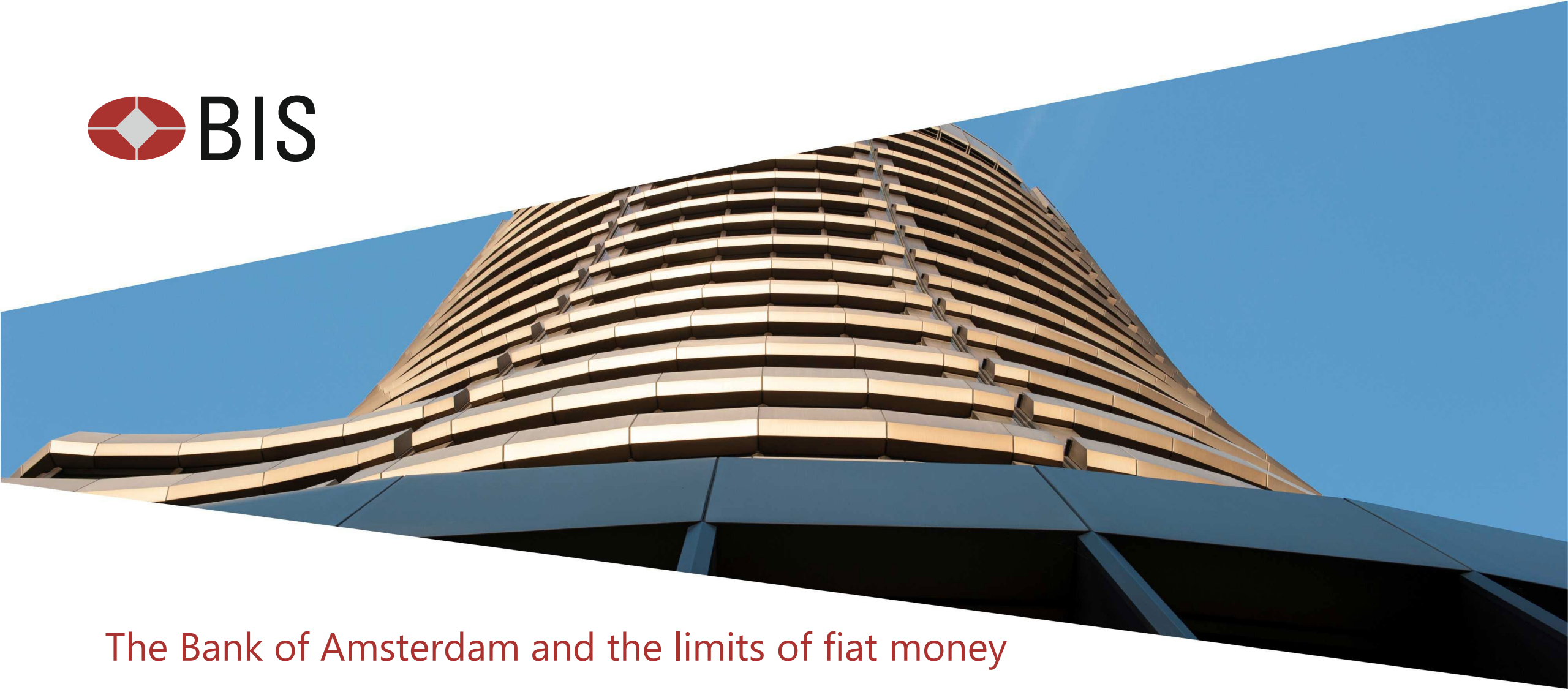

The Bank of Amsterdam and the limits of fiat money

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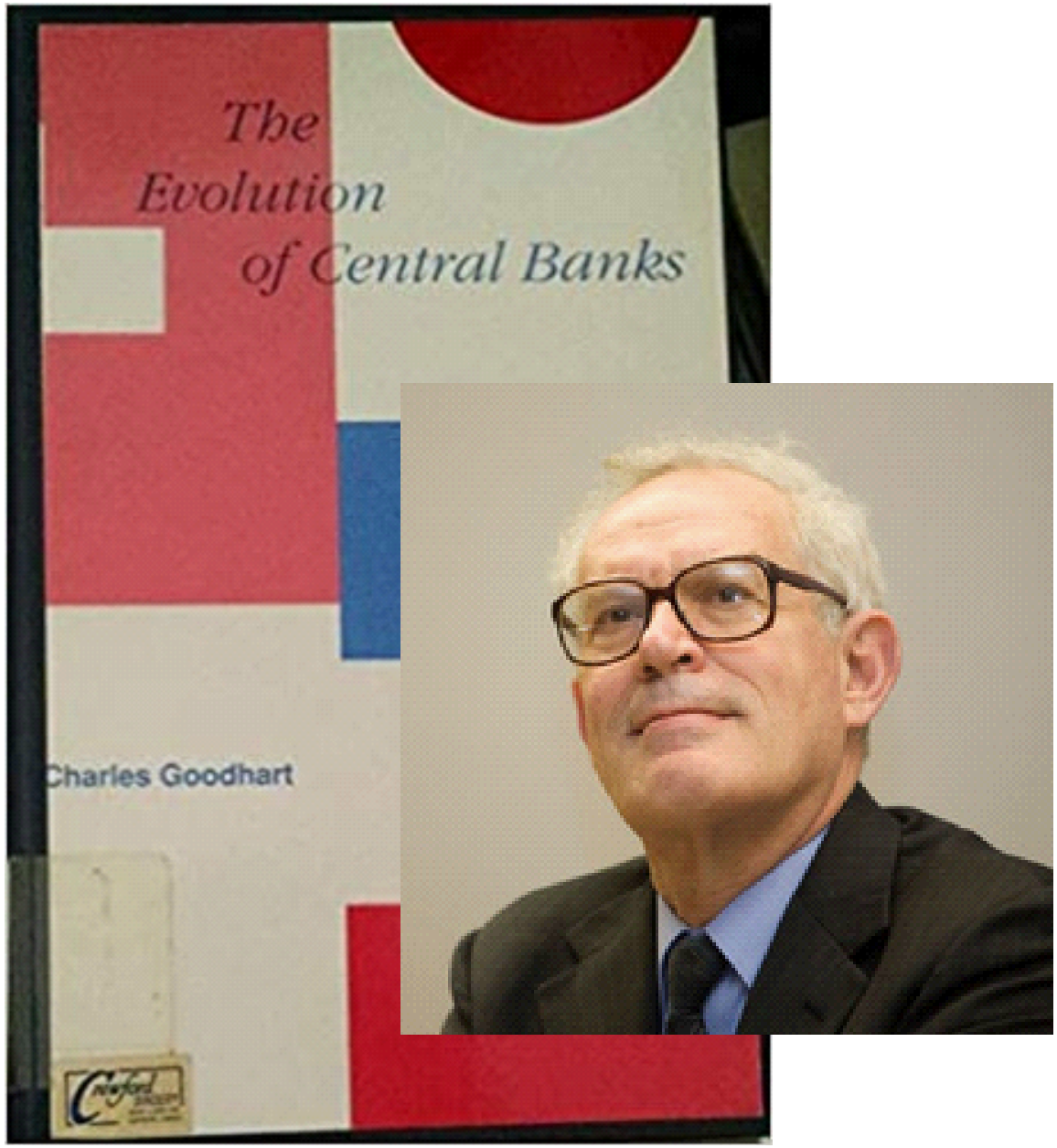
*The views expressed here are those of the authors and not necessarily those of the Bank for International Settlements or De Nederlandsche Bank


The
Evolution
of Central Banks
Charles Goodhart

Bank of Amsterdam (1609 - 1820)

