Cryptocurrencies, Currency Competition, and the Impossible Trinity

Pierpaolo Benigno*
Linda M. Schilling**
Harald Uhlig***

*University of Bern,
**Ecole Polytechnique CREST
***University of Chicago

May 2020

Motivation

Global currencies are on the rise

- Facebook's Libra 2020:
  - backed by pool of low-risk assets and currencies
  - Wide platform adoption already, 2.38 billion monthly active users as of 2019 (source: statista.com)
- Bitcoin (2009):
  - 32 million bitcoin wallets set up globally by December 2018 (source: bitcoinmarketjournal.com)

Motivation

WHAT MAKES GLOBAL CURRENCY SPECIAL?

National currency only

- No medium of exchange abroad
- Exchange to other national currency possible
- Exchange rate risk

With Global currency

- Serves as medium of exchange in multiple countries
  - No exchange rate risk
  - But: GLOBAL CURRENCIES COMPETE LOCALLY WITH NATIONAL CURRENCY
  - And: NATIONAL CURRENCIES COMPETE TRANSNATIONALLY THROUGH GLOBAL CURRENCY

Question

WHAT ARE THE MONETARY POLICY IMPLICATIONS OF INTRODUCING GLOBAL CURRENCIES ?

Impossible Trinity: Under free capital flows, can have independent monetary policy when giving up a pegged exchange rate.

Main Result:

- Free capital flows + global currency $\Rightarrow$ eliminates indep. Mon Policy
- Constraints Impossible Trinity

Literature

Currency Competition

- Kareken and Wallace (1981), Manuelli and Peck (1990), Garratt and Wallace (2017), Schilling and Uhlig (2018)

Impossible Trinity

- Fleming (1962), Mundell (1963)

Exchange Rate Dynamics and Currency Dominance

- Obstfeld and Rogoff (1995); Casas, Diez, Gopinath, Gourinchas (2016)

Currency Substitution

- Girton and Roper (1981), Matsuyama, Kiyotaki, and Matsui (1993)

Monetary Theory, Asset Pricing and Cryptocurrencies

- Fernández-Villaverde and Sanches (2016), Benigno (2019), Biais, Bisiere, Bouvard, Casamatta, Menkveld (2018), Huberman, Leshno, Moallemi (2017)

Model I

- discrete time, $t = 0, 1, 2 \ldots$
- 2 countries
- 1 tradeable consumption good
- 3 currencies: home H, foreign F, global G
- 2 sovereign bonds, Home and Foreign
- 1 representative, infinitely lived agent in each country
  - utility $u(\cdot)$ strictly increasing, continuous differentiable, concave
  - discount factor $\beta \in (0, 1)$
  - Intertemporal utility

Model II

Monies

- Liquidity services:
  - L_t in Home country,
  - L_t^* in Foreign
- Exchange rates:
  - Q_t price of one unit global currency in terms of home currency,
  - Q_t^* price of one unit global currency in terms of foreign currency,
  - S_t price of one unit foreign currency in terms of home currency
- Nominal Stochastic Discount Factors
  - Home: M_{t+1}
  - Foreign: M_{t+1}^*

