and bargaining – that may not be easily captured in naturally occurring field data. This makes it difficult to empirically assess some of the model's aggregate predictions. Laboratory experiments instead can be used to evaluate both individual and aggregate outcomes since we generate data from an experiment designed to specifically implement the model. Second, our model admits multiple equilibria regarding the circulation of currencies and therefore is silent on which equilibrium individuals ultimately coordinate on. Laboratory methods provide a means for resolving equilibrium selection and is an important rationale we use experiments. Third, isolating the main factors driving the use and acceptance of multiple currencies is challenging for several reasons that can be at least partially alleviated using experimental methods. Empirical findings on currency competition are limited due to the lack of micro-level field data. For instance, existing studies rely on rare natural experiments or survey evidence that are not

incentivized and prone to measurement issues.[1] Experimental methods allow us to directly observe currency use and acceptance over time instead of relying on proxies for these decisions. In addition, we can isolate the key factors influencing the use and acceptance of currencies by providing clean control of the laboratory environment. Finally, controlled monetary policy experiments in the field can be costly, infeasible, and unethical to implement. Experiments instead provide a systematic way to examine the effects of policy and collect data without causing harm to individuals or the economy. Overall, we view experimental methods as a useful complement to existing research that can offer insights into the effects of monetary policies on currency competition that are otherwise difficult to establish.

The theoretical framework for the experiment is based on a two-country, two-currency search model developed by Zhang (2014). Search-theoretic models are particularly useful at addressing international currency use, since they explicitly formalize the essential role of money in different transactions rather than assuming circulation patterns exogenously. In the model, each country issues one currency distributed lump-sum to domestic residents. Gains from trade between buyers and sellers can be facilitated with a portfolio of currencies. However, while sellers always accept domestic currency, they must incur a fixed cost in order to accept foreign currency.[2] Since sellers' acceptance decisions depend on buyers' portfolio choices, and vice versa, complementarities in the trading environment lead to multiple steady-state equilibria where zero, one, or two international monies can emerge. For instance, when acceptance costs are sufficiently high, an equilibrium with two national currencies arises endogenously. Network externalities can also lead to coordination failures, with no guarantee that the socially efficient monetary system maximizing aggregate welfare is chosen.

By formalizing the role of currency in payments, the model provides a channel for monetary policy – through changes in a country's money growth rate – to affect prices, trade, and welfare. For instance, currency substitution occurs as an endogenous response to local inflation: as it becomes more costly to hold local money, agents start substituting with foreign currency such as dollars. This captures the phenomenon of dollarization common in many Latin American and eastern European economies. The theory also emphasizes an important influence on the choice of money as an international medium of exchange. Fundamentals like inflation, as well as expectations regarding other agents' behavior, jointly determine this decision and thereby determine the circulation patterns that arise. Due to inertia, it may be difficult to dislodge an incumbent currency from its international role. At the same time, a change in inflation can permanently shift payment patterns. International currency use, therefore, reflects both fundamentals and history, consistent

[1] Colacelli and Blackburn (2009) is an exception and study the circulation of secondary currencies using micro-level survey data from Argentina. Even in cases where field data is available, it is not always possible to use it to verify whether individual behavior supports assumptions or predictions of theoretical models.

[2] The idea is quite general and is based on the fact that an object that is widely recognizable, such as dollars in the U.S., is better at facilitating trade than alternatives. For example, the fact that sellers in the U.S. are not as familiar with pesos makes them reluctant to accept pesos as payment unless some costly information is acquired. See e.g. Lester, Postlewaite, and Wright (2012), Li, Rocheteau, and Weil (2012), Zhang (2014), and Gomis-Porqueras, Kam, and Waller (2017) for formal models.

with what we observe in practice. While the strategic complementarities and multiple equilibria are intuitive at capturing international payment patterns, the theory is silent on which of many potential equilibria is more likely.

To better understand how relative money growth rates affect the emergence of different international currency regimes and address issues related to equilibrium selection, we design a laboratory experiment based on the model described above. The experiment involves human subjects making individual decisions over time in a similar manner as those in the theoretical model. In particular, subjects are divided into two countries, Red and Blue, and assigned roles as buyers or sellers. Subjects first interact all together in a centralized market where they receive lump-sum transfers of domestic tokens and trade a consumption good at an endogenous market price. The main role of this market is to allow subjects to rebalance their portfolios before proceeding to a decentralized market featuring pairwise meetings and bargaining between buyers and sellers across countries. In addition, prior to being matched, sellers can choose to accept foreign tokens at a fixed cost. Once matched, buyers and sellers bargain over the terms of trade. The key outcome variables are then inflation, foreign currency acceptance, consumption, production, and welfare.

The main treatment variable in the experiment is the money growth rate of each currency. The Baseline treatment features the same money growth rates for both currencies and is parameterized so that four currency regimes are theoretically possible: an equilibrium with two national currencies where both country's sellers only accept local currency, two equilibria with one national currency and one international currency where one country's sellers only accept local currency while the other country's sellers accept both currencies, and finally an equilibrium with two international currencies where both country's sellers accept both currencies. In the Blue30 treatment, the Blue currency's growth rate is set higher than the Red currency's growth rate, which implies an equilibrium with two international currencies ceases to exist as the two currencies are no longer perfect substitutes. Finally, in the Blue90 treatment, the Blue currency's growth rate is set even higher than in the Blue30 treatment, such that the blue currency is no longer valued and therefore not used in any equilibrium.

Results from the experiments offer a detailed understanding of how different money growth rates across treatments and countries affect inflation, foreign currency acceptance, output, and welfare. First, the behavior of inflation aligns with theoretical predictions: higher money growth generates higher inflation in the experiments, consistent with the literature (see Section 2 for a detailed discussion). Second, our experiments establish new findings concerning sellers' decision to accept foreign currency. In settings with different money growth rates, sellers tend to accept the less inflationary currency more frequently than the more inflationary currency. This finding underscores the importance of relative money growth rates in establishing a currency's international role. Finally, our experiments also identifies instances where theoretical predictions are not supported. While the model predicts a country with higher money growth has lower welfare, we do not find significant support in the experiments. While we do not detect significant differences in welfare across treatments, we identify factors in the bargaining process indicating subjects have

more difficulty negotiating mutually acceptable trades when using currencies with different money growth rates.

The remainder of the paper is organized as follows. Section 2 discusses related literature and highlights our contribution. We introduce the theoretical framework in Section 3 that forms the basis for the experiments. Section 4 describes the experimental design and procedures, and Section 5 highlights the main results from the experiments. We conclude in Section 6 with closing remarks and paths for future research.

2 Related Literature

Our study broadly fits within a growing literature studying monetary economics and macroeconomics using experimental methods (see Duffy (1998, 2010, 2016, 2022) and Hommes (2021) for a comprehensive overview). In particular, we contribute to two branches in this literature: experiments on multiple currencies as media of exchange using search-theoretic models and experiments on the real effects of inflationary monetary policies.

The closest paper to our study is Ding and Puzzello (2020) who also use experimental methods to implement the two-country, two-currency model of Zhang (2014) but with constant money supplies.[3] The key contribution of the present paper relative to Ding and Puzzello (2020) is our introduction of active monetary policies through a constant money growth rule associated with each country's currency. Importantly, our focus on how different money growth rates affect the international status of a currency is distinct and novel. The design of our experiment also differs along several key dimensions. First, we offer subjects a considerable amount of feedback on decisions, particularly in the bargaining stage, by introducing decision aids in the experimental interface that allow subjects to see the consequences of different actions before committing to a decision. Second, given the added complexity introduced with money injections over time, we streamlined other aspects of the design, e.g., keeping the rest of the environment symmetric across countries and removing legal restrictions on foreign-currency transactions. In terms of results, our findings on equilibrium selection are consistent with Ding and Puzzello (2020): both of our studies find that subjects coordinate on an equilibrium where they tend to accept both currencies, despite treatment differences, indicating a regime with multiple currencies may be a more robust outcome than other ones. Since the two studies focus on different treatment variables – i.e., legal restrictions and costs of accepting foreign currency vs. money growth rates – our results on the effects of money growth are distinct and not directly comparable to Ding and Puzzello (2020). Overall, we view our studies as complementary that together offer a more nuanced understanding of the factors driving the rise and fall of international circulation patterns.

Early contributions to the study of money as a medium of exchange using experimental methods include Brown (1996) and Duffy and Ochs (1999, 2002), which implement versions of the Kiyotaki and Wright (1989, 1993) model with indivisible commodity and fiat money, respectively. Duffy

[3] See Craig and Waller (2000), Zhang (2014), Geromichalos and Simonovska (2014), and Lagos, Rocheteau, and Wright (2017) for more detailed overviews of the related literature on search-theoretic models with multiple currencies.

and Puzzello (2014b) pioneered the use of divisible money search models in the laboratory by comparing experimental environments based on Lagos and Wright (2005) and Aliprantis, Camera, and Puzzello (2007b) where money is and is not essential. Camera and Casari (2014) examine a related issue of coordination on monetary equilibria in a different framework featuring decentralized matching. More recently, Davis, Korenok, Norman, Sultanum, and Wright (2022) and Jiang, Norman, Puzzello, Sultanum, and Wright (2024) study whether fiat money is essential in finite horizon economies where monetary exchange may or may not be supported in equilibrium.

This paper also relates to experiments studying multiple currencies using search-theoretic models with indivisible currencies and no money growth. Jiang and Zhang (2018) study currency competition by implementing a two-country, two-currency search model based on Matsuyama, Kiyotaki, and Matsui (1993) which has fixed prices and therefore exchange rates. In contrast, prices are endogenous in our study and key outcome variables we investigate in the experiments. Similar to us, they find subjects tend to coordinate on a regime where both currencies are everywhere accepted. Arrieta-Vidal, Florián, López, and Morales (2022) develop a similar experiment as Jiang and Zhang (2018) but with de-dollarization policies designed to reduce foreign currency acceptance and find such policies do promote the use of local currency. Rietz (2019) studies the effects of introducing a secondary currency in an experiment based on a two-currency version of Kiyotaki and Wright (1993). Relative to these studies, we introduce multiple divisible currencies and active monetary policies through changes in money growth rates. We therefore directly obtain observables from the laboratory such as prices and inflation that these studies abstract from by design.

There are also experimental studies with multiple assets or payment instruments using alternative monetary models. Arifovic (1996) studies the behavior of exchange rates in a two-currency overlapping generations model based on Kareken and Wallace (1981) where the nominal exchange rate is indeterminate. Exchange rates fluctuate over time in human subject experiments, which can be well captured using a genetic algorithm learning rule. Noussair, Plott, and Riezman (1997) also examine exchange rates in a two-currency cash-in-advance economy when subjects must carry foreign currency before purchasing foreign goods, therefore abstracting from currency choice and acceptance. While the exchange rate is also observable in our experiment, we abstract from a detailed analysis in this study and delegate a closer investigation in a companion paper. Camera, Noussair, and Tucker (2003) examine the use of assets dominated in rate-of-return in an experimental economy with a fiat currency and real asset. Arifovic, Duffy, and Jiang (2023) develop an experimental framework to understand the factors driving the adoption of a new payment method when there is an already existing payment method accepted by sellers. In contrast with these studies, we focus on how inflation affects the use and acceptance of two intrinsically worthless currencies.

Finally, our study also contributes to a growing experimental literature that investigates the real effects of inflationary monetary policies in search-theoretic models of money. Duffy and Puzzello (2022) implement a version of Lagos and Wright (2005) to study the real effects of deflationary policies and different implementations of the Friedman rule. They also consider an inflationary

monetary policy in one treatment and find, in contrast with theory and our study, that inflation leads to higher output and welfare. Jiang, Puzzello, and Zhang (2023) use a similar framework and focus on the effects of inflationary monetary policies and different money injection schemes. We implement a similar lump-sum transfer scheme to introduce increases in the money supply and similarly find the quantity theory holds, i.e. higher money growth rates lead to higher inflation rates.[4] The present study complements this literature by introducing two currencies, both of which can grow over time.

3 Theoretical Framework

We first describe the theoretical framework that forms the basis for the experiments. The model is based on the two-country, two-currency model of Zhang (2014). An advantage of this framework is it provides microfoundations for the use of different currencies as media of exchange and is therefore amenable to laboratory experiments. The model also features divisible currencies and goods which makes it possible to study the effects of monetary policy through changes in the money growth rate. See Zhang (2014) for details in a slightly more general formalization.

Time is discrete and continues forever. There are two countries, Red and Blue, populated with a finite number of $2N_r$ and $2N_b$ agents, respectively, where N_r and N_b denote country sizes.[5] Each period consists of two stages where the economic activity will differ: stage 1 (CM) features centralized meetings where agents can trade a general good in order to rebalance their portfolios, while stage 2 (DM) features pairwise meetings and bargaining over local and foreign goods. In the CM, all trade occurs in a frictionless competitive market where agents can consume a numéraire good, which is produced with a linear production function in labor. The supply of hours in the CM is h, which implies the real wage is one given competitive labor markets in the CM. In the DM, agents from each country are evenly divided between *buyers* and *sellers*. Sellers from $s = \{r, b\}$ can produce output q_s but do not want to consume, while buyers want to consume but cannot produce. In this study, we focus on a uniform matching technology across countries where conditional on being a buyer, the probability of being matched with a domestic seller is $\alpha = 0.5$, and the probability of being matched with a foreign seller is $(1 - \alpha) = 0.5$.[6]

For tractability, instantaneous utilities for buyers and sellers are additively separable and quasi-

[4]See also Duffy and Puzzello (2022) and Jiang, Puzzello, and Zhang (2023) and references therein for earlier experimental studies incorporating inflationary monetary policies using alternative frameworks, such as Marimon and Sunder (1993, 1994, 1995), Lim, Prescott, and Sunder (1994), Lian and Plott (1998), Bernasconi and Kirchkamp (2000), Deck, McCabe, and Porter (2006), and Anbarci, Dutu, and Feltovich (2015).

[5]Due to the finite population, informal enforcement schemes can theoretically arise (see Aliprantis, Camera, and Puzzello (2007a) and Araujo, Camargo, Minetti, and Puzzello (2012)). In a similar framework but in a closed economy with one currency and a constant money supply, Duffy and Puzzello (2014a) find informal enforcement schemes do not emerge in experiments with 6 and 14 subjects.

[6]More generally, search and information frictions can make international trade more difficult than local trade. See, e.g., Zhang (2014) where buyers are mobile while sellers are immobile such that with probability α, a buyer stays in his country of origin and with probability $1 - \alpha$, visits the foreign country. One can interpret α then as the degree of economic integration, which we fix for the present study but intend to vary in follow-up work

linear in labor hours h:

$$\mathcal{U}^B = U(x) - h + u(q_s),$$

$$\mathcal{U}^S = U(x) - h - c(q_s),$$

where x is CM consumption, h is CM production using labor, and q_s is quantity traded in the DM of country s. To ease the complexity of our experiment, functional forms for utilities and cost functions are assumed to be the same across countries. Further, $u(\cdot)$ and $c(\cdot)$ are assumed to be C^2 with $u' > 0$, $u'' < 0$, $c' > 0$, $c'' > 0$, $u(0) = c(0) = c'(0) = 0$, and $U'(0) = u'(0) = \infty$. Also, let $q^* \equiv \{q : u'(q^*) = c'(q^*)\}$ and $x^* \in (0, \infty)$ solve $U'(x^*) = 1$. All goods are perishable, and agents discount the future between periods with a discount factor $\beta \in (0, 1)$. Since agents lack commitment and individual histories are private information in the DM, unsecured credit cannot be used, which makes a medium of exchange essential for trade.

Each country issues its own fiat currency, $i = \{r, b\}$, both intrinsically worthless, divisible, and storable. Currency $m_i \in \mathbb{R}_+$ is valued at ϕ_i, the price of money in terms of the numéraire. The nominal exchange rate is defined here as the price of the blue currency in terms of the red currency, $\frac{\phi_b}{\phi_r}$. Since market clearing in the CM implies that the law of one price holds, agents can trade currencies at the market clearing exchange rate. Hence, the CM also functions as a foreign exchange market. Money supplies, M_i, grow or shrink each period at a constant rate $(\gamma_i - 1)$, where $\gamma_i \equiv \frac{M_i'}{M_i}$. Variables with a prime denote next period's parameters or choices. Changes in the money supply are implemented through lump-sum monetary transfers or taxes of domestic currency in the CM to that country's buyers.

