A Model of Monetary Exchange in Over-the-Counter Markets

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Money in financial over-the-counter markets

Broad question:

Quantity of money and performance of OTC markets

What we do:

- Build model of fiat money used as medium of exchange in OTC markets
- Study effects of monetary policy on asset prices and financial liquidity

How we do it:

Embed the OTC market structure and gains from trade in financial assets of Duffie, Gârleanu and Pedersen (2005) into the monetary framework of Lagos and Wright (2005)

Applications and results

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1. Determine asset prices and standard measures of financial liquidity (spreads, trade volume, dealer supply of immediacy)

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1. Determine asset prices and standard measures of financial liquidity (spreads, trade volume, dealer supply of immediacy)
2. Generate a *speculative premium* (or *speculative 'bubble'*)
3. Explain positive correlation between real stock yield and nominal Treasury yield (the *Fed Model*)
4. Lead to equilibria with recurrent belief driven *liquidity crises* (times of sudden large increases in trading delays and spreads, and sharp persistent declines in asset prices, trade volume, and dealer participation in marketmaking)

Environment

- *Time.* Discrete, infinite horizon, two subperiods per period
- *Population.* $[0, 1]$ investors, $[0, v]$ dealers (both infinitely lived)
- *Commodities.* Two divisible, nonstorable consumption goods:
  - *dividend good*
  - *general good*

Preferences

Dealers: $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (c_{td} - h_{td})$

Investors: $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (\varepsilon_{ti} y_{ti} + c_{ti} - h_{ti})$

- $\beta \in (0, 1)$: discount factor
- c_{td}, c_{ti} : consumption of general good
- h_{td}, h_{ti} : effort to produce general good
- y_{ti} : consumption of dividend good
- ε_{ti} : preference shock, i.i.d. over time, cdf $G(\cdot)$ on $[\varepsilon_L, \varepsilon_H]$

Endowments and production technology

First subperiod

A^s productive units (*trees*)

- Each unit yields y dividend goods *at the end of the first subperiod*
- Each unit permanently "fails" with probability $1 - \pi$ at the beginning of the period
- Failed units immediately replaced by new units (allocated uniformly to investors)

Second subperiod

- Linear technology allows dealers and investors to transform effort into general goods

Assets

Equity shares

- A^s equity shares
- At the beginning of period t:
  - $(1-\pi)\,A^s$ shares of failed trees disappear
  - $(1-\pi)\,A^s$ shares of new trees allocated uniformly to investors

Fiat money

- Money supply: A_t^m dollars
- Monetary policy: $A_{t+1}^m = \mu A_t^m$, $\mu \in \mathbb{R}_{++}$

  (implemented with lump-sum injections/withdrawals)

Market structure

First subperiod: OTC market

- money, equity (*cum dividend*)
- dealer-investor pairwise trade
- Walrasian trade between all dealers

Second subperiod: centralized market

- general good, money, equity (*ex dividend*)
- Walrasian trade between all dealers and investors

"Anonymity" $\Rightarrow$ *quid pro quo* trade
$\Rightarrow$ money serves as means of payment

OTC market structure

Investors

- Contact a dealer with probability δ

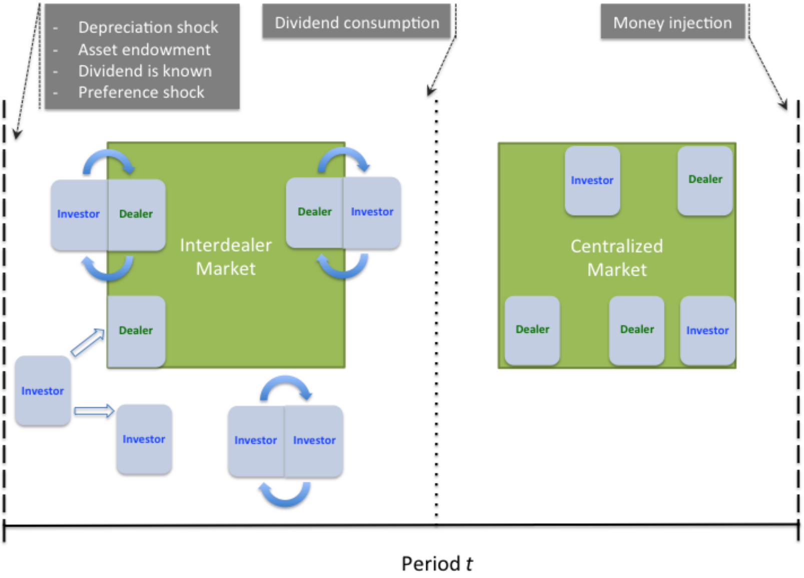
Dealers

- Contact an investor with probability $\kappa \equiv \delta / v$
- Have access to a competitive interdealer market