Bonds

- Nominal interest rates:
  - i_t on bond in Home,
  - i_t^* on bond in Foreign

Model III

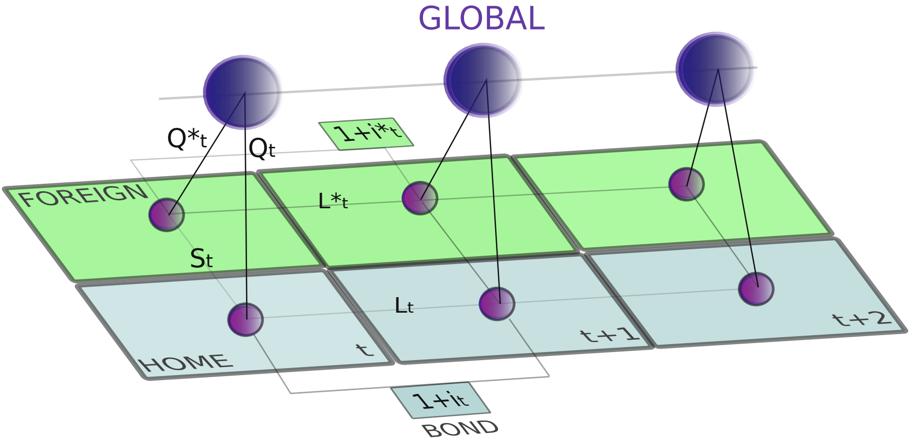
ASSUMPTIONS

- Complete Markets:

$$M_{t+1} = M^*_{t+1} \frac{S_t}{S_{t+1}} \tag{1}$$

- No arbitrage (uniqueness + existence SDF)
- Liquidity Immediacy: The purchase of Home and Foreign currency yields an immediate liquidity service L_t, respectively L^*_t
- No short sale on global currency (no neg. liquid service)
- No transaction costs

Timing



Standard Asset pricing

Let R an arbitrary stochastic asset return, denominated in Home currency.

Intertemporal utility maximization of agents implies (Cochrane, 2008)

$$1 = \mathbb{E}_t[M_{t+1} R_{t+1}] \tag{2}$$

Standard Asset pricing II

EQUILIBRIUM BOND PRICES

$$\frac{1}{1+i_t} = \mathbb{E}_t[M_{t+1}] \tag{3}$$

$$\frac{1}{1+i_t^*} = \mathbb{E}_t[M_{t+1}^*] \tag{4}$$

EQUILIBRIUM CURRENCY PRICES

Home

$$1 = L_t + \mathbb{E}_t[M_{t+1}] \tag{5}$$

$$1 \underset{(=)}{\geq} L_t + \mathbb{E}_t[M_{t+1}\frac{Q_{t+1}}{Q_t}] \tag{6}$$

Foreign

$$1 = L_t^* + \mathbb{E}_t[M_{t+1}^*] \tag{7}$$

$$1 \underset{(=)}{\geq} L_t^* + \mathbb{E}_t[M_{t+1}^*\frac{Q_{t+1}^*}{Q_t^*}] \tag{8}$$

Benchmark: No Global Currency

EQUILIBRIUM BOND PRICES

$$\frac{1}{1+i_t} = \mathbb{E}_t[M_{t+1}] \tag{9}$$

$$\frac{1}{1+i_t^*} = \mathbb{E}_t[M_{t+1}^*] \tag{10}$$

EQUILIBRIUM CURRENCY PRICES

Home

$$1 = L_t + \mathbb{E}_t[M_{t+1}] \tag{11}$$

$$1 \underset{(=)}{\geq} L_t + \mathbb{E}_t[M_{t+1}\frac{Q_{t+1}}{Q_t}] \tag{12}$$

Foreign

$$1 = L_t^* + \mathbb{E}_t[M_{t+1}^*] \tag{13}$$

$$1 \underset{(=)}{\geq} L_t^* + \mathbb{E}_t[M_{t+1}^*\frac{Q_{t+1}^*}{Q_t^*}] \tag{14}$$

Benchmark: No Global Currency II

Stochastic Uncovered Interest parity

$$0 = \mathbb{E}_t \left[M_{t+1} \left((1 + i_t^*) \frac{S_{t+1}}{S_t} - (1 + i_t) \right) \right] \tag{15}$$

⇒ Take-away: Absent direct currency competition, exchange rate Home-Foreign and interest rates are intertwined!