While domestic currency is perfectly recognizable, it is difficult for sellers to verify the quality of foreign currency. In particular, they must incur a fixed flow cost, $\psi_s \geq 0$, at the start of the DM in order to recognize and hence accept payment in foreign money. For example, firms must invest in a verification device in order to authenticate genuine foreign notes from counterfeits. Alternatively, firms must install new technologies such as debit card devices and new cash registers, or incur administrative costs for dealing with multi-payment options. The fixed cost is homogeneous across sellers within a country but can differ across countries. It is common knowledge in a match whether the seller has invested, and sellers do not accept currencies they do not recognize.

In what follows, we focus on stationary equilibria where real balances are constant over time. In addition, we focus on equilibria where sellers always accept their domestic currency but must decide whether or not to accept foreign currency. The model generates different equilibria (i.e., currency regimes) defined by sellers' foreign currency acceptance decisions:

1. National currency regime (N, N): both country's sellers only accept their local currency.

2. Blue international currency regime (N, I): Blue sellers only accept their local currency, whereas Red sellers accept both currencies.

3. Red international currency regime (I, N): Red sellers only accept their local currency, whereas Blue sellers accept both currencies.

4. Two international currencies regime (I, I): both country's sellers accept both currencies.

The equations determining equilibrium are summarized in Appendix A (see Zhang 2014 for additional details on the derivation). Since the model generates multiple equilibria for the same parameter values, equilibrium selection is an important reason we go to the lab.

4 Experimental Design

In this section, we first describe the parameter values used for the experimental treatments, summarize the key theoretical predictions evaluated by the experiments, and state our hypotheses. Next, we summarize the experimental procedures and administration. Finally, we discuss the experimental implementation, including a description of the decision aids and the interface. We use the term "token" instead of "money" or "currency" when discussing the experiment in order to align with the terminology presented to subjects. Similarly, we use the terms Red group and Blue group when referring to the two countries in the experiment.

4.1 Parameter Values and Hypotheses

The objective of this paper is to study the effects of monetary policy implemented through changes in money growth on inflation, the use and acceptance of different currencies, and welfare. The money growth rate for each currency is therefore the main treatment variable of the experiments. Specifically, we design three treatments that vary the Blue token's growth rate. In the *Baseline* treatment, both tokens have the same token growth rate so that the token supplies grow by 5% each period ($\gamma_r = \gamma_b = 1.05$). In the *Blue30* treatment, the Blue token has a higher growth rate than the Red token. In particular, the growth rate of Blue tokens is 30% each period ($\gamma_b = 1.3$) while the growth rate of Red tokens remains at 5% ($\gamma_r = 1.05$). Finally, in the *Blue90* treatment, the growth rate of Blue tokens is 90% each period ($\gamma_b = 1.9$) while the growth rate of red tokens remains at the same 5% ($\gamma_r = 1.05$) as the previous two treatments.[7]

[7] There are several reasons for the magnitudes of token growth rates we chose for the treatments. First, we chose 5% token growth rates in the Baseline treatment rather than 0% growth since we did not want a constant money supply to be a focal point for the experiment. Second, we chose 30% growth for the Blue token in the Blue30 treatment since this magnitude is considerably higher than the baseline magnitude of 5% growth and in line with magnitudes used in the literature, e.g. Duffy and Puzzello (2022) and Jiang, Puzzello, and Zhang (2023). Finally, we chose a 90% growth rate for the Blue token in the Blue90 treatment since this growth rate supports the existence of non-monetary equilibria across currency regimes as discussed in the main text.

Table 1: Treatment Parameters and Theoretical Predictions

		Baseline				Blue30			Blue90		
Parameters	Blue token growth rate (γ_b)	1.05				1.30			1.90		
	Red token growth rate (γ_r)	1.05				1.05			1.05		
	Buyer's bargaining power	0.50				0.50			0.50		
	Degree of economic integration (α)	0.50				0.50			0.50		
	Discount factor	0.875				0.875			0.875		
	Equilibrium	(N,N)	(N,I)	(I,N)	(I,I)	(N,N)	(N,I)	(I,N)	(N,N)	(N,I)	(I,N)
Theoretical Predictions	**Red Country**										
	Inflation rate	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	Foreign Currency Acceptance	No	Yes	No	Yes	No	Yes	No	No	Yes	No
	Red Tokens	21.51	0.00	31.18	0.17-33.98*	21.51	7.51	23.96	21.51	6.91	11.97
	Blue Tokens	21.51	31.18	0.00	0.17-33.98*	3.04	14.00	0.00	0.00	0.00	0.00
	Qty DM traded	8.35	15.35	15.35	17.75	4.29	6.17	9.99	4.17	0.56	3.03
	Welfare DM	13.16	14.83	15.83	15.40	13.16	11.37	13.97	13.16	3.34	8.94
	Blue Country										
	Inflation rate	0.05	0.05	0.05	0.05	0.3	0.3	0.3	0.9	0.9	0.9
	Foreign Currency Acceptance	No	No	Yes	Yes	No	No	Yes	No	No	Yes
	Red Tokens	21.51	0.00	31.18	0.17-33.98*	21.51	7.51	23.96	21.51	6.91	11.97
	Blue Tokens	21.51	31.18	0.00	0.17-33.98*	3.04	14.00	0.00	0.00	0.00	0.00
	Qty DM traded	8.35	15.35	15.35	17.75	4.29	6.17	9.99	4.17	0.56	3.03
	Welfare DM	13.16	15.83	14.83	15.40	7.98	10.79	12.97	6.60	1.45	7.93

Notes: Welfare is measured by the utility of consumption and disutility from production in the DM and averaged across buyers and sellers per round. In the *Equilibrium* row, 'N' denotes 'national' currency – i.e., only accepted in the home country – and 'I' denotes 'international' currency – i.e., accepted in both countries. * For the (I,I) equilibrium, Red and Blue tokens are perfect substitutes, allowing for a range of values as a solution.

Table 1 presents parameters used for each treatment, equilibria in terms of currency regimes predicted to exist by the model, and the outcomes associated with each currency regime. Across treatments, we vary the growth rate of the Blue tokens (row 1) and keep constant all other parameters (rows 2–5). The row labeled *Equilibrium* distinguishes among different currency regimes with an "N" and "I" denoting the "national" currency and "international" currency, respectively. The outcomes associated with each equilibrium predicted by the model are presented in the bottom

part of the table, labeled *Theoretical Predictions*. We focus on three variables of interest: (i) inflation, (ii) foreign currency acceptance, and (iii) welfare. The first variable of interest is inflation. In particular, in accordance with the quantity theory of money, changes in money growth lead to one-to-one changes in inflation. Specifically, our design enables comparisons of inflation both across treatments and groups such that:

$$\pi_r^{\text{Baseline}} = \pi_r^{\text{Blue30}} = \pi_r^{\text{Blue90}} = \pi_b^{\text{Baseline}} < \pi_b^{\text{Blue30}} < \pi_b^{\text{Blue90}},$$

where π_i denotes the inflation rate of currency $i \in \{r, b\}$. We summarize these relative rankings in Hypothesis 1.

Hypothesis 1 *Inflation rates respond to money growth rates such that:*

(a) *Inflation of the Red token is the same for all treatments.*

(b) *Inflation of the Blue token is lowest in the Baseline and highest in Blue90 treatment.*

(c) *Inflation of the Blue token is the same as inflation of the Red token in the Baseline treatment.*

(d) *Inflation of the Blue token is higher than inflation of the Red token in the Blue30 and Blue90 treatments.*

The second variable of interest is the foreign currency acceptance decision. In the Baseline treatment, the theory predicts all four currency regimes exist, whereas only three currency regimes exist in the Blue30 and Blue90 treatments. That is, regime (I, I) is not an equilibrium in the Blue30 and Blue90 treatments since a necessary condition for both currencies to be perfect substitutes – as is the case when all sellers accept foreign currency – is for the two money growth rates to be equal (see Appendix A and Zhang 2014 for further details). Furthermore, as the blue currency growth rate increases past a certain threshold, the blue currency is no longer valued, and hence the three currency regimes are non-monetary equilibria in terms of the Blue currency. Hence, we choose a 90% growth for the Blue token in the Blue90 treatment as this growth rate supports the existence of non-monetary equilibria across the existing currency regimes, as illustrated with the zero Blue tokens in the last three columns of Table 1. As Table 1 shows, agents rely on red token alone for DM transactions under the Blue90 parameter set. We summarize these observations with Hypothesis 2.

Hypothesis 2 *Foreign currency acceptance decisions respond to the money growth rates such that:*

(a) *Acceptance rates are symmetric across groups in the Baseline treatment. Specifically, Blue sellers accept foreign currency at the same rate as Red sellers.*

(b) *Acceptance rates are asymmetric in the Blue30 and Blue90 treatments. Specifically, Blue sellers accept foreign currency at higher rates than Red Sellers.*

Finally, the third variable of interest is welfare. Since quantities and therefore welfare are the same across treatments in the CM, we focus on welfare measured as the total gains from trade in the DM (similar measures are used in the literature, e.g., Duffy and Puzzello (2022), Ding and Puzzello (2020), and Jiang, Puzzello, and Zhang (2023)).[8] We summarize welfare comparisons with Hypothesis 3.

Hypothesis 3 *Welfare responds to the money growth rates such that:*

(a) *Average welfare across Blue and Red subjects is the highest in the Baseline and lowest in the Blue90 treatment.*

(b) *Welfare of Blue subjects is the same as welfare of Red subjects in the Baseline treatment.*

(c) *Welfare of Blue subjects is lower than welfare of Red subjects in the Blue30 and Blue90 treatments.*

4.2 Experimental Protocol and Administration

The experiments were conducted at Purdue University in February 2023, March 2023, and December 2023. We used the ORSEE software (Greiner, 2015) to recruit 240 students for 12 sessions. No subject participated in more than one session, although some subjects may have previously participated in other economics experiments. We adopt a between-subjects design where each session consists of subjects making decisions under either the Baseline, Blue30, or Blue90 parameter set. Subjects in each session were evenly split into Red and Blue groups, and subjects remained in their assigned group throughout the experiment. Sessions lasted approximately 2.5 hours with an average earnings of \$37.5 (including the \$5 show-up fee). Table 2 summarizes session details for the two treatments.[9]

We implement the infinite horizon using random termination protocol (Roth and Murnighan, 1978), where each session consisted of multiple sequences which lasted for an indefinite number of rounds. Specifically, to implement a discount factor of $\beta = 0.875$, we instruct subjects that at the end of each round, the computer would roll a fair eight-sided dice where the sequence would end if 1 is rolled and the sequence would continue to the next round if 2–8 is rolled.[10] In order to match random realizations across session of different treatments, the number of rounds in each sequence and session was pre-drawn using the procedure described to subjects. Table 2 presents the sequence lengths used in the experiment, where the same sequence lengths were matched between the Baseline, Blue30, and Blue90 sessions.

[8] In the model, CM consumption is x^*, where x^* is the first-best level of CM consumption that solves $U'(x^*) = 1$, which is independent of money growth and therefore constant across treatments.

[9] The third session in the Blue90 treatment ended prematurely with 50 minutes left and 16 total rounds played since a participant left due to an emergency. We conducted analysis to verify this session did not look substantially different from the other sessions in the treatment (available by request).

[10] In the instructions, subjects needed to test this procedure five times before continuing (see page 3 of the Instructions in Appendix C). This allowed subjects to observe different possible realizations of sequence lengths, including some very short sequences and some much longer ones.

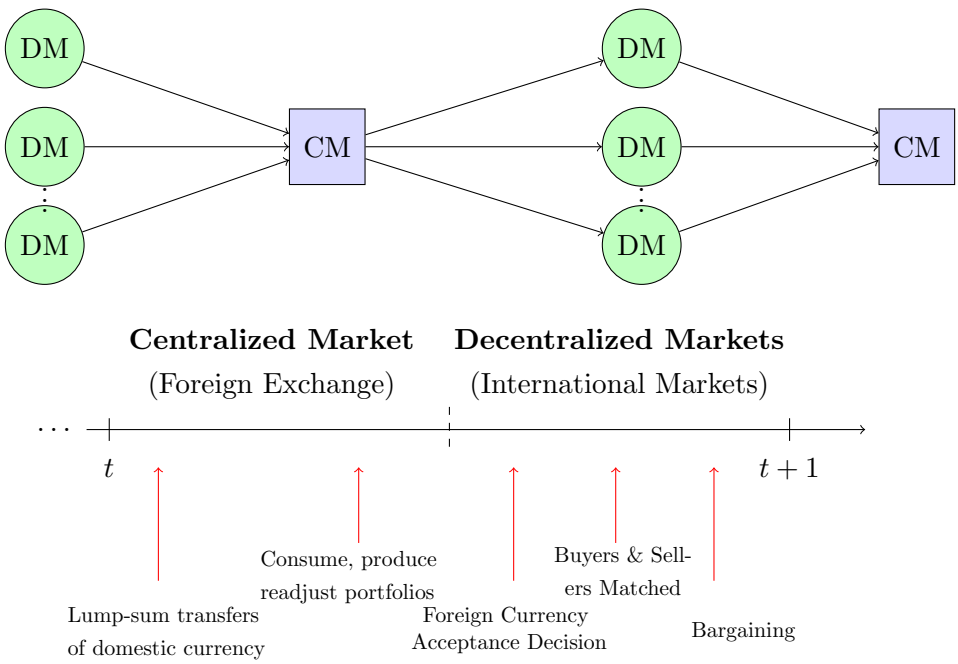
Table 2: Summary of Experimental Sessions

Treatment	Session	Seq. lengths	Subjects	Red	Blue	Rounds	Sequences	Duration	Earnings
Baseline	1	11,7,2,15,6	20	10	10	32	3.8	108 min.	$44
Baseline	2	3,5,16,8,9	20	10	10	25	3.1	104 min.	$34
Baseline	3	7,9,6,1,12	20	10	10	26	4.3	102 min.	$39.2
Baseline	4	9,3,16,4,13	20	10	10	29	3.3	119 min.	$39
Average			20	10	10	28	3.6	108.3 min.	$39.0
Blue30	1	11,7,2,15,6	20	10	10	22	3.1	92 min.	$34.7
Blue30	2	3,5,16,8,9	20	10	10	32	4	112 min.	$32.1
Blue30	3	7,9,6,1,12	20	10	10	35	5	113 min.	$38.7
Blue30	4	9,3,16,4,13	20	10	10	28	3	116 min.	$40.9
Average			20	10	10	29.3	3.8	108.3 min.	$36.6
Blue90	1	11,7,2,15,6	20	10	10	41	5	118 min.	$49.8
Blue90	2	3,5,16,8,9	20	10	10	24	3	109 min.	$27.9
Blue90	3	7,9,6,1,12	20	10	10	16	2	78 min.*	$25.4
Blue90	4	9,3,16,4,13	20	10	10	28	3	114 min.	$44.2
Average			20	10	10	27.3	3.3	104.8 min.	$36.8

Notes: *Red* and *Blue* are the number of subjects assigned to Red and Blue groups, respectively. *Rounds* are the total number of rounds completed. *Sequences* are the number of sequences completed, where decimals represent the proportion of rounds of the last sequence completed. For example, 3.8 for Session 1 of the Baseline treatment means subjects completed 3 full sequences and 12 out of 15 rounds (or 80%) of the fourth sequence. *Duration* is the duration of the main experiment potion (i.e., instructions, quiz, and post-experimental survey are excluded). *Earnings* denotes the average earning for the experiment accounting for the fact that subjects who earned less than $15 were paid $15 to ensure some minimal earning for the 2.5 hours of their time. *: Session ended prematurely (see footnote 9).

Figure 1 summarizes the timing of events within a round of a sequence. In particular, subjects are assigned roles as either buyers or sellers in stage 1 and would reverse roles in stage 2. The assignment of roles is randomly determined at the beginning of the sequence and remains fixed for the duration of the sequence. We allow subjects to act as a buyer and a seller within a round for two main reasons. First, we wanted to give subjects experience with performing both roles as buyers or sellers in a given stage which facilitates subjects learning the consequences of their decisions for both sides. Second, we wanted to reduce variation in subject payments across roles. Since sellers consistently lose points by producing while buyers gain points from consuming, we wanted to avoid subject resentment due to their fixed role.

Figure 1: Timing of Events in a Round



4.3 Instructions, Experimental Interface, and Decision-Aids

The main novelty of this study is the introduction of different money growth rates across two currencies in an experiment based on Zhang (2014). Since subjects' choices in this setting are relatively complex, we made several design choices to aid subjects' decision-making. In particular, we use both verbal and visual displays of instructions of the token injection scheme. At the beginning a each sequence, subjects were informed of the specific amount of new domestic tokens transferred to buyers in each round so that subjects could see the token increase schedule over time. To illustrate how these token increases occur, subjects could could hover over an interactive graph on their computer screen to see specific token amounts for each round. In addition, subjects are provided printed versions of the same graph and a more extensive table of the token growth schedule and lump-sum transfers for the duration of the experiment (see Appendix C for the full set of instructions).