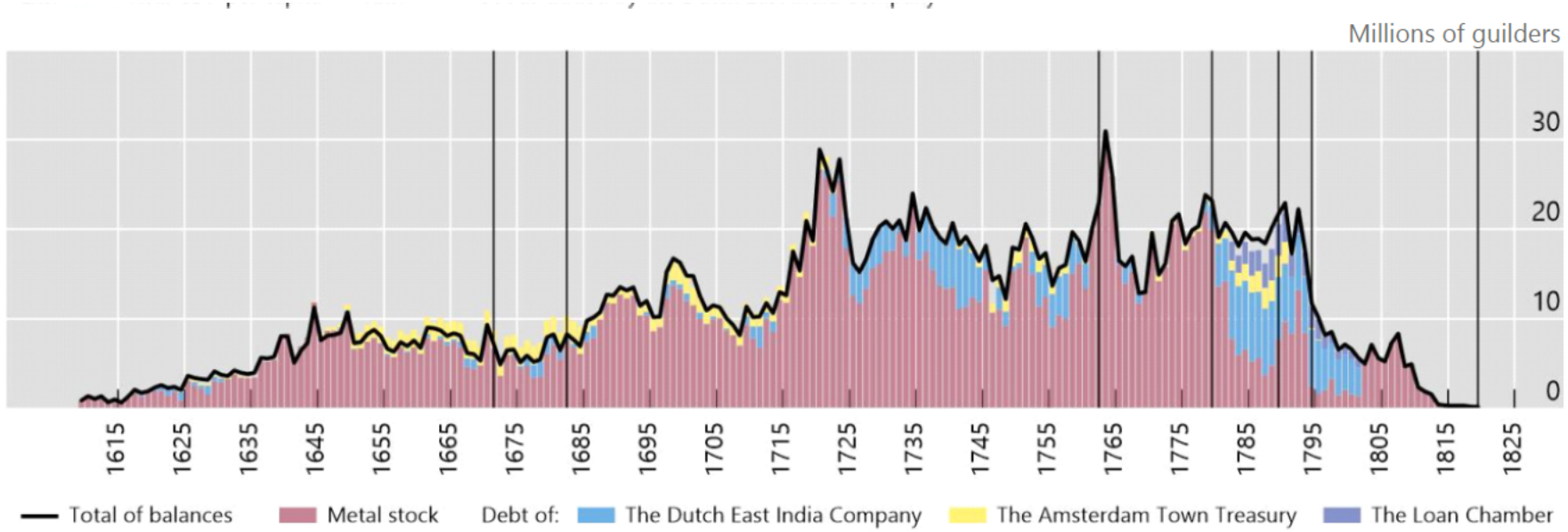
- Began as public deposit (payment) bank, effectively a stablecoin backed by metal coins; morphs into proto-central bank issuing fiat money and adjusting money supply through asset sales/purchases to maintain stable value
- In its heyday, Amsterdam bank money was the first global currency for trade and finance

Adam Smith on the Bank of Amsterdam

"At Amsterdam, however, no point of faith is better established than that for every guilder, circulated as bank money, there is a correspondent guilder in gold or silver to be found in the treasure of the bank. The city is guarantee that it should be so. The bank is under the direction of the four reigning burgomasters who are changed every year. Each new set of burgomasters visits the treasure, compares it with the books, receives it upon oath, and delivers it over, with the same awful solemnity, to the set which succeeds; and in that sobre and religious country oaths are not yet disregarded"