Results (1): With Global Currency

Assumption

- Global currency is valued $Q_t, Q_t^* > 0$
- Global currency used in both countries

Proposition 1 (Crypto-enforced Monetary Policy Synchronization)
(i) The nominal interest rates on bonds *have to be* equal $i_t = i_t^*$
(ii) The liquidity services in Home and Foreign are equal $L_t = L_t^*$
(iii) The nominal exchange rate between home and foreign currency follows a martingale under the risk-adjusted measure

$$\tilde{\mathbb{E}}_t[S_{t+1}] := \frac{\mathbb{E}_t[M_{t+1}S_{t+1}]}{\mathbb{E}_t[M_{t+1}]} = S_t \tag{16}$$

Results: Economic Mechanism

A INTRODUCTION OF GLOBAL CURRENCY CREATES GLOBAL COMPETITION BETWEEN NATIONAL CURRENCIES

- Local currency competition: Home $\Leftrightarrow$ Global
- Local currency competition: Foreign $\Leftrightarrow$ Global
- Global currency competition: Home $\Leftrightarrow$ Foreign (through Global)

B DIRECT COMPETITION BETWEEN BONDS

- Local competition: Home currency $\Leftrightarrow$ home bond
- Local competition: Foreign currency $\Leftrightarrow$ foreign bond
- Global competition: Home bond $\Leftrightarrow$ Foreign bond ($i = i^*$)
  (Not UIP since without adjustment for exchange rates)

Results (2): With Global Currency

Assumption

- Global currency is valued $Q_t, Q_t^* > 0$
- National currencies are used in both countries

Proposition 2 (Crowding Out)
Independently of whether the global currency is used in country f or not:
If $i_t < i_t^*$ then
(i) the global currency is not adopted in country h
(ii) The liquidity services satisfy $L_t < L_t^*$
(iii) The nominal exchange rate between home and foreign currency follows a supermartingale under the risk-adjusted measure of country h

$$\tilde{\mathbb{E}}_t[S_{t+1}] := \frac{\mathbb{E}_t[M_{t+1}S_{t+1}]}{\mathbb{E}_t[M_{t+1}]} < S_t \tag{17}$$

Results: Economic Mechanism

Premise: At least one currency is used in each country

INTEREST RATES AND LIQUIDITY SERVICES ARE IN ONE-TO ONE RELATIONSHIP $i \leftrightarrow L$, $i^* \leftrightarrow L^*$

- Bonds compete with currency nationally
- If one country offers a lower interest rate $i_t < i_t^*$, also the liquidity services of currency in that country have to be lower $L_t < L_t^*$

GLOBAL CURRENCY: FEATURES ADDITIONAL RISKY RETURN (EXCHANGE RATE)

- In contrast to the national currency, the global currency not only offers sure liquidity services.
- market completeness, free capital flows and no arbitrage: Expectations and pricing of the exchange rate of the global currency coincide internationally

$\Rightarrow$ Global currency is adopted in country with higher liquidity services (since GC overpriced in country with lower liquidity services)

Result (3): Losing control of medium of exchange

Assumption

- Global currency is valued $Q_t, Q_t^* > 0$
- Assume the global currency is used in country f

Proposition 3 (Crowding Out)
If the CB in country h sets $i_t > i_t^*$ then the national currency h is abandoned and the global currency takes over.

Asset-backed Global Currency

Assumption

- Assume a consortium of companies issues the global currency, backed by bonds of country h
- Assume that the consortium promises to trade any fixed amount of the global currency at fixed price Q_t
- to make money, the consortium charges a fee ϕ_t
- $Q_{t+1} = (1 + i_t - \phi_t)\, Q_t$

Proposition 4 (Crowding Out)
Assume the global currency is valued.
(i) If $\phi_t < i_t$, then currency h is crowded out and only the global currency is used in country h
(ii) If $\phi_t = i_t$: Both currencies h and the global currency coexist
(iii) If $\phi_t > i_t$: then only currency h is used

Insight: GC may combine best of both worlds, liquidity + interest. If $\phi_t > i_t$, the consortium consumes the interest entirely.