Our experiment also departs in three ways relative to the environment described in Section 3, namely with regards to subjects' roles and actions in the CM and DM. First, recall all agents can consume and produce the CM good in order to rebalance their portfolio of currencies. In the experiment, we assign and fix subjects' roles in the CM as buyers or sellers where only buyers can consume the good and only sellers can produce. This does not change the model's theoretical predictions and has the advantage of simplifying subjects' choice sets. Second, our implementation of Kalai (1977) bargaining in the DM follows the bargaining game in Ding and Puzzello (2020) where upon being matched, a subject in a pair is selected to be a proposer with probability $\theta = 0.5$ while

the other is the responder with complementary probability.[11] Finally, we implement competitive pricing in the CM by having subjects participate in a market game based on Shapley and Shubik (1977), which provides non-cooperative foundations for competitive equilibrium outcomes.[12] In the beginning of each CM, sellers submit a quantity to produce for red and/or blue tokens while buyers submit a bid of red and/or blue tokens for the consumption good. The market price for red (blue) tokens is then computed as the sum of red (blue) tokens bid divided by the sum of production for red (blue) tokens.

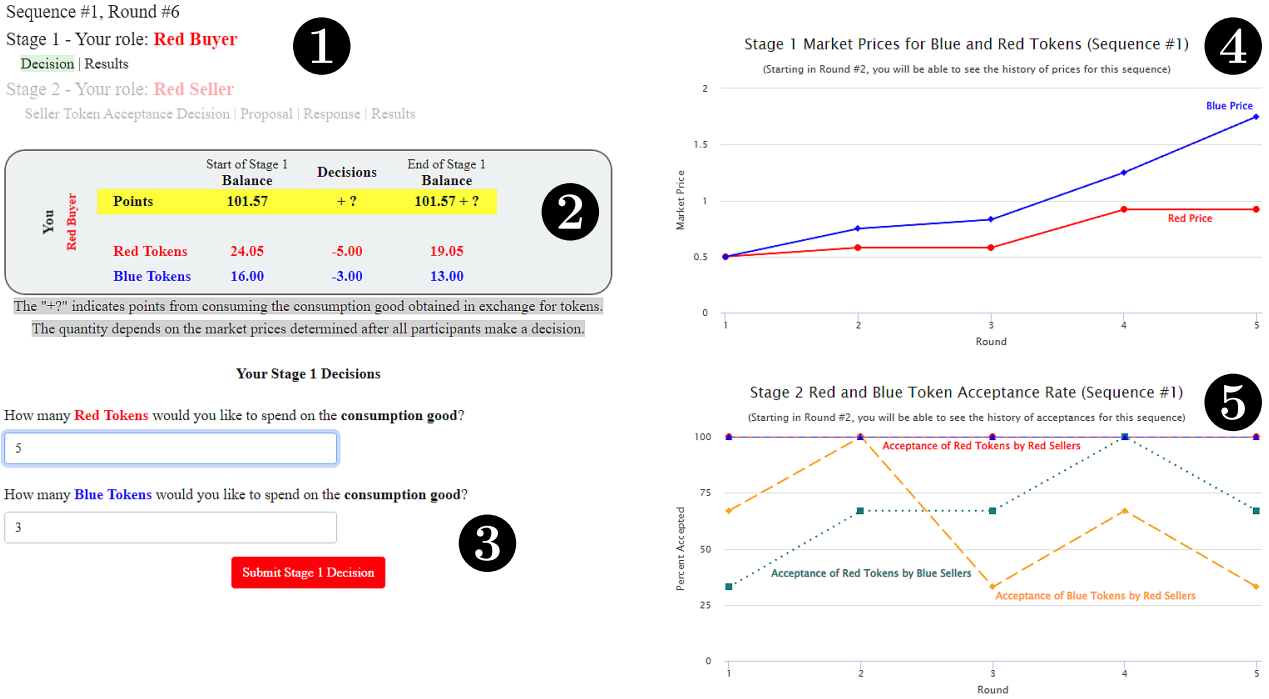
The added complexity associated with introducing money growth motivated several additional changes relative to the design in previous work. First, we use the same functional forms for the utility of consumption and cost of production in both CM and DM stages within a round. Second, we switch the order of the CM and DM to facilitate token transfers at the beginning of each round. Finally, at the beginning of each sequence, we randomly assign half the participants in each group as buyers in the CM and sellers in the DM so that the other half are sellers in the CM and buyers in the DM. These changes streamlined the presentation of the environment while making earnings across participants symmetric (e.g., there is then no need for exogenous transfers to sellers as in Ding and Puzzello (2020)).

To ensure subjects understood the details of the environment and the consequences of their decisions, we undertook the following steps. First, we provide printed copies of the instructions for each subject for the duration of the experiment. Second, subjects were required to answer ten quiz questions following the instructions. Although the questions were not incentivized, subjects could only proceed to the experiment if they answered all questions. If they missed a question, they were given a hint directing them to a specific page of the instructions and had the option to ask for additional explanations from the experimenter. Finally, throughout the experiment, subjects could use decision aids within the computer interface. Upon entering a potential decision but before submitting a final response, subjects could see the consequences of that decision on their payoffs. For example, if a buyer in stage 1 enters how many red tokens they would like to spend on the consumption good, the interface displays the impact on their token balance (see Figure 2a). Similarly, during the offer proposal and response decisions in stage 2, subjects can see the consequences of their proposal for both parties in the match (see Figure 3b).

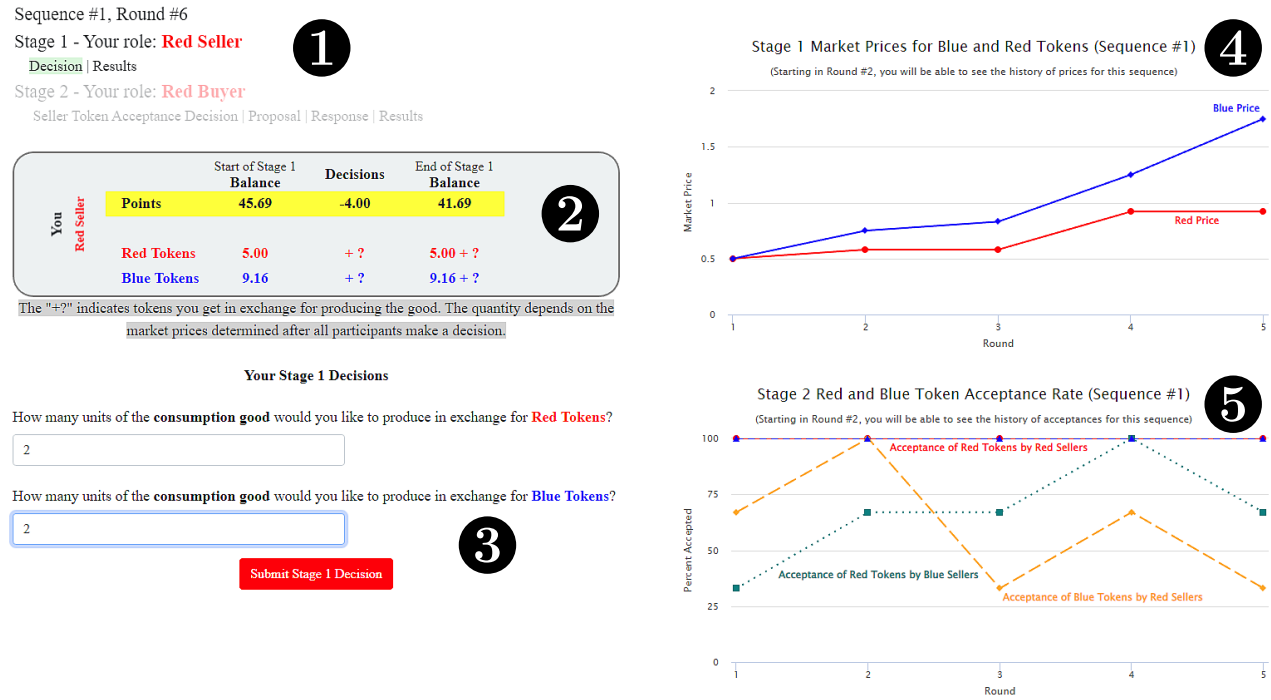
[11] Hu and Rocheteau (2020) provide microfoundations for Kalai bargaining by applying the gradual bargaining approach in decentralized markets of Rocheteau, Hu, Lebeau, and In (2021). Duffy, Lebeau, and Puzzello (2022) investigate Nash and Kalai bargaining solutions in the laboratory and find subjects' actions are closer to the Kalai solution where both parties receive roughly half of the match surplus.

[12] There are several experiments that use the market game to implement competitive markets. See e.g., Arifovic (1996), Duffy, Matros, and Temzeledis (2011), Duffy and Puzzello (2014a), Duffy and Puzzello (2014b), Duffy and Puzzello (2022), and Jiang, Puzzello, and Zhang (2023), among many others.

Figure 2: Centralized Market Screenshots



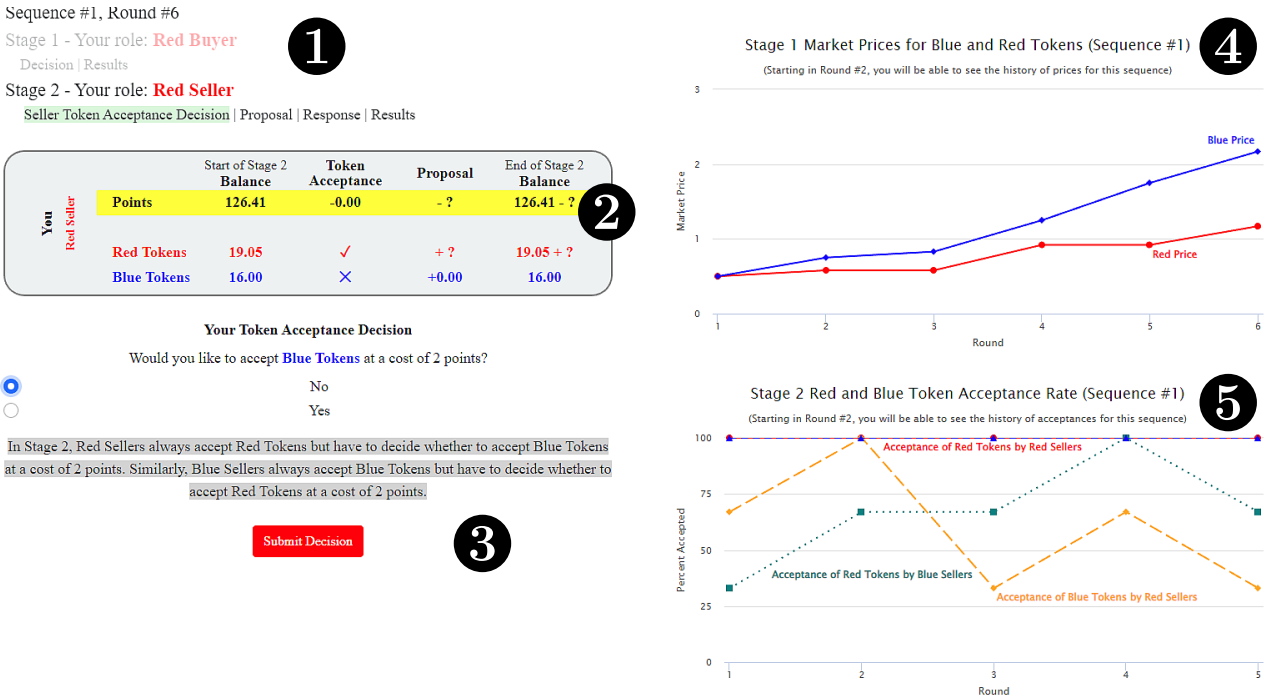
(a) Buyer's Decision



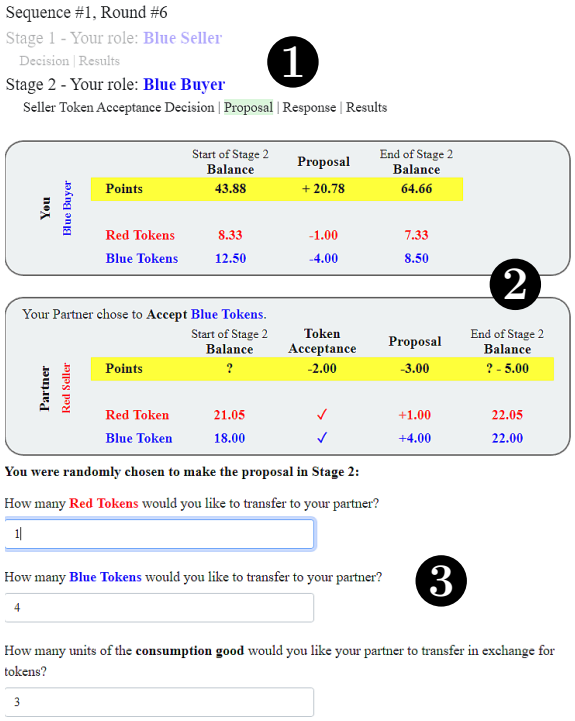
(b) Seller's Decision

Notes: The screenshots show decision screens in the Blue30 treatment. (1) current round and stage summary; (2) impact of decision on points and token balances (updated upon entry); (3) decision entry; (4) history of prices in the CM; (5) history of foreign token acceptance decisions in the DM.

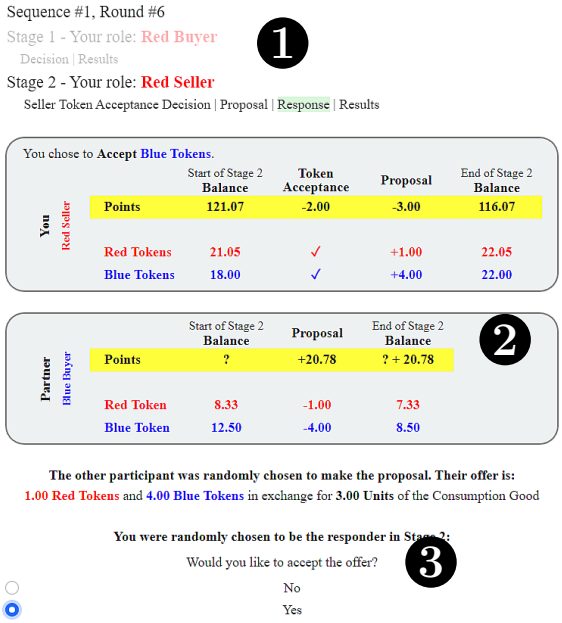
Figure 3: Decentralized Market Screenshots



(a) Sellers' Token Acceptance Decision



(b) Proposer's Decision



(c) Responder's Decision

Notes: The screenshots show decision screens in the Blue30 treatment. (1) current round and stage summary; (2) impact of decision on points and token balances are updated upon entry; (3) decision entry; (4) history of prices in the CM; (5) history of foreign token acceptance decisions in the DM.

Figures 2 and 3 show screenshots of the interface for stages 1 and 2, respectively. Within a sequence, subjects had access to the history of prices and foreign token token acceptance decisions (bullets 4 and 5 in Figures 2 and 3). In addition, the interactive history graphs allowed subjects to hover over each point to get more detailed information such as the exact price in a particular round. The interactive history part of the screen was available on all pages including waiting pages.

5 Results

We now highlight the main results from the experiments. We organize the discussion in terms of three categories of observeables central to our study: inflation in Section 5.1, sellers' foreign currency acceptance rates in Section 5.2, and output and welfare in Section 5.3. All results in this section are based on all data from the experiment.