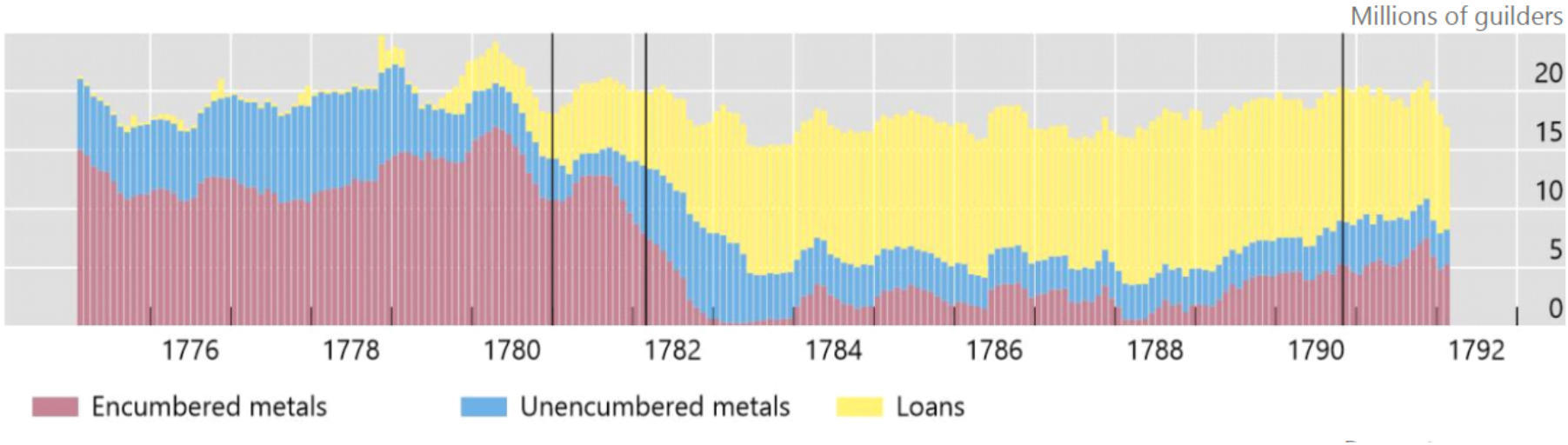
(Adam Smith, Wealth of Nations, 1776)

Assets of the Bank of Amsterdam



Source: Quinn and Roberds (2014, 2017)

Assets of the Bank of Amsterdam close up



Source: Quinn and Roberds (2014, 2017)

How can a bank that issues fiat money go bust?

- Fiat money is not debt that has to be repaid
- But this does not mean there are no limits
- Portfolio choice resulting from currency competition is a constraint

- Key question: how negative must bank equity be before value of fiat money (relative to the alterantive) collapses?

Model ingredients

- Merchants face portfolio choice between coins and Bank money
  - Gives rise to money demand function, which is subject to network effects
- Bank buys or sells coins to adjust the supply of Bank money to maintain a fixed agio, or premium
  - Akin to currency board maintaining target exchange rate
- Loans on the balance sheet place hard limit on how far money supply can be reduced by selling coins
  - Agio breaks below target when money demand falls below threshold; in limiting case, money value falls to zero

Model

- Three dates, indexed by $\{0, 1, 2\}$
- Economic fundamentals Θ, lognormally distributed
- $\theta \equiv \log \Theta$ has mean y and standard deviation $1/\sqrt{\alpha}$
  - Snapshot of dynamic economy where fundamentals $\{\theta_t\}$ follow a Gaussian random walk
- Two assets: coins and bank money (deposits)
  - Coin is numeraire of value 1

- Continuum of risk-neutral merchants, indexed by $i \in [0, 1]$
- Merchant i's valuation of bank money is

$$v_i \cdot f\left(m\right)$$

where $f\left(m\right)$ is increasing function of money holding m, reflecting network effects of bank money and

$$v_i = \theta + \varepsilon_i$$

where ε_i is i.i.d Gaussian with mean 0, std dev $1/\sqrt{\beta}$

- Merchants know their own type, but must infer the distribution of other merchants' types

Monetary operations of the Bank of Amsterdam

- Bank of Amsterdam balance sheet

$$C + L = M + E$$

  respectively coins, loans, money and equity
- Buys coins by crediting the seller's account; sells coins debiting the buyers account (akin to QE/QT); purchases expand money stock, sales contract money stock
- Observes θ, and chooses money stock $M(\theta)$ to maintain constant agio $\bar{\gamma}$ on bank money

$$p = 1 + \bar{\gamma}$$

Global game two-step solution procedure

- First, given risk neutrality, consider switching strategies for merchants around switching point v^*
- Then show that the unique switching equilibrium is also the solution to iterated deletion of dominated strategies

Money demand

- Money demand follows from the portfolio decision of merchants

$$D(\theta) = \text{Prob}\left(v_i \geq v^* | \theta\right) = \Phi\left(\sqrt{\beta}\left(\theta - v^*\right)\right)$$

where $\Phi(.)$ is standard normal c.d.f.