Example 1: Money in Utility I

Consumers in Home have preferences

$$E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left(u(c_t) + v\left(\frac{M_{H,t} + Q_t M_{G,t}}{P_t} \right) \right) \tag{18}$$

budget constraint

$$B_{H,t} + S_t B_{F,t} + M_{H,t} + Q_t M_{G,t} = W_t + P_t(Y_t - c_t) \tag{19}$$

- $u(\cdot)$, $v(\cdot)$ concave
- P_t, P_t^* price of consumption good in units of home and foreign currency
- $M_{H,t}$, $M_{G,t}$ money holdings in home resp. global currency
- $B_{H,t}$, $B_{F,t}$ home resp. foreign bond holdings
- Y_t income
- W_t wealth

$$W_t = M_{H,t-1} + Q_t M_{G,t-1} + (1 + i_{t-1}) B_{H,t-1} + (1 + i^*_{t-1}) S_t B_{F,t-1} \tag{20}$$

Example 1: Money in Utility II

FOC's

$$B_H: \qquad \frac{u_C(c_t)}{P_t}\frac{1}{1+i_t} = \mathbb{E}_t\left[\beta\frac{u_C(c_{t+1})}{P_{t+1}}\right] \tag{21}$$

$$B_F: \qquad \frac{u_C(c_t)}{P_t}\frac{1}{1+i_t^*} = \mathbb{E}_t\left[\beta\frac{u_C(c_{t+1})}{P_{t+1}}\frac{S_{t+1}}{S_t}\right] \tag{22}$$

$$M_H: \qquad \frac{u_C(c_t)}{P_t} = \mathbb{E}_t\left[\beta\frac{u_C(c_{t+1})}{P_{t+1}}\right] + \frac{1}{P_t}v'\left(\frac{M_{H,t}+Q_tM_{G,t}}{P_t}\right) \tag{23}$$

$$M_G: \qquad Q_t\frac{u_C(c_t)}{P_t} = \mathbb{E}_t\left[\beta\frac{Q_{t+1}\,u_C(c_{t+1})}{P_{t+1}}\right] + \frac{Q_t}{P_t}v'\left(\frac{M_{H,t}+Q_tM_{G,t}}{P_t}\right) \tag{24}$$

Example 1: Money in Utility III

Matching Terms

$$M_{t+1} = \beta \frac{u_C(c_{t+1})}{u_C(c_t)} \frac{P_t}{P_{t+1}} \tag{25}$$

$$M^*_{t+1} = \beta \frac{u_C(c^*_{t+1})}{u_C(c^*_t)} \frac{P^*_t}{P^*_{t+1}} \tag{26}$$

$$L_t = \frac{v'\left(\frac{M_{H,t}+Q_t M_{G,t}}{P_t}\right)}{u_C(c_t)} \tag{27}$$

$$L^*_t = \frac{v'\left(\frac{M^*_{F,t}+Q^*_t M^*_{G,t}}{P^*_t}\right)}{u_C(c^*_t)} \tag{28}$$

$\Rightarrow$ In Equ. $L = L^*$

Similar for Cash-in-advance models!

Conclusion

THE INTRODUCTION OF A GLOBAL CURRENCY

- enforces direct competition between national currencies through the global currency
- If all currencies are in use:
  - crypto-enforced monetary policy synchronization (CEMPS)
  - exchange rates become risk-adjusted martingales
- If interest rates differ:
  - crowding out of currencies
  - race down to ZLB

Praline: Deterministic Benchmark

Inflation Rates: $\pi_t = \frac{P_t}{P_{t-1}} - 1, \quad \pi_t^* = \frac{P_t^*}{P_{t-1}^*} - 1$

Real interest rates: $r_t = i_t - \pi_t$ (Fisher)

Proposition 2 (Deterministic CMU)

(i) The liquidity services in Home and Foreign are equal $L_t = L_t^*$

(ii) The nominal interest rates on bonds are equal $i_t = i_t^*$

(iii) The nominal exchange rate between home and foreign currency is constant $S_t = S$

- $\Rightarrow$ inflation rates $\pi_t = \pi_t^*$ are the same
- $\Rightarrow$ real interest rates $r_t = r_t^*$ are the same