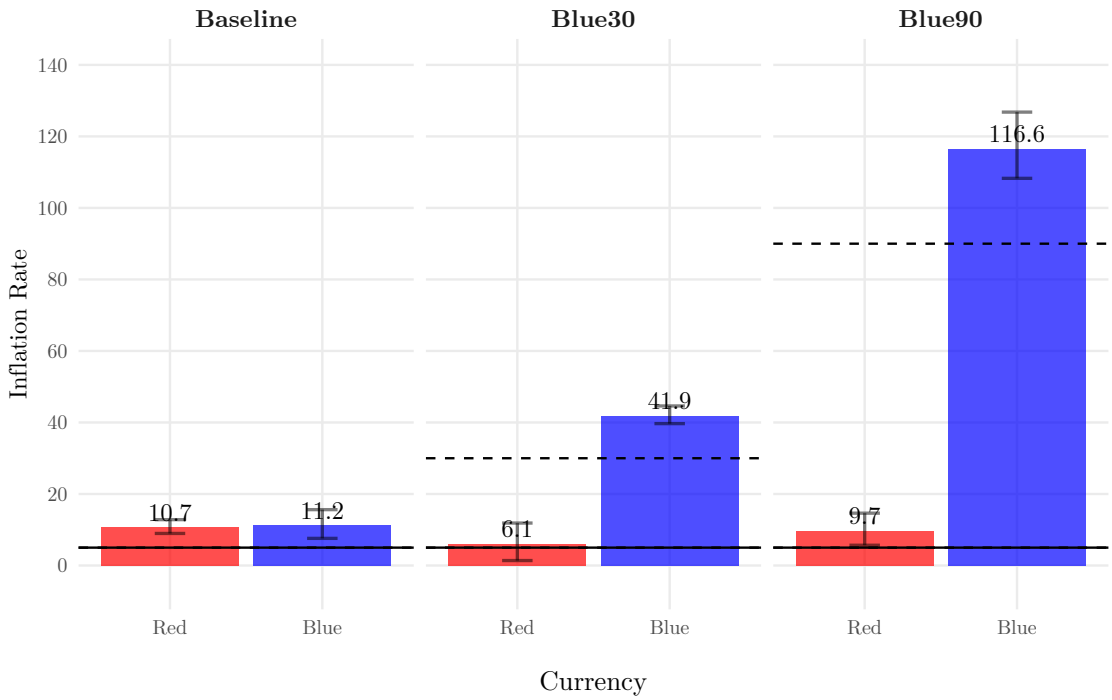
5.1 Inflation

Figure 4 presents estimated inflation rates in each treatment with error bands denoting 95% confidence intervals.[13] Overall, the behavior of inflation is consistent with theoretical predictions. Figure 4 shows estimated inflation of the red token is 10.7%, 6.1%, and 9.7% in the Baseline, Blue30, and Blue90 treatments, respectively, while inflation of the blue token is 11.2%, 41.9%, and 116.6% in the Baseline, Blue30, and Blue90 treatments.

There are several notable observations in Figure 4. First, consistent with Hypothesis 1, blue inflation in both the Blue30 and Blue90 treatments is significantly higher than blue inflation in the Baseline treatment as well as the red inflation in Baseline, Blue30, and Blue90 treatments. Second, inflation rates for treatments where theory predicts the same inflation rate for the red and blue token (i.e., 5% inflation in the Baseline treatment), are not significantly different from each other. We summarize these observations with Result 1.

[13] To estimate inflation, we follow the procedure in Jiang, Puzzello, and Zhang (2023) and regress the natural log of the Blue or Red price in the CM on the round, treatment dummies for Blue30 and Blue90, sequence dummies, and the interaction of treatment dummies with the round. If λ denotes the coefficient on the round, our estimated inflation rate for the Baseline treatment is then e^{λ}, or the growth rate of the price level in the Baseline treatment. Similarly, if λ_{30} (λ_{90}) denotes the coefficient on the interaction term of the round and the Blue30 (Blue90) treatment dummy, then the estimated inflation rate for the Blue30 (Blue90) treatment is $e^{\lambda+\lambda_{30}}$ ($e^{\lambda+\lambda_{90}}$). We summarize the table of regression coefficients and p-values used for Figure 4 in Table 6 in Appendix B.

Figure 4: Inflation (%)



Notes: The black solid line corresponds to the theoretical inflation rate of 5% of the Red token in all treatments; the black dashed lines correspond to the theoretical inflation rates of 30% and 90% of the Blue token in the Blue30 and Blue90 treatments, respectively.

Result 1 *Inflation rates responds to token growth rates in line with theory and Hypothesis 1.*

(a) *In the Baseline Treatment, Red and Blue inflation rates are not significantly different,*

(b) *Blue inflation is significantly higher than Red inflation in the Blue30 and Blue90 treatments,*

(c) *Red inflation is not significantly different in the Blue30 and Blue90 treatments from the Baseline treatment,*

(d) *Blue inflation is significantly higher in the Blue30 and Blue90 treatments than in the Baseline treatment.*

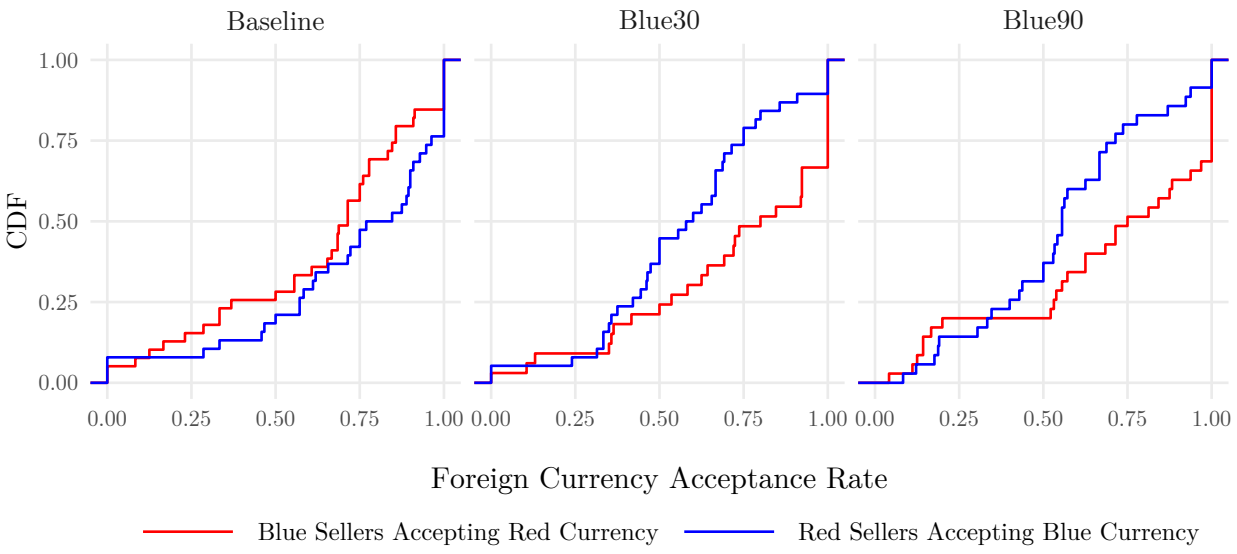
There are several reasons why Result 1 is important. First and foremost, our results on inflation can be used as a check whether our experiment design leads to sensible outcomes. That is, in instances where theory predicts the same inflation rate across treatments or countries, we indeed observe inflation across treatments is not statistically different; in addition, in instances where theory predicts higher inflation of the Blue currency, we observe significantly higher inflation of the Blue currency. Second, the theory provides precise point predictions regarding the inflation rates given the money growth rates. The fact that the endogenous inflation rates from the experiments are close to the theoretically predicted ones is encouraging and is empirical support for the quantity

theory of money. While Hypothesis 1 does not make claims on point predictions, we observe inflation across treatments is higher than theoretically predicted. This inflationary bias is consistent with previous studies, namely Duffy and Puzzello (2022) and Jiang, Puzzello, and Zhang (2023). We also observe the inflationary bias of the blue token is strongest in the Blue90 treatment with highest money growth. Nonetheless, our results are reassuring since comparative static predictions clearly hold across treatments which increases our confidence in interpreting results that are more unique to the particular model we implement – namely foreign currency acceptance and welfare.

5.2 Foreign Currency Acceptance

We now turn our attention to the behavior of sellers when deciding whether to accept foreign currency. In particular, we calculate each seller's average foreign currency acceptance rate in the DM. We then sort sellers based on the frequency with which they accept foreign currency in the experiment and show the cumulative distribution in Figure 5.

Figure 5: Distribution of Token Acceptance Decisions



Notes: Acceptance rates are calculated for each seller in the DM. The red series represents the empirical CDF of the acceptance rates of the Red token by Blue sellers, and the blue series represents the empirical CDF of the acceptance of the Blue token by Red sellers.

Figure 5 shows substantial heterogeneity in foreign currency acceptance within treatments. Nonetheless, several clear patterns emerge across treatments. In the Blue30 and Blue90 treatments, Blue sellers are more likely to accept foreign currency than Red sellers; i.e., Blue sellers are more likely to accept red tokens than Red sellers are to accept blue tokens. Moreover, the distributions in the Blue30 and Blue90 treatments are significantly different using non-parametric Kolmogorov-Smirnov tests (p-values of 0.02 and 0.06, respectively). In addition, there is no significant difference between Red and Blue sellers' foreign currency acceptance rates in the Baseline treatment (p-value of 0.11).

Table 3: Foreign Currency Acceptance Rate (%)

	Mean			Median			Always Accept		
	Baseline	Blue30	Blue90	Baseline	Blue30	Blue90	Baseline	Blue30	Blue90
Red Sellers	72.1	58.0	56.2	80.8	58.9	55.6	23.7	10.5	8.6
	(5.9)	(4.8)	(5.6)	(9.2)	(7.4)	(5.2)	(8.0)	(7.0)	(6.4)
	$\wr$	$\lessdot\lessdot$	$\wedge$	$\wr$	$\lessdot\lessdot$	$\lessdot\lessdot$	$\wr$	$\lessdot\lessdot$	$\lessdot\lessdot$
Blue Sellers	63.3	72.2	68.8	71.4	80.0	75.0	15.4	33.3	31.4
	(6.3)	(7.6)	(5.7)	(5.3)	(12.7)	(10.1)	(6.3)	(12.4)	(8.0)

Notes: Bootstrapped standard errors are in parentheses. $<$ and $\ll$ denote statistical significance at the 0.1 and 0.05 levels, respectively, and $\sim$ denotes no significance. p-values are determined using two-tailed non-parametric randomization tests (see footnote 14 for more details of these tests).

To investigate the robustness of these findings to alternative alternative measures and tests, we present in Table 3 summary statistics of foreign currency acceptance in terms of mean acceptance rates, median acceptance rates, and the proportion of sellers who always accept the foreign currency, i.e., the proportion of sellers with an acceptance rate of one. The estimates in Table 3 provide further support for Hypothesis 2 and the patterns shown in Figure 5. In particular, there is no significant difference between Red and Blue sellers across the three measures in the Baseline treatment (p-values of 0.20, 0.20, and 0.37 using a non-parametric randomization test), whereas there is a significant difference between the Red and Blue sellers in the Blue30 treatment (p-values of 0.04, 0.04, and 0.02) and Blue90 treatment (p-values of 0.08, 0.04, 0.02).[14] Importantly, these findings provide support for Hypothesis 2: higher Blue token growth rates reduce the acceptance of blue tokens by red sellers relative to the acceptance of red tokens by blue sellers.[15] We summarize these observations with Result 2.

Result 2 *Foreign currency acceptance decisions depend on token growth rates consistent with Hypothesis 2:*

(a) *Foreign currency acceptance rates are symmetric across groups in the Baseline treatment. Specifically, there is no significant difference between foreign currency acceptance rates by Blue sellers and Red sellers.*

[14]The null hypothesis for the non-parametric randomization test is there is no difference in sellers' foreign currency acceptance across groups. Hence, the the group labels Red and Blue are interchangeable (Moir, 1998; Good, 2013; Holt and Sullivan, 2023). The distribution is obtained through random permutation of group labels among sellers, respecting the session structure of the data. That is, for each column in Table 3, we first randomly draw four sessions and from each session, we randomly draw 10 Red sellers and 10 Blue sellers. Finally, we shuffle the red and blue labels and calculate the statistic of interest (e.g., the difference between mean acceptance rates). The p-value for a two-sided test is then determined by finding the fraction of the time the simulated statistic is greater in absolute value than the actual difference observed in the experiment.

[15]Table 7 in Appendix B provides an analogous set of statistics reported in Table 3 decomposed by sessions. The main patterns observed in Table 3 hold at the session level. For example, for each session of the Blue90 treatment, the three statistics regarding Blue sellers' foreign currency acceptance rates are at least as large as the corresponding statistics for Red sellers.

(b) *Foreign currency acceptance rates are asymmetric in the Blue30 and Blue90 treatments. Specifically, foreign currency acceptance by Blue sellers accept foreign is higher than for Red Sellers.*

In addition, foreign currency acceptance rates by Red sellers are lower in the Blue30 treatment than in the Baseline treatment (p-values of 0.03, 0.02, 0.13 across the three measures presented in Table 3); similarly, foreign currency acceptance rates by Red sellers are lower in the Blue90 treatment than in the Baseline treatment (p-values of 0.02, 0.02, 0.09 across the three measures presented in Table 3). At the same time, foreign currency acceptance rates by Blue sellers shows a marginal increase. Although the means, medians, and the proportion of 'Always Accept' all increase, the increase is not significant except for the case of Baseline to Blue30 (15.4 vs. 33.3, p-value 0.07).

5.3 Production, Consumption, and Welfare

We now turn our attention to production, consumption, and welfare. Table 4 summarizes production by sellers and consumption by buyers across countries. The table delineates the welfare levels between the two countries as well as the aggregate welfare across the treatments. Despite the variability in average quantities produced and consumed in the CM, there is no significant difference in average welfare across treatments. In contrast, there is a marginal decrease in average DM welfare from the Baseline to Blue30 and Blue90 treatments. Although directionally consistent with theory and Hypothesis 3, these differences are not statistically significant. For example, we find a p-value of 0.18 when comparing average DM welfare in the Baseline versus Blue30 treatments (8.99 vs. 8.18) and a p-value of 0.12 when comparing the Baseline versus Blue90 treatments (8.99 vs. 8.31). In addition, there is no significance difference in DM welfare across red and blue groups (8.50 vs. 9.48 in the Baseline treatment, p-value of 0.22; 7.78 vs. 8.57 in the Blue30 treatment, p-value of 0.33; 8.08 vs. 8.53 in the Blue90 treatment, p-value of 0.57). These findings are consistent with Ding and Puzzello (2020) who do not find significant differences in welfare across treatments. We summarize these observations with Result 3.

Result 3 *Welfare does not respond to the money growth rates:*

(a) *Average welfare is not different between the Baseline, Blue30, and Blue90 treatments.*

(b) *Welfare of Blue subjects is not significantly different from welfare of Red subjects in the Baseline treatment.*

(c) *Welfare of Blue subjects is not significantly different from welfare of Red subjects in the Blue30 and Blue90 treatments.*

Table 4: Production, Consumption, and Welfare

	Baseline		Blue30		Blue90	
	Red	Blue	Red	Blue	Red	Blue
Centralized Market						
Quantity produced by sellers	17.66	17.50	20.75	14.44	18.68	17.02
Quantity consumed by buyers	18.01	17.15	15.44	19.75	17.24	18.46
Welfare per round	13.64	13.30	10.25	16.80	12.57	14.29
Welfare average	13.47		13.52		13.43	
Decentralized Market						
Quantity produced by sellers	13.29	10.62	11.83	10.73	14.47	11.28
Quantity consumed by buyers	12.20	11.71	11.59	10.97	13.70	12.05
Welfare per round	8.50	9.48	7.78	8.57	8.08	8.53
Welfare average	8.99		8.18		8.31	

Notes: Welfare is measured as the utility of consumption minus the dis-utility from production. Welfare per round is calculated across all buyers and sellers within a given country. The welfare average is calculated across all buyers and sellers for both countries. Within a given country, the average quantities produced and consumed within a treatment may not coincide due to matches and trade across countries.

In addition, Table 4 shows production and consumption are lower in the DM relative to the CM and relative to theory. This can be attributed to a large proportion of negotiations that break down in the DM (in contrast, the CM features a Walrasian market so that all agents trade unless the market price is zero). To investigate this further, we explore in Section 5.4.1 the conditions under which terms of trades are not satisfactory to one of the parties.

5.4 Additional Analyses

In this subsection, we expand our analyses along two main directions. First, Section 5.4.1, analyzes the factors affecting the bargaining outcomes in the DM. In particular, we characterize the circumstances in which the proposed terms of trade by one of the parties did not satisfy the other party. Second, Section 5.4.2 investigates the impact of learning within and across sequences and discusses the results one could expect in the long run.