Bilateral terms of trade

- Investor makes offer with probability θ
- Dealer makes offer with probability $1 - \theta$

Timeline and marketstructure



Value functions

Dealers

$W_t^D(\mathbf{a}_t)$: value of entering CM with $\mathbf{a}_t \equiv (a_t^m, a_t^s)$

$\hat{W}_t^D(\mathbf{a}_t)$: value of rebalancing portfolio $\mathbf{a}_t$ in OTCM

$V_t^D(\mathbf{a}_t)$: value of entering OTCM

Investors

$W_t^I(\mathbf{a}_t)$: value of entering CM

$V_t^I(\mathbf{a}_t, \varepsilon_t)$: value of entering OTCM

Centralized market

Dealers

$$W_t^D(\mathbf{a}_t) = \max_{c_t, h_t, \tilde{\mathbf{a}}_{t+1}} \left[c_t - h_t + \beta V_{t+1}^D(\mathbf{a}_{t+1}) \right]$$

$$c_t + \boldsymbol{\phi}_t \tilde{\mathbf{a}}_{t+1} \leq h_t + \boldsymbol{\phi}_t \mathbf{a}_t$$

$$\mathbf{a}_{t+1} = \left(\tilde{a}_{t+1}^m, \pi \tilde{a}_{t+1}^s\right)$$

Investors

$$W_t^I(\mathbf{a}_t) = \max_{c_t, h_t, \tilde{\mathbf{a}}_{t+1}} \left[c_t - h_t + \beta \int V_{t+1}^I(\mathbf{a}_{t+1}, \varepsilon') \, dG(\varepsilon') \right]$$

$$c_t + \boldsymbol{\phi}_t \tilde{\mathbf{a}}_{t+1} \leq h_t + \boldsymbol{\phi}_t \mathbf{a}_t + T_t$$

$$\mathbf{a}_{t+1} = \left(\tilde{a}_{t+1}^m, \pi \tilde{a}_{t+1}^s + (1 - \pi) A^s\right)$$

Dealer problem in OTCM

$$
\begin{aligned}
V_t^D(\mathbf{a}_{td}) &= \kappa\theta \int \hat{W}_t^D\left(\bar{a}_{td}^m, \bar{a}_{td}^s\right) dH_t\left(\mathbf{a}_{ti}, \varepsilon\right) \\
&\quad + \kappa(1-\theta) \int \hat{W}_t^D\left(\bar{a}_{td^*}^m, \bar{a}_{td^*}^s\right) dH_t\left(\mathbf{a}_{ti}, \varepsilon\right) \\
&\quad + (1-\kappa)\hat{W}_t^D(\mathbf{a}_{td})
\end{aligned}
$$

where

$$
\begin{aligned}
\hat{W}_t^D(\mathbf{a}_t) &= \max_{\hat{a}_t^m, \hat{a}_t^s} W_t^D\left(\hat{a}_t^m, \hat{a}_t^s\right) \\
\hat{a}_t^m + p_t \hat{a}_t^s &\leq a_t^m + p_t a_t^s
\end{aligned}
$$

p_t : nominal equity price in the OTC interdealer market

Investor problem in OTCM

$$
\begin{aligned}
V_t^I\left(\mathbf{a}_{ti},\varepsilon_i\right) \;=\;& \delta\theta\int\left[\varepsilon_i y\bar{a}^s_{ti^*}+W_t^I\left(\bar{a}^m_{ti^*},\bar{a}^s_{ti^*}\right)\right]dF_t^D\left(\mathbf{a}_{td}\right)\\
&+\delta\left(1-\theta\right)\int\left[\varepsilon_i y\bar{a}^s_{ti}+W_t^I\left(\bar{a}^m_{ti},\bar{a}^s_{ti}\right)\right]dF_t^D\left(\mathbf{a}_{td}\right)\\
&+\left(1-\delta\right)\left[\varepsilon_i y a^s_{ti}+W_t^I\left(\mathbf{a}_{ti}\right)\right]
\end{aligned}
$$

Trading situations in OTCM

1. Dealer with interdealer market
2. Dealer-investor trade
   - investor offers w.p. θ
   - dealer offers w.p. $1 - \theta$

Dealer with interdealer market

Dealer with $\mathbf{a}_t = (a_t^m, a_t^s)$ chooses $(\hat{a}_{td}^m, \hat{a}_{td}^s)$

$$\hat{a