- Switching point v^* satisfies the indifference condition

$$\frac{v^*}{1+\bar{\gamma}} \cdot E\left(f | v^*, y\right) = 1$$

Left-hand side is the expected payoff from holding bank money conditional on being the marginal type v^*, while the right-hand side is the payoff to holding coins

Money demand

Switching point v^* satisfies the indifference condition

$$\frac{v^*}{1+\bar{\gamma}} \cdot E\left(f \middle| v^*, y\right) = 1$$

Conditional expectation follows from answer to the following question:

> *"My valuation is exactly v^*; what is the distribution over others' valuations? Since everyone follows a switching strategy around v^*, money holding resulting from others' portfolio choice is the proportion of valuations that are above my own"*

Money demand

- Answer to above question defines density over proportion of merchans that hold money
- Indifference condition is

$$\frac{v^*}{1+\bar{\gamma}}\int_0^1 f(z)\,dG(z|v^*,y)=1$$

where c.d.f. is

$$G(z|v^*,y)=\Phi\left(\frac{\alpha}{\sqrt{\alpha+\beta}}(v^*-y)+\sqrt{\frac{\alpha+\beta}{\beta}}\Phi^{-1}(z)\right)$$

- Note that $\beta\to\infty$ implies $G(z|v^*,y)\to z$, so that the density is uniform, and the prior mean y does not enter; but in general, the prior mean y shifts the whole distribution in a first-degree stochastic dominance sense

Money market equilibrium

To maintain the agio at $\bar{\gamma}$, money supply $M(\theta)$ has to satisfy

$$\begin{aligned} M(\theta) &= D(\theta) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - v^*\right)\right) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - (1+\bar{\gamma})/E\left(f|v^*, y\right)\right)\right) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - (1+\bar{\gamma})/\int_0^1 f(z)\, dG\left(z|v^*, y\right)\right)\right) \end{aligned}$$

- Trouble looms when money supply cannot contract sufficiently; the agio then breaks below target

Break point

Balance sheet identity

$$C + L = M + E$$

Since $C \geq 0$, agio breaks when $M > L - E$

- Break point θ^* is the level of fundamentals below which the agio breaks; it is defined as solution to

$$\Phi\left(\sqrt{\beta}\left(\theta^* - v^*\right)\right) = L - E$$

or

$$\theta^* = v^* + \frac{\Phi^{-1}\left(L - E\right)}{\sqrt{\beta}}$$

- Large loan portfolio and negative equity is a toxic mix that undermines fiat money

Results

- For any α, there is β sufficiently large such that there is a unique, dominance solvable equilibrium. This equilibrium is in switching strategies around v^*
- In the limit as $\alpha \to \infty$ and $\beta \to \infty$ but $\sqrt{\beta}/\alpha \to k$, money demand is

$$D(\theta) = \begin{cases} 0 & \text{if } \theta < \theta^* \\ 1 & \text{if } \theta \geq \theta^* \end{cases}$$

and price of bank money is

$$p(\theta) = \begin{cases} 0 & \text{if } \theta < \theta^* \\ 1 + \bar{\gamma} & \text{if } \theta \geq \theta^* \end{cases}$$

Break point $\theta^*(y)$ is an increasing function of the ex ante mean of fundamentals y

Further research/policy questions

- Bank-sovereign nexus redux
  - Modern day equivalent of merchants is the banking sector
  - What are the relevant portfolio decisions?
  - Where are the break points?
- Exchange rates as a barometer of fiat money value
  - Inflation is not always the result of excess demand
  - Spike in inflation and collapse of economic activity can go together, especially in emerging and developing economies undergoing financial crises
- Financial innovation on run dynamics
  - "Cryptoisation"
  - What is the outside option for relevant portfolio choice?