5.4.1 Bargaining Breakdown

We now delve deeper into the bargaining breakdowns in the DM and investigate the role of foreign currency acceptance in offer acceptance decisions. Overall, we find that between 28% and 35% of offers in the DM stage are rejected across all treatments of our experiment, which is in line with Ding and Puzzello (2020) who find rejection rates between 28.8% and 46.7%. Next, we consider factors that may influence offer rejection. We organize the analysis by categorizing different matches based on subjects' role in the DM (buyer or seller), role in the bargaining (proposer or responder), group (red or blue), and foreign currency acceptance decision taken before the bargaining (seller accepts or not). Given our experimental design, there are sixteen combinations of meetings in

each treatment (i.e., {red seller, blue seller} × {red buyer, blue buyer} × {seller proposer, buyer proposer} × {seller accepts foreign currency, seller does not accept foreign currency}), yielding 48 possible match types.

Several notable patterns emerge across match types. First, among the 24 match types where the seller is the responder, the four match types with the lowest acceptance rates involve blue sellers who do not accept foreign currency in the Blue30 and Blue90 treatments. Moreover, the proportion of offers accepted across these meeting types is only 23% to 29%. A similar pattern exists when sellers are proposers. In particular, among the 24 match types with the seller as the proposer, four of the five match types with the lowest acceptance rate include sellers who do not accept foreign currency in Blue30 or Blue90 treatments. Table 5 quantifies and expands on these observations with formal regression analysis of DM offer acceptance decisions.

Columns (1) and (2) of Table 5 show the offered terms of trade in the DM are less satisfactory in the Blue30 and Blue90 treatments relative to the Baseline treatment, with the Blue90 treatment significantly different from the Baseline. Columns (1) and (2) also show the foreign currency acceptance decision, especially by Blue sellers, is an important factor in offers being accepted, suggesting trades are more likely when Blue sellers accept foreign currency. Columns (3)–(8) shed more light on treatment differences. In particular, columns (3) and (4) show that although foreign currency acceptance decisions in the Baseline treatment are important determinants of a successful bargaining outcome in the DM ('FCA seller' coefficient is significant at 0.01 level), there is no difference in offer acceptance decisions between meetings with Red sellers and meetings with Blue sellers ('BlueSeller' and 'BlueSeller × FCA seller' coefficients are not significant in columns (3) and (4)). This makes sense due to the symmetric nature of currencies in the Baseline treatment. In contrast, there are differences between meetings with Red sellers and meetings with Blue sellers in Blue30 and Blue90 treatments. Columns (6) and (8) show meetings with Blue sellers are more likely to result in DM offer rejection ('BlueSeller' coefficient is significant at 0.01 level), and foreign currency acceptance decisions are more critical for the Blue sellers ('BlueSeller×FCA seller' coefficient is significant at 0.01 level). This finding is consistent with theory since the Blue currency has a lower rate of return in the Blue30 and Blue90 treatments. Intuitively, it might be more difficult for subjects to specify satisfactory terms of trade when Blue currency is not accepted (i.e., if blue tokens are not valued, agents would refuse to trade no matter the quantity proposed).

Table 5: Probit Regression Analysis of DM Offer Acceptance Decisions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All Treatments		Baseline		Blue30		Blue90	
Blue30	−0.132	−0.160*						
	(0.088)	(0.093)						
Blue90	−0.202**	−0.237***						
	(0.081)	(0.088)						
Seller responder	−0.836***	−0.847***	−0.804***	−0.804***	−0.880***	−0.913***	−0.820***	−0.832***
	(0.036)	(0.037)	(0.044)	(0.044)	(0.039)	(0.058)	(0.083)	(0.075)
BlueSeller	−0.261***	−0.541***	−0.210*	−0.200	−0.242***	−0.664***	−0.325***	−0.708***
	(0.052)	(0.110)	(0.100)	(0.169)	(0.092)	(0.210)	(0.092)	(0.060)
BlueBuyer	0.089	0.093	−0.004	−0.004	0.211**	0.225**	0.062	0.063*
	(0.063)	(0.061)	(0.166)	(0.167)	(0.097)	(0.095)	(0.044)	(0.036)
FCA seller	0.320***	0.089	0.332***	0.341***	0.358***	0.010	0.285***	−0.019
	(0.053)	(0.065)	(0.119)	(0.077)	(0.120)	(0.076)	(0.076)	(0.125)
BlueSeller×FCA seller		0.459***		−0.016		0.716***		0.639***
		(0.152)		(0.297)		(0.197)		(0.135)
Constant	0.940***	1.102***	0.933***	0.927***	0.742***	0.941***	0.796***	0.959***
	(0.087)	(0.105)	(0.162)	(0.130)	(0.049)	(0.071)	(0.115)	(0.105)
Observations	3,439	3,439	1,120	1,139	1,170	1,170	1,130	1,130
Log Likelihood	−1,949.468	−1,938.145	−619.602	−619.598	−659.331	−649.877	−667.632	−660.188

Notes: The dependent variable is *DM Offer Acceptance Decision*, coded 1 when the offer in the DM is accepted and 0 when the offer is rejected. FCA seller is coded 1 if the seller accepts foreign currency prior and 0 if the seller does not accept foreign currency. Robust standard errors, clustered by session presented in parentheses. $*$ p $<$ 0.10, $**$ p $<$ 0.05, $***$ p $<$ 0.01.

5.4.2 Evidence of Learning and Long-term Outcomes

In this subsection, we document changes in behavior observed within sequences and highlight a possible direction for long-term outcomes that could occur if our experiments were not subject to time constraints. Figure 6 shows foreign currency acceptance rates across rounds within sequences. As the rounds progresses and the relative difference in token supplies becomes larger, red sellers

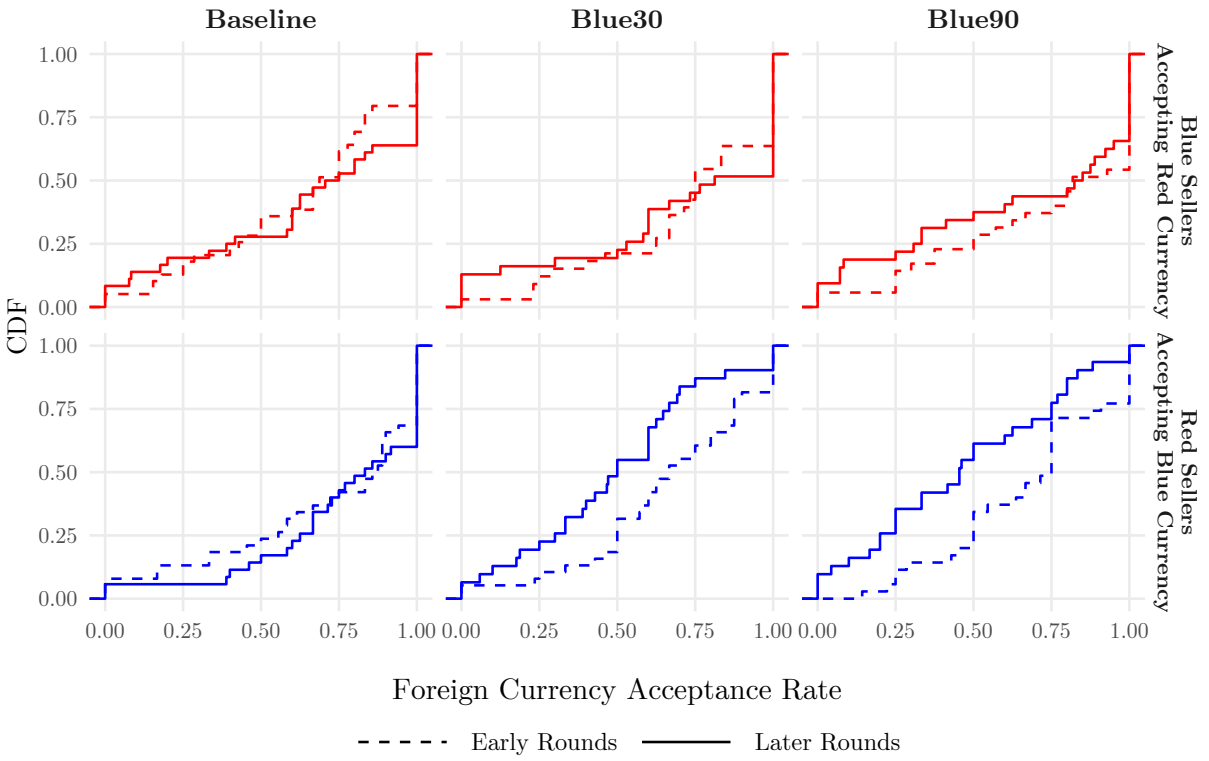
respond by adjusting their foreign currency acceptance decisions. For example, the bottom right panel shows red sellers in the Blue90 treatment reduce foreign currency acceptance from the first four rounds (labeled 'Early Rounds' and denoted with a dashed blue line) to rounds five and above (labeled 'Later Rounds' and denoted with a solid blue line). This difference is statistically significant (p-value of 0.03 using the Kolmogorov-Smirnov test). At the same time, there is no such difference for the Baseline treatment, as shown in the bottom left panel (p-value of 0.88 using the Kolmogorov-Smirnov test). In addition, we find the proclivity to accept foreign currency does not seem to vary across rounds. Combined, these results indicate that if the matches were to go longer, the difference between treatments would become even more stark in the direction of our hypotheses.[16] One reason there is not much difference in early rounds is that some subjects may not be forward-looking and therefore fail to incorporate future consequences of inflation in their decisions. Since each match begins with the same number of red and blue tokens, subjects' behavior in early rounds is more similar. Of course, this is a limitation of the experimental design and the difficulty in implementing infinite horizon in the lab.[17]

The presence of within-sequence learning is a new finding in this class of experiments. In particular, Jiang, Puzzello, and Zhang (2023) implement a similar model with money growth but only one currency and do not find evidence in favor of learning either within or across sequences. Our results above suggest the salience of money growth as experienced through the quantity of available tokens over time is an important factor when subjects are deciding between acceptance or holdings of the two currencies. In our setup, sellers are faced with an acceptance decision and should anticipate their choice has a direct impact on the tokens traded in a match. Over time, they may experiment with different decisions and ultimately learn which choice generates higher payoffs. This is an important consideration that maps into real-world economies with multiple payments: launching a new currency has historically been challenging due to inertia and learning about transacting in a new regime (see, e.g., Craig and Waller (2000) and Lotz and Rocheteau (2002)).

[16] Restricting the data to 'Later Rounds' and carrying out the Kolmogorov-Smirnov test comparing the foreign currency acceptance rates of the Red and Blue sellers, we find p-values of 0.01 for both the Blue30 and Blue90 treatments. At the same time, we find a p-value of 0.47 for the Baseline treatment.

[17] Jiang, Puzzello, and Zhang (2021) propose an alternative method for implementing infinite horizon experiments in a similar monetary model that uses the discount factor to back out subjects' continuation value following a period of deterministic length. Relative to this method, results using random termination or a block design are not substantially different. See also Jiang, Norman, Puzzello, Sultanum, and Wright (2024) for a different approach that studies finite horizon environments where money is valued; however, such a setting would not be able to implement money growth and therefore inflation.

Figure 6: Token Acceptance CDF by Currency, Early vs Later Rounds



Notes: The two series of data in each panel corresponds to splitting the data in two halves: for each sequence played, for rounds below 5 ("Early Rounds") and equal or greater than 5 ("Later Rounds"). The series in red represent the empirical CDF of acceptance of Red currency by Blue sellers and the series in blue represents the empirical CDF of acceptance of Blue currency by Red sellers.

6 Conclusion

In this paper, we designed a human subject experiment to study how monetary policy through changes in money growth affects the emergence of international currency regimes, foreign currency acceptance, and welfare. The experiments are based on a two-country, two-currency search model where buyers and sellers jointly make currency portfolio and acceptance decisions. The theory generates multiple equilibria based on sellers' acceptance currency acceptance decisions where zero, one, or two international currencies can circulate. We then implement the theoretical environment in the lab in order to evaluate the model's testable predictions and resolve issues related to equilibrium selection. We design the experiments specifically to investigate how inflation, foreign currency acceptance, trade, and welfare change when relative money growth rates in the two countries vary.

Our study highlights three key findings. The first result establishes the effect of money growth on inflation is consistent with theory. Specifically, the quantity theory prediction that higher money growth should lead to higher inflation holds both within and across treatments, i.e., we observe no difference in inflation in instances where theory predicts the same inflation rates, and we observe

higher inflation in instances where theory predicts higher inflation. Our second class of findings concerns the decision by individual sellers to accept foreign currency and forms the main results of this paper. The experiments reveal that in treatments with disparate money growth rates, sellers choose to accept a less inflationary currency at a higher rate than a more inflationary currency. This result highlights the importance of relative inflation in affecting a currency's international status. We also establish the importance of foreign currency acceptance on affecting both the likelihood and quantity of trade. Our third result centers on welfare implications. Although theory predicts a country with higher inflation has lower welfare, we do not find significant support for this hypothesis in the experiments. Specifically, although the relative ranking of observed welfare in DM is consistent with theoretical predictions, the differences are not significant.

Our study opens several avenues for future work. First, the present study focuses on economies defined by different monetary policies for money growth and, therefore, different inflation rates. The underlying theoretical model, however, is much richer and has several other dimensions we plan on exploring in future work. Among these is the parameter capturing the degree of economic integration, i.e., how likely sellers in one country are to interact with buyers from another country. This dimension may be increasingly important as economies become more globalized. Second, we implemented a between-subject design in the present study where each subject was assigned to only one treatment and one country. It would be interesting to implement a within-subject design and explore how experience with high inflation or inflation uncertainty affects prices, currency acceptance, and welfare when money growth goes back down. This is particularly topical as countries around the world aim to curb inflation through more active monetary policies. Third, subjects had no access to currency markets or credit in our experiments. Relaxing these constraints would be interesting and establish the robustness of our results to central features of actual payment systems. Finally, this paper implemented experiments with human subjects, which necessarily imposes limits on the number of agents that could feasibly interact within each treatment and the time it takes to run the experiment. Complementing this work with agent-based simulations has the potential to shed new insight into conditions that may not be possible or feasible to run in the lab.[18]

[18] Jasmina Arifovic pioneered the agent-based simulation approach with her implementation of genetic algorithm to study macroeconomic questions in Arifovic (1994, 1995, 1996, 2001). In a companion project, we incorporated a genetic algorithm for the environment studied here but decided to leave out the results in order to focus on the experimental contribution. We also plan to further explore the behavior of exchange rates in our setting and compare with Arifovic (1996).

References

Aliprantis, C. D., G. Camera, and D. Puzzello (2007a): "Anonymous markets and monetary trading," *Journal of Monetary Economics*, 54(7), 1905–1928.

——— (2007b): "Contagion equilibria in a monetary model," *Econometrica*, pp. 277–282.

Anbarci, N., R. Dutu, and N. Feltovich (2015): "Inflation tax in the lab: a theoretical and experimental study of competitive search equilibrium with inflation," *Journal of Economic Dynamics and Control*, 61, 17–33.

Araujo, L., B. Camargo, R. Minetti, and D. Puzzello (2012): "The essentiality of money in environments with centralized trade," *Journal of Monetary Economics*, 59(7), 612–621.

Arifovic, J. (1994): "Genetic algorithm learning and the cobweb model," *Journal of Economic dynamics and Control*, 18(1), 3–28.

——— (1995): "Genetic algorithms and inflationary economies," *Journal of Monetary Economics*, 36(1), 219–243.

——— (1996): "The Behavior of the Exchange Rate in the Genetic Algorithm and Experimental Economies," *Journal of Political Economy*, 104(3), 510–541.

——— (2001): "Evolutionary dynamics of currency substitution," *Journal of Economic Dynamics and Control*, 25(3-4), 395–417.

Arifovic, J., J. Duffy, and J. H. Jiang (2023): "Adoption of a new payment method: Experimental evidence," *European Economic Review*, 154, 104410.

Arrieta-Vidal, J., D. Florián, K. López, and V. Morales (2022): "Policies for transactional de-dollarization: A laboratory study," *Journal of Economic Behavior & Organization*, 200, 31–54.

Bernasconi, M., and O. Kirchkamp (2000): "Why do monetary policies matter? An experimental study of saving and inflation in an overlapping generations model," *Journal of Monetary Economics*, 46(2), 315–343.

Brown, P. M. (1996): "Experimental evidence on money as a medium of exchange," *Journal of Economic Dynamics and control*, 20(4), 583–600.

Camera, G., and M. Casari (2014): "The coordination value of monetary exchange: Experimental evidence," *American Economic Journal: Microeconomics*, 6(1), 290–314.

Camera, G., C. Noussair, and S. Tucker (2003): "Rate-of-return dominance and efficiency in an experimental economy," *Economic Theory*, 22(3), 629–660.

Colacelli, M., and D. J. Blackburn (2009): "Secondary currency: An empirical analysis," *Journal of monetary economics*, 56(3), 295–308.

Craig, B. R., and C. Waller (2000): "Dual-currency economies as multiple-payment systems," *Economic review*, 36(1), 2–13.

Davis, D., O. Korenok, P. Norman, B. Sultanum, and R. Wright (2022): "Playing with money," *Journal of Economic Behavior & Organization*, 200, 1221–1239.

Deck, C. A., K. A. McCabe, and D. P. Porter (2006): "Why stable fiat money hyperinflates: Results from an experimental economy," *Journal of Economic Behavior & Organization*, 61(3), 471–486.

Ding, S., and D. Puzzello (2020): "Legal restrictions and international currencies: An experimental approach," *Journal of International Economics*, 126, 103342.

Duffy, J. (1998): "Monetary theory in the laboratory," *Federal Reserve Bank of St. Louis Review*, 80(5), 9–26.

——— (2010): "Experimental macroeconomics," *Behavioural and Experimental Economics*, pp. 113–119.

——— (2016): "Macroeconomics: a survey of laboratory research," *Handbook of experimental economics*, 2, 1–90.

——— (2022): "Why macroeconomics needs experimental evidence," *The Japanese Economic Review*, 73(1), 5–29.

Duffy, J., L. Lebeau, and D. Puzzello (2022): "Bargaining Under Liquidity Constraints: Experimental Evidence," *Working Paper*.

Duffy, J., A. Matros, and Temzeledis (2011): "Competitive Behavior in Market Games: Theory and Evidence," *Journal of Economic Theory*, 146, 1437–1463.

Duffy, J., and J. Ochs (1999): "Emergence of money as a medium of exchange: An experimental study," *American Economic Review*, 89(4), 847–877.

——— (2002): "Intrinsically worthless objects as media of exchange: Experimental evidence," *International Economic Review*, 43(3), 637–673.

Duffy, J., and D. Puzzello (2014a): "Experimental evidence on the essentiality and neutrality of money in a search model," in *Experiments in Macroeconomics*, vol. 17, pp. 259–311. Emerald Group Publishing Limited.

——— (2014b): "Gift exchange versus monetary exchange: Theory and evidence," *American economic review*, 104(6), 1735–1776.

——— (2022): "The friedman rule: experimental evidence," *International Economic Review*, 63(2), 671–698.

Eichengreen, B. (2020): "International Currencies in the Lens of History," *Handbook of the History of Money and Currency*, pp. 335–359.

Geromichalos, A., and I. Simonovska (2014): "Asset Liquidity and International Portfolio Choice," *Journal of Economic Theory*, 151.

Gomis-Porqueras, P., T. Kam, and C. Waller (2017): "Nominal exchange rate determinacy under the threat of currency counterfeiting," *American Economic Journal: Macroeconomics*, 9(2), 256–273.

Good, P. (2013): *Permutation tests: a practical guide to resampling methods for testing hypotheses*. Springer Science & Business Media.

Greiner, B. (2015): "Subject pool recruitment procedures: organizing experiments with ORSEE," *Journal of the Economic Science Association*, 1(1), 114–125.

Holt, C. A., and S. P. Sullivan (2023): "Permutation tests for experimental data," *Experimental Economics*, pp. 1–38.

Hommes, C. (2021): "Behavioral and experimental macroeconomics and policy analysis: A complex systems approach," *Journal of Economic Literature*, 59(1), 149–219.

Hu, T.-W., and G. Rocheteau (2020): "Bargaining under liquidity constraints: Unified strategic foundations of the Nash and Kalai solutions," *Journal of Economic Theory*, 189, 105098.

Jiang, J. H., P. Norman, D. Puzzello, B. Sultanum, and R. Wright (2024): "Is Money Essential? An Experimental Approach," *Journal of Political Economy*.

Jiang, J. H., D. Puzzello, and C. Zhang (2021): "How long is forever in the laboratory? Three implementations of an infinite-horizon monetary economy," *Journal of Economic Behavior & Organization*, 184, 278–301.

——— (2023): "Inflation, Output, and Welfare in the Laboratory," *European Economic Review*, 152, 104351.

Jiang, J. H., and C. Zhang (2018): "Competing currencies in the laboratory," *Journal of Economic Behavior & Organization*, 154, 253–280.

Kalai, E. (1977): "Proportional solutions to bargaining situations: interpersonal utility comparisons," *Econometrica: Journal of the Econometric Society*, pp. 1623–1630.

Kareken, J., and N. Wallace (1981): "On the Indeterminacy of Equilibrium Exchange Rates," *The Quarterly Journal of Economics*, 96(2), 207.

Kiyotaki, N., and R. Wright (1989): "On money as a medium of exchange," *Journal of political Economy*, 97(4), 927–954.

——— (1993): "A search-theoretic approach to monetary economics," *The American Economic Review*, pp. 63–77.

Lagos, R., G. Rocheteau, and R. Wright (2017): "Liquidity: A new monetarist perspective," *Journal of Economic Literature*, 55(2), 371–440.

Lagos, R., and R. Wright (2005): "A unified framework for monetary theory and policy analysis," *Journal of political Economy*, 113(3), 463–484.

Lester, B., A. Postlewaite, and R. Wright (2012): "Information, liquidity, asset prices, and monetary policy," *The Review of Economic Studies*, 79(3), 1209–1238.

Li, Y., G. Rocheteau, and P.-O. Weil (2012): "Liquidity and the Threat of Fraudulent Assets," *Journal of Political Economy*, 36(1), 815–846.

Lian, P., and C. R. Plott (1998): "General equilibrium, markets, macroeconomics and money in a laboratory experimental environment," *Economic Theory*, 12, 21–75.

Lim, S. S., E. C. Prescott, and S. Sunder (1994): "Stationary solution to the overlapping generations model of fiat money: experimental evidence," *Experimental Economics*, pp. 75–97.

Lotz, S., and G. Rocheteau (2002): "On the Launching of a New Currency," *Journal of Money, Credit, and Banking*, 34, 563–588.

Marimon, R., and S. Sunder (1993): "Indeterminacy of equilibria in a hyperinflationary world: Experimental evidence," *Econometrica: Journal of the Econometric Society*, pp. 1073–1107.

——— (1994): "Expectations and learning under alternative monetary regimes: an experimental approach," *Economic Theory*, 4(1), 131–162.

——— (1995): "Does a constant money growth rule help stabilize inflation?: experimental evidence," in *Carnegie-Rochester Conference Series on Public Policy*, vol. 43, pp. 111–156. Elsevier.

Matsuyama, K., N. Kiyotaki, and A. Matsui (1993): "Toward a theory of international currency," *The Review of Economic Studies*, 60(2), 283–307.

Moir, R. (1998): "A Monte Carlo analysis of the Fisher randomization technique: reviving randomization for experimental economists," *Experimental Economics*, 1, 87–100.

Noussair, C. N., C. R. Plott, and R. G. Riezman (1997): "The principles of exchange rate determination in an international finance experiment," *Journal of Political Economy*, 105(4), 822–861.

Rietz, J. (2019): "Secondary currency acceptance: Experimental evidence with a dual currency search model," *Journal of Economic Behavior & Organization*, 166, 403–431.

Rocheteau, G., T.-W. Hu, L. Lebeau, and Y. In (2021): "Gradual bargaining in decentralized asset markets," *Review of Economic Dynamics*, 42, 72–109.

Roth, A., and K. Murnighan (1978): "Equilibrium behavior and repeated play of the prisoner's dilemma," *Journal of Mathematical psychology*, 17(2), 189–198, Publisher: Elsevier.

Shapley, L., and M. Shubik (1977): "Competitive Behavior in Market Games: Theory and Evidence," *Journal of Political Economy*, 85, 937–968.

Zhang, C. (2014): "An information-based theory of international currency," *Journal of International Economics*, 93(2), 286–301.

Appendices

Appendix A: Equilibrium of Theoretical Model

Here we describe the stationary equilibrium of the two-country, two-currency model where aggregate real balances in each country are constant over time. This implies the rate of return of currency i in each country is constant and will equal the inverse of the money growth rate, $\gamma_i^{-1} = \frac{\phi_i'}{\phi_i}$.

Centralized Market (CM) Value Functions

In the centralized market, a representative buyer of each country chooses consumption of the numéraire good x, labor h, and real balances to bring forward the next period. Portfolios are expressed in real terms: let $\mathbf{z} \equiv (z_r, z_b) \equiv (\phi_r m_r,\ \phi_b m_b) \in \mathbb{R}_+^2$ represent a Red buyer's portfolio of assets, and let $\widehat{\mathbf{z}} \equiv (\widehat{z}_r, \widehat{z}_b) \equiv (\phi_r \widehat{m}_r,\ \phi_b \widehat{m}_b) \in \mathbb{R}_+^2$ denote a Blue buyer's portfolio. Also let $W_r^B(\mathbf{z})$ and $V_b^B(\mathbf{z})$ ($W_b^B(\widehat{\mathbf{z}})$ and $V_b^B(\widehat{\mathbf{z}})$) denote value functions for buyers from Red (Blue) in the CM and DM, respectively.

In the beginning of the CM, a buyer from the Red country faces the following maximization problem:

$$W_r^B(\mathbf{z}) = \max_{x,h,\mathbf{z}' \in \mathbb{R}_+^2} \{U(x) - h + V_r^B(\mathbf{z}')\} \tag{1}$$

$$\text{s.t. } x + \phi_r m_r' + \phi_b m_b' = h + z_r + z_b + T_r \tag{2}$$

$$T_r \equiv (\gamma_r - 1)\phi_r M_r. \tag{3}$$

The portfolio taken into the DM is $\mathbf{z}' = (z_r', z_r') = (\phi_r' m_r', \phi_b' m_b')$, while T_r is the lump-sum transfer of domestic currency from the government (expressed in numéraire goods). Substituting $m_c' = \frac{z_c'}{\phi_c'}$ for currency $c = \{r, b\}$ into the budget constraint and then eliminating h yields

$$W_r^B(\mathbf{z}) = U(x^*) - x^* + z_r + z_b + T_r + \max_{z' \in \mathbb{R}_+^2} \{-\gamma_r z_r' - \gamma_b z_b' + V_r^B(\mathbf{z}')\}. \tag{4}$$

A Red buyer's lifetime utility at the beginning of the CM is the sum of his net consumption in the CM, real balances in domestic and foreign currency, the lump-sum transfer from the local government, and the continuation value at the beginning of the DM minus the investment in real balances. The value function for a Blue buyer is similar. Notice that with quasi-linear preferences, the lump-sum transfer does not affect the buyer's problem in the CM.

A few results from the CM value function are worth highlighting. First, $W_r^B(\mathbf{z})$ is linear in total wealth $\overline{z} = z_r + z_b$: $W_r'(\overline{z}) = 1$. Second, there are no wealth effects since z' is independent of z, which follows from the quasi-linearity of the utility function. So long as holding money is costly, i.e. $\gamma_c \geq \beta$, sellers have no strict incentive to carry real balances in the DM, and they will leave the CM with no asset holdings. Consequently, their CM value function can be written as $W_i^S(\mathbf{z}) = U(x^*) - x^* + z_i + z_j + V_i^S(\mathbf{0})$, which is also linear in total wealth.

Provided the DM value functions are strictly concave, there will generally be a unique portfolio where all buyers in a country demand the same real balances. A caveat is when the two currencies are perfect substitutes; in that case, buyers can hold different portfolios but they will have the same total value.

Terms of Trade

Terms of trade in the DM are determined according to Kalai (1977)'s proportional bargaining rule. This pricing mechanism permits sellers to extract a constant fraction of the match surplus in order to recover some of their ex-ante investment. Under proportional bargaining, a buyer acquires output in exchange for payment to the seller and receives a constant share, $\frac{\theta}{1-\theta}$, of the seller's surplus, where $\theta \in (0,1]$ measures the buyer's bargaining power, and threat points are given by continuation values.

Given the model specification, terms of trade will depend on buyers' portfolios and private sellers' acceptance strategy. To apply the pricing mechanism, notice that the surplus of a buyer who gets q_s for payment d_s to a seller is $u(q_s) + \beta W_i^B(\overline{z} - d_s) - \beta W_i^B(\overline{z}) = u(q_s) - \beta d_s$, by the linearity of W_i^B. Similarly, the seller's surplus is $\beta d_s - c(q_s)$.

Consider first a meeting between a Red buyer and a seller from s who only accepts domestic currency. Under proportional bargaining, quantity traded and payment to the seller, (q_s, d_s) solves

$$\max_{q_s, d_s}[u(q_s) - \beta d_s] \tag{5}$$

$$\text{s.t. } u(q_s) - \beta d_s = \frac{\theta}{1-\theta}[\beta d_s - c(q_s)] \tag{6}$$

$$d_s \leq z_s. \tag{7}$$

The bargaining problem maximizes the buyer's surplus, subject to each party receiving a constant share of the match surplus, and a feasibility constraint (7) that says the buyer cannot transfer more real balances than he current holds, which is just real balances in the seller's domestic currency, z_s. Consequently, the bargaining problem must satisfy

$$q_s \in \arg\max \theta[u(q_s) - c(q_s)]$$

$$\text{s.t. } d_s = (1-\theta)u(q_s) + \theta c(q_s) \leq z_s.$$

The transfer of wealth from buyers to sellers is therefore given by $p(q_s) \equiv \theta c(q_s) + (1-\theta)u(q_s)$. As a result, output q_s solves

$$p(q_s) = \min\{p(q^*), z_s\} \tag{8}$$

where

$$p(q_s) \equiv \theta c(q_s) + (1-\theta)u(q_s). \tag{9}$$

The bargaining solution simply says that when $z_s \geq p(q^*)$, the buyer has enough wealth to finance purchase of the first-best q^*, and payment to the seller will be $p(q^*) = \theta c(q^*) + (1-\theta)u(q^*)$. When $z_s < p(q^*)$, the buyer just gives the seller his cash on hand, z_s, and gets in return $q_s < q^*$.

When instead the seller incurs the fixed cost to accept both currencies, terms of trade satisfy a similar problem as (5) – (6), but with the feasibility constraint $d_s^f \leq z_r + z_b$ since the buyer can now pay with both currencies. In what follows, the superscript f is used to distinguish variables when sellers accept both domestic and foreign currencies. Consequently, output q_s^f solves

$$p(q_s^f) = \min\{p(q^*), z_r + z_b\} \tag{10}$$

where

$$p(q_s^f) \equiv \theta c(q_s^f) + (1-\theta)u(q_s^f). \tag{11}$$

Foreign Currency Acceptance Decision

Before matches are formed in the DM, private sellers can acquire at some cost the information, or technology, in order to accept payment in foreign currency. Since the decision to acquire information about a currency determines its acceptability in trade, this breaks the indeterminacy that results when multiple assets can be used as means of payment. Without this decision, the model would predict that the two currencies are perfect substitutes that circulate at the same rate of return.

Sellers' strategies are given by $\sigma_s \in [0,1]$, where $\sigma_s = 0$ if a private seller from $s = \{r, b\}$ rejects payment in foreign currency and $\sigma_s = 1$ if foreign currency is accepted. When $\sigma_s \in (0,1)$, both currencies are accepted in a fraction of trades.

Given the bargaining solution, a seller's expected payoff if he rejects payment in foreign currency is

$$\Pi_s \equiv (1-\theta)\{\lambda_{rs}[u(q_s) - c(q_s)] + \lambda_{bs}[u(\widehat{q}_s) - c(\widehat{q}_s)]\}$$

where λ_{is} denotes the probability that a seller from $s = \{r, b\}$ meets a buyer from $i = \{r, b\}$, $(1-\theta)$ is the seller's share in the trade surplus, and $\widehat{q}_s$ is DM output in meetings with Blue buyers. Notice this expression omits the seller's continuation value in the CM since the terms of trade do not depend on the seller's portfolio as sellers do not carry real balances into the DM.

If a seller incurs the fixed cost to accept foreign money, his expected payoff is

$$\Pi_s^f \equiv -\psi_s + (1-\theta)\{\lambda_{rs}[u(q_s^f) - c(q_s^f)] + \lambda_{bs}[u(\widehat{q}_s^f) - c(\widehat{q}_s^f)]\}.$$

A private seller's expected gain from accepting both currencies is therefore

$$\begin{aligned}\Delta_s &\equiv \Pi_s^f - \Pi_s \\ &= -\psi_s + (1-\theta)\left\{\lambda_{rs}[S(q_s^f) - S(q_s)] + \lambda_{bs}[S(\widehat{q}_s^f) - S(\widehat{q}_s)]\right\},\end{aligned}$$

where $S(\cdot) \equiv u(\cdot) - c(\cdot)$ defines total surplus in DM trades.

Consequently, the seller will choose to invest if $\Delta_s > 0$ and not invest if $\Delta_s < 0$. When $\Delta_s = 0$, sellers are indifferent and invest with an arbitrary probability. Optimal strategies $\sigma = (\sigma_r, \sigma_b)$ must therefore satisfy

$$\sigma_s = \begin{cases} 1 \\ \in [0,1] \\ 0 \end{cases} \text{ if } \Delta_s \begin{cases} > \\ = \\ < \end{cases} 0. \tag{12}$$

The focus is on Nash equilibria where all sellers in a country adopt optimal strategies. Since sellers will reject currencies they do not recognize and it is common knowledge whether the seller is informed, trade occurs under full information.

Decentralized Markets (DM) Value Function

Given the bargaining solution, the DM value functions simplify greatly. Since the terms of trade do not depend on sellers' portfolios, the DM value function can be written solely in terms of the buyer's problem.

Consider a representative buyer from country 1. Using the linearity of $W_r^B(z)$ and the bargaining solution, the DM value function simplifies to:

$$V_r^B(\mathbf{z}) = \alpha a_r \theta[\sigma_r S(q_r^f) + (1-\sigma_r)S(q_r)] + (1-\alpha)a_b\theta[\sigma_b S(q_b^f) + (1-\sigma_b)S(q_b)] \tag{13}$$

$$+\beta[z_r + z_b + W_r^B(\mathbf{0})]$$

The last terms result from the linearity of $W_r^B(\mathbf{z})$ and is the value of proceeding to the next period's CM with one's portfolio intact. A Blue country buyer's value function can be obtained by reversing the subscripts, replacing z with $\widehat{z}$, and replacing q with $\widehat{q}$.

Upon substituting the DM value function into the CM value function to yields the buyer's optimal choice of real balances:

$$\max_{\mathbf{z}\in\mathbb{R}_+^2}\{-(\gamma_r-\beta)z_r-(\gamma_b-\beta)z_b+\alpha a_r\left\{\theta[\sigma_r S(q_r^f)+(1-\sigma_r)S(q_r)]\right\} \tag{14}$$

$$+(1-\alpha)a_b\left\{\theta[\sigma_b S(q_b^f)+(1-\sigma_b)S(q_b)]\right\}.$$

The objective function simply says that a buyer chooses a portfolio to maximize his expected surplus in domestic and foreign meetings, net of the cost of holding currency. Since the objective is continuous and maximizes over a compact set, a solution to the buyer's problem exists.

Given monetary policy described by (γ_r, γ_b), a stationary monetary equilibrium is a list of quantities traded $\{(q_s, q_s^f), (\widehat{q}_s, \widehat{q}_s^f)\}$, sellers' strategies σ_s, and real balances $\{\mathbf{z} \equiv (z_r, z_b), \widehat{\mathbf{z}} \equiv (\widehat{z}_r, \widehat{z}_b)\}\ \forall\ s = \{r, b\}$ such that

1. $\{(q_s, q_s^f), (\widehat{q}_s, \widehat{q}_s^f)\} \in \mathbb{R}_+^2 \times \mathbb{R}_+^2$ solves the bargaining problem;
2. $\sigma_s \in [0, 1]$ solves sellers' currency acceptance decision;
3. $\{(z_r, z_b), (\widehat{z}_r, \widehat{z}_b)\} \in \mathbb{R}_+^2 \times \mathbb{R}_+^2$ solves buyers' portfolio problem;
4. Money markets clear.

In a monetary equilibrium where both currencies are valued, $z_r > 0$ and $z_b > 0$, DM output solves

$$\gamma_r-\beta=\alpha a_r[\sigma_r L(q_r^f)+(1-\sigma_r)L(q_r)]+(1-\alpha)a_b[\sigma_b L(q_b^f)] \tag{15}$$

$$\gamma_b-\beta=\alpha a_r[\sigma_r L(q_r^f)]+(1-\alpha)a_b[\sigma_b L(q_b^f)+(1-\sigma_b)L(q_b)] \tag{16}$$

where

$$L(\cdot)\equiv\frac{\theta[u'(\cdot)-c'(\cdot)]}{\theta c'(\cdot)+(1-\theta)u'(\cdot)}.$$

Buyers wish to bring currencies into the DM since these objects facilitate trade across different meeting types, but doing so is costly as captured by the terms $\gamma_r - \beta$ and $\gamma_b - \beta$ on the left sides of (15) and (16). The function $L(\cdot)$ is the *liquidity premium* and represents the marginal payoff an agent gets from his liquid wealth that can be used to acquire more output in the DM instead of carrying it over to the next CM. There are analogous equations for buyers in country 2: for $\widehat{z}_r > 0$ and $\widehat{z}_b > 0$, DM output must satisfy

$$\gamma_r-\beta=(1-\alpha)a_r[\sigma_r L(\widehat{q}_r^f)+(1-\sigma_r)L(\widehat{q}_r)]+\alpha a_b[\sigma_b L(\widehat{q}_b^f)], \tag{17}$$

$$\gamma_b-\beta=(1-\alpha)a_r[\sigma_r L(\widehat{q}_r^f)]+\alpha a_b[\sigma_b L(\widehat{q}_b^f)+(1-\sigma_b)L(\widehat{q}_b)]. \tag{18}$$

Intuitively, the equilibrium conditions equate the marginal benefit of liquidity to its cost. As a result, a currency demands a liquidity premium only if it is accepted in trade, as determined by σ_s. When no sellers accept a currency, it will not be valued. Also notice that $L(\cdot)$ is strictly decreasing in DM output over the relevant range: that is, $L'(\cdot) < 0$ for $q \in [0, q^*]$. In what follows, the focus is on equilibria where $\gamma_i \geq \beta$, since there is no solution otherwise.

Notice when there are no asymmetries in meeting arrangements – i.e., when the economy is perfectly integrated ($\alpha = \frac{1}{2}$) and both countries and governments are of equal sizes ($N_r = N_b$) – then all buyers, irrespective of country origin, will hold the same portfolios.

Finally to close the model, market clearing implies that for each currency, aggregate supply must equal aggregate demand. As a result, all buyers from the same country hold the same portfolio when currencies are not perfect substitutes. Total demand for the red currency is $N_r m_r + N_b \widehat{m}_r$ and total demand for the blue currency is $N_r m_b + N_b \widehat{m}_b$. Market clearing then implies

$$N_r m_r + N_b \widehat{m}_r = M_r, \tag{19}$$

$$N_r m_b + N_b \widehat{m}_b = M_b. \tag{20}$$

Appendix B: Additional Results

Table 6: Inflation OLS Estimates

	Dependent variable:	
	log(Red Price)	log(Blue Price)
Round	0.102***	0.106***
	(0.009)	(0.020)
Round×Blue30	−0.043	0.244***
	(0.028)	(0.022)
Round×Blue90	−0.009	0.667***
	(0.028)	(0.033)
Blue30	0.262**	0.066
	(0.126)	(0.170)
Blue90	−0.043	0.065
	(0.145)	(0.201)
Sequence2	0.522***	0.504***
	(0.151)	(0.095)
Sequence3	0.891***	0.991***
	(0.119)	(0.144)
Sequence4	1.001***	1.474***
	(0.102)	(0.156)
Sequence5	1.578***	1.886***
	(0.092)	(0.241)
Constant	−1.266***	−1.375***
	(0.121)	(0.159)
Observations	345	345
R^2	0.619	0.954

Notes: The *Round* variable is the within sequence round, *Blue30* and *Blue90* are treatments dummies. Robust standard errors, clustered by session presented in parentheses. $*$ p $<$ 0.10, $**$ p $<$ 0.05, $***$ p $<$ 0.01.

Table 7: Foreign Currency Acceptance Rate By Session (%)

	Mean			Median			Always Accept		
	Baseline	Blue30	Blue90	Baseline	Blue30	Blue90	Baseline	Blue30	Blue90
Red	80 76	66 60	64 59	90 77	73 66	67 57	33 30	22 20	22 10
Sellers	71 60	53 52	59 44	74 57	57 50	56 50	20 11	0 0	0 0
Blue	75 67	81 77	76 70	76 71	96 92	88 75	22 20	50 50	33 33
Sellers	59 53	77 52	68 64	67 65	90 56	68 67	10 10	33 0	33 25

Notes: Four numbers in each cell correspond to the four sessions sorted from high to low for ease of comparison.

Appendix C: Experiment Instructions

Experiment Instructions (Page 1 of 10)

Time left to complete in

Today's experiment will last about 2 hours and 25 minutes.

You will be paid a show-up fee of $5 together with any money you accumulate during this experiment. The amount of money you accumulate will depend partly on your actions, partly on the actions of other participants, and partly on chance. All earnings during the experiment will be recorded in points. At the end of the experiment, your total points earned are converted to dollars at the rate of 20 points = $1.00 US Dollar.

It is important that during the experiment you remain **silent**. If you have a question or need assistance of any kind, please **raise your hand, but do not speak -** and an experiment administrator will come to you, and you may then whisper your question.

In addition, please **turn off your cell phones and put them away now**. Please do not use or place on your desk any personal items, including pens, paper, phones, etc. Please do not look into anyone else's booth at any time.

Anybody who breaks these rules will be asked to leave.

Agenda:

- Instructions
- Quiz to ensure everyone understands the instructions
- Experiment
- Questionnaire

Next

Groups (Page 2 of 10)

Time left to complete ins

There are 20 participants in today's session.

At the beginning of the session, each participant is randomly assigned to a group: **Red Group** or **Blue Group**. Specifically, 10 participants are assigned to the **Red Group** and 10 participants are assigned to the **Blue Group**.

You will remain in your assigned group for the entire duration of the experiment.

Next

Sequences of Rounds (Page 3 of 10)

Time lef

The experiment consists of **5 sequences of rounds** in which participants will make production and consumption decisions

Each sequence will last for a random number of **rounds** as follows:

- At the end of each round, the computer rolls a eight-sided fair dice to determine whether the sequence will continue with a new round
- If the number is “1”, “2”, ... , “7”, the **sequence continues** for at least one more round (87.5% chance)
- If the number is “8”, the **sequence ends** (12.5% chance)
- This means after each round, there is always a 87.5% chance the sequence continues to a new round and a 12.5% chance the sequence ends

To test this procedure, click the 'Test' button below. You will need to test this procedure 5 times.

Round	1	2	3	4	5	6
Dice Roll	2	5	5	4	4	

Roll Dice

Remember that at the end of each round the computer rolls an eight-sided fair dice. The sequence ends when the computer rolls an 8.

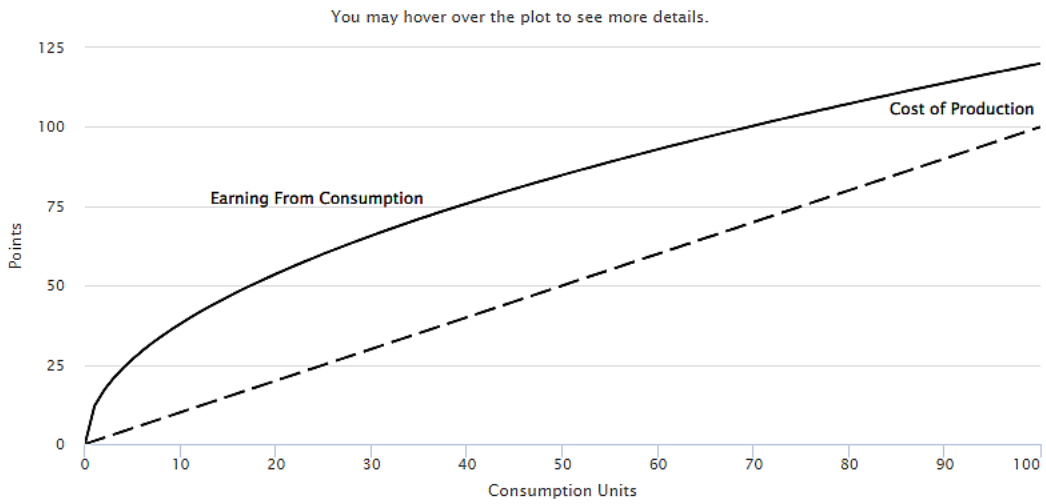
Test #4

Buyers and Sellers (Page 4 of 10)

Time left to complete in:

Each round consists of **two stages**. In each stage, you may be a **Buyer** or a **Seller** such that if you are a buyer in stage 1, you will be a seller in stage 2, and vice versa.

A **Buyer** will decide how many units of a consumption good to consume given the earnings (in points). A **Seller** will decide how many units of a consumption good to produce given the costs (in points).



For example, consuming 20 units yields 53.67 points for the buyer, while producing 20 units costs 20 points to the seller. Notice that for the duration of the experiment, you are provided with a separate print-out that contains this graph as well as the detailed table of earnings and costs.

Points from consumption and production accumulate across rounds and sequences and are converted into cash at the exchange rate of 20 points = $1

Next

Tokens and Trade (Page 5 of 10)

Time left to complete

Trade between Buyers and Sellers is facilitated using two types of **tokens**: **Red Tokens** and **Blue Tokens**.

For example, when you are a Buyer in a stage, you can decide to use tokens to purchase the good from a Seller in order to get **points** from consumption; when you are a Seller in a stage, you can decide to produce the good in exchange for tokens which you then can use in the next stage where you will be a Buyer.

Notice that tokens, the consumption good, and points are all different objects. **You can trade tokens in exchange for the consumption good, but you cannot consume tokens** (which means that holding tokens does not yield points). Only consuming the good yields points.

To summarize:

- The **consumption good** is produced and consumed within each stage and cannot be saved for the future.
  - If you are a Buyer, you can consume the good to earn points.
  - If you are a Seller, you can produce the good, which costs points.
- You can trade using **Red Tokens** and **Blue Tokens**.
- Tokens can be transferred into future stages and rounds but not future sequences.
- Points from consumption and production of the good accumulate across rounds and sequences and are converted into cash **at the exchange rate of 20 points = $1.**

Next

Stage 1 Details (Page 6 of 10)

Time left to complete instructi

In Stage 1 each participant will be assigned to be either a **Buyer** or a **Seller**. The assignment occurs before the sequence begins and remains fixed for all Stage 1 decisions in the sequence.

Buyers Decide

The quantity of **Red Tokens** to spend (denoted S_R) to purchase a consumption good
The quantity of **Blue Tokens** to spend (denoted S_B) to purchase a consumption good

Sellers Decide

The quantity of a consumption good to produce for **Red Tokens** (denoted Q_R)
The quantity of a consumption good to produce for **Blue Tokens** (denoted Q_B)

After all participants make their decisions, the Stage 1 market prices are determined using the supply and demand of corresponding tokens:

$$P_R = \frac{\text{Sum of Red Tokens Spent by all the Buyers}}{\text{Total Quantity of the Consumption Good Produced for Red Tokens by all the Sellers}} \qquad P_B = \frac{\text{Sum of Blue Tokens Spent by all the Buyers}}{\text{Total Quantity of the Consumption Good Produced for Blue Tokens by all the Sellers}}$$

If either the numerator or denominator in the above are zero, then the associated price is zero and no trade takes place for those tokens.

After Stage 1 prices are determined, the following will occur.

If you are a Buyer

You spend quantities of tokens you have chosen (S_R and S_B)
You receive the quantity of the good you afford at market prices ($S_R / P_R + S_B / P_B$)
Your token balances are adjusted to reflect your expenditures
Your point earnings are increased to reflect your consumption

If you are a Seller

You sell quantities of the good you have chosen (Q_R and Q_B)
You receive tokens from the sale at market prices ($Q_R \times P_R$ **Red Tokens** and $Q_B \times P_B$ **Blue Tokens**)
Your token balances are adjusted to reflect your sales
Your point earnings are reduced to reflect your production costs

Next

Stage 2 Details (Page 7 of 10)

Time left to complete in

Buyers in Stage 1 become Sellers in Stage 2 and vice versa.

At the beginning of Stage 2, Sellers first must decide whether to accept both types of tokens. By default, a Seller from the **Red Group** always can accept **Red Tokens** at no cost, and a Seller from **Blue Group** always can accept **Blue Tokens** at no cost. However, **Red Sellers** can purchase the option to accept **Blue Tokens** for 2 points. Similarly, **Blue Sellers** can purchase the option to accept **Red Tokens** for 2 points.

After Sellers make their acceptance decision, all participants will be randomly split into buyer-seller pairs according to the following probabilities:

	Probability Paired with **Red Seller**	Probability Paired with **Blue Seller**
Red Buyer	50%	50%
Blue Buyer	50%	50%

For instance, the probability a **Red Buyer** is paired with a **Red Seller** is 50% and the probability a **Red Buyer** is paired with a **Blue Seller** is 50%. Similarly, the probability a **Blue Buyer** is paired with a **Red Seller** is 50% and the probability a **Blue Buyer** is paired with a **Blue Seller** is 50%.

We will refer to the participant you are matched with as your "partner" for that round. Notice that in Stage 2 of the next round, you may be paired with a different partner.

Next

Stage 2 Details Continued (Page 8 of 10)

Time left to complete instructions: **1**

After all participants are paired, the computer will randomly pick one partner to be a **proposer** and one to be a **responder**. Specifically, there is a 50% chance the Buyer will be the proposer and a 50% chance the Seller will be the proposer. The proposer is informed of his/her own token holdings, the token holdings of the partner, the partner's group, and if the partner is a Seller, the type(s) of token accepted by the partner.

Trade Proposal Consists Of

The quantity of the consumption good to be transferred to the Buyer

and

The quantity of **Red Tokens** and/or **Blue Tokens** to be transferred to the Seller

After the proposal is submitted, the other participant will decide whether to accept or reject the proposal. Specifically,

Responders Decision

Accept

↓

The proposed exchange takes place. The Seller incurs a cost (in points) from producing the required quantity but receives the tokens (if any) that offered in exchange. The Buyer receives a benefit (in points) from the consumption of the good, but gives up tokens offered in exchange.

or

Reject

↓

If the proposal is rejected, then no trade takes place. This means the token and point balances of both participants will remain unchanged

Next

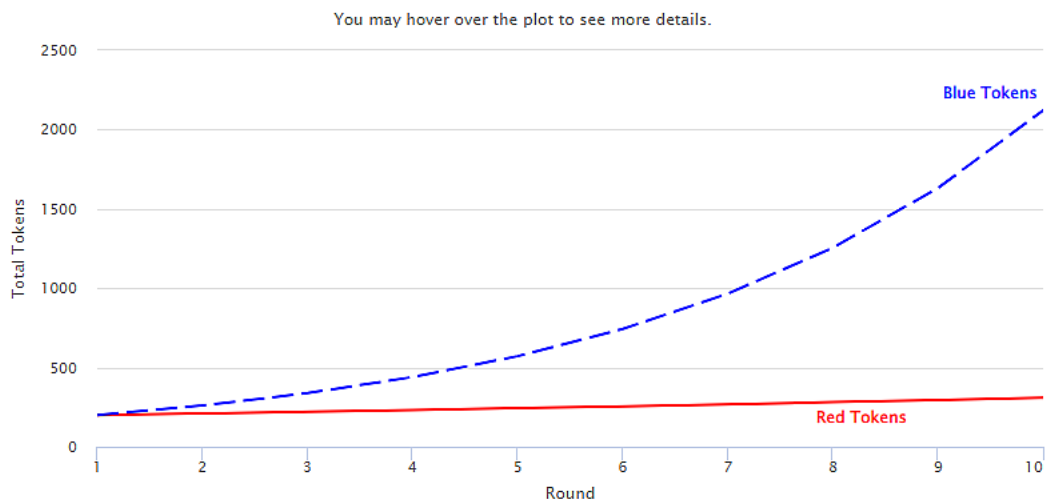
Tokens (Page 9 of 10)

Time left to complete ins

At the beginning of round 1, all Stage-1 Buyers are given an initial endowment of tokens. Specifically, each **Red Buyer** receives 25 **Red Tokens** and 15 **Blue Tokens** and each **Blue Buyer** receives 15 **Red Tokens** and 25 **Blue Tokens**.

Thus, at the start of each sequence there are 200 **Red Tokens** and 200 **Blue Tokens** in total.

The total number of **Red Tokens** and **Blue Tokens** available will increase in each round over the course of a sequence according to a predetermined schedule. Specifically, the amount of **Red Tokens** increases by 5% each round while the amount of **Blue Tokens** increases by 30% each round. For example, the total number of tokens over the first 10 rounds is displayed below.



The additional tokens are transferred equally among the buyers of the corresponding group. For example, at the beginning of round 2, an additional 2 **Red Tokens** are transferred to each **Red Buyer**, so that the total number of **Red Tokens** is 210.0. Similarly, at the beginning of round 2, an additional 12 **Blue Tokens** are transferred to each **Blue Buyers** so that the total number of **Blue Tokens** is 260.0. Notice that in rounds 2, 3, 4 … **Red Buyers** do not receive transfers of **Blue Tokens** and **Blue Buyers** do not receive transfers of **Red Tokens**.

Notice that for the duration of the experiment, you are provided with a separate print-out that contains this graph as well as the detailed table of token transfers.

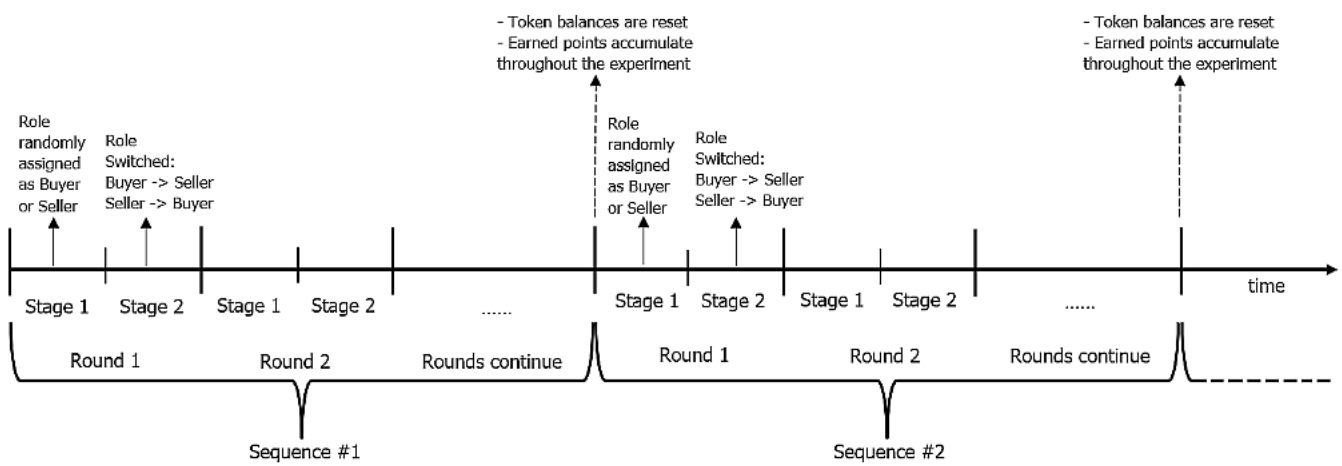
When a new sequence begins, the token holdings of all participants will reset.

Next

Summary (Page 10 of 10)

Time left to compl

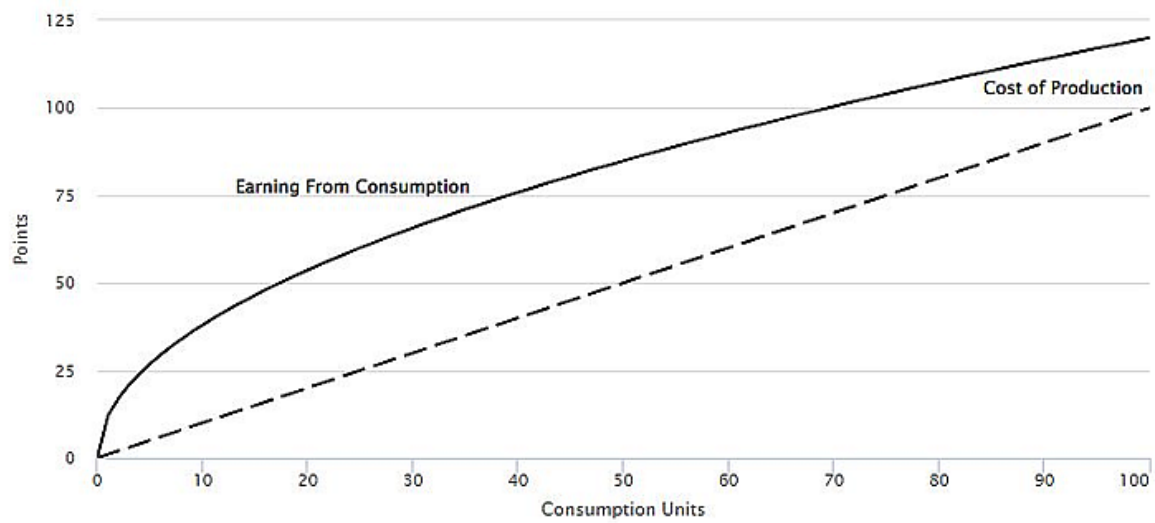
- Each participant will be randomly assigned to either **Red Group** or **Blue Group** for the duration of the experiment.
- The experiment is made up of 3 sequences.
- The number of rounds in a sequence is random and described in the instructions.
- Each round consists of 2 stages, and in each stage you will either be a **Buyer** or a **Seller**. If you are a Buyer in Stage 1 you will be a Seller in Stage 2 and vice-versa.
  - In **Stage 1**, all participants will make consumption and production decisions together (prices will be determined by the supply and demand for the consumption good).
  - In **Stage 2**, all participants are matched in partner pairs. One of two participants is randomly chosen to be the proposer and one the responder.
    - The proposer makes a trade proposal that consists of a consumption good quantity and a price in tokens.
    - The responder accepts or rejects the proposal.
- A **consumption good** is produced and consumed within each stage.
  - Buyers **earn points** by buying and consuming the consumption good.
  - Sellers **spend points** by producing and selling the consumption good.
  - The consumption good cannot be saved or transferred to future rounds.
- Buyers and Sellers can trade the consumption good in exchange for **Red Tokens** and **Blue Tokens**.
  - **Holding tokens do not yield any points**. Therefore, any token balances at the end of the session cannot be exchanged for points or converted to cash.
  - Tokens can be transferred to future stages and rounds within a sequence, but not from one sequence to the next.
- **Points** earned from consumption and production accumulate across rounds and sequences and are converted into cash at the end of the experiment at the exchange rate of **20 points = $1**.



Begin Quiz

C.1. Additional printed materials

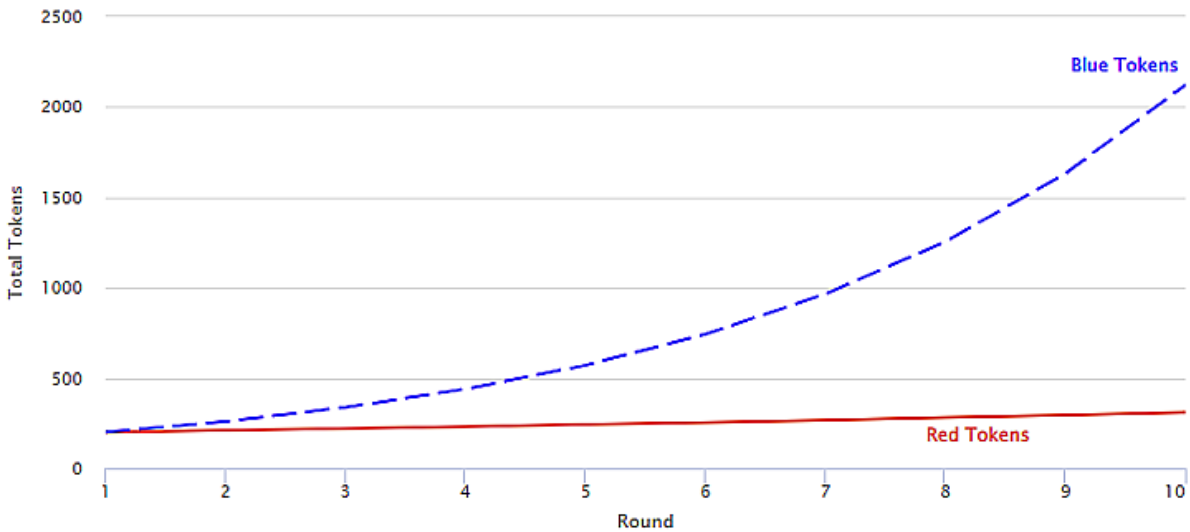
Benefit of consuming and cost of producing the consumption good:



The schedule below shows the earnings of buying and consuming units of the consumption good, and the cost of producing and selling them.

Values for 0 to 25 units			*Values for 26 to 50 units*			*Values for 51 to 75 units*			*Values for 76 to 100 units*		
Units of consumption	**Earnings (points)**	**Cost (points)**	**Units of consumption**	**Earnings (points)**	**Cost (points)**	**Units of consumption**	**Earnings (points)**	**Cost (points)**	**Units of consumption**	**Earnings (points)**	**Cost (points)**
0	0	0	**26**	61	26	**51**	86	51	**76**	104.6	76
1	12	1	**27**	62	27	**52**	87	52	**77**	105	77
2	17	2	**28**	63	28	**53**	87.4	53	**78**	106	78
3	21	3	**29**	65	29	**54**	88	54	**79**	107	79
4	24	4	**30**	66	30	**55**	89	55	**80**	107.3	80
5	27	5	**31**	67	31	**56**	90	56	**81**	108	81
6	29	6	**32**	68	32	**57**	91	57	**82**	109	82
7	32	7	**33**	69	33	**58**	91.4	58	**83**	109.3	83
8	34	8	**34**	70	34	**59**	92	59	**84**	110	84
9	36	9	**35**	71	35	**60**	93	60	**85**	111	85
10	38	10	**36**	72	36	**61**	94	61	**86**	111.3	86
11	40	11	**37**	73	37	**62**	94.5	62	**87**	112	87
12	42	12	**38**	74	38	**63**	95	63	**88**	113	88
13	43	13	**39**	75	39	**64**	96	64	**89**	113.2	89
14	45	14	**40**	76	40	**65**	97	65	**90**	114	90
15	46	15	**41**	77	41	**66**	97.5	66	**91**	114.5	91
16	48	16	**42**	78	42	**67**	98	67	**92**	115	92
17	49	17	**43**	79	43	**68**	99	68	**93**	116	93
18	51	18	**44**	79.6	44	**69**	100	69	**94**	116.3	94
19	52	19	**45**	80	45	**70**	100.4	70	**95**	117	95
20	54	20	**46**	81	46	**71**	101	71	**96**	118	96
21	55	21	**47**	82	47	**72**	102	72	**97**	118.2	97
22	56	22	**48**	83	48	**73**	103	73	**98**	119	98
23	58	23	**49**	84	49	**74**	103.2	74	**99**	119.4	99
24	59	24	**50**	85	50	**75**	104	75	**100**	120	100
25	60	25									

Schedule of token transfers:



The schedule below shows the total number of tokens held among all 20 participants in each round.

The first column (rounds 1 to 10) corresponds to what is presented in the graph above.

The experiment may last longer than 1 block depending on the random number realization.

Values for rounds 1 to 10			*Values rounds for 11 to 20*			*Values for rounds 21 to 30*			*Values for rounds 31 to 40*		
Round	**Red Token total quantity**	**Blue Token total quantity**	**Round**	**Red Token total quantity**	**Blue Token total quantity**	**Round**	**Red Token total quantity**	**Blue Token total quantity**	**Round**	**Red Token total quantity**	**Blue Token total quantity**
1	200	200.0	**11**	325.78	2,757.2	**21**	530.66	38,009.9	**31**	864.39	523,999.1
2	210.00	260.0	**12**	342.07	3,584.3	**22**	557.19	49,412.9	**32**	907.61	681,198.9
3	220.50	338.0	**13**	359.17	4,659.6	**23**	585.05	64,236.8	**33**	952.99	885,558.5
4	231.53	439.4	**14**	377.13	6,057.5	**24**	614.30	83,507.8	**34**	1000.64	1,151,226.1
5	243.10	571.2	**15**	395.99	7,874.8	**25**	645.02	108,560.2	**35**	1050.67	1,496,593.9
6	255.26	742.6	**16**	415.79	10,237.2	**26**	677.27	141,128.2	**36**	1103.20	1,945,572.1
7	268.02	965.4	**17**	436.57	13,308.3	**27**	711.13	183,466.7	**37**	1158.36	2,529,243.7
8	281.42	1,255.0	**18**	458.40	17,300.8	**28**	746.69	238,506.7	**38**	1216.28	3,288,016.8
9	295.49	1,631.5	**19**	481.32	22,491.1	**29**	784.03	310,058.7	**39**	1277.10	4,274,421.9
10	310.27	2,120.9	**20**	505.39	29,238.4	**30**	823.23	403,076.3	**40**	1340.95	5,556,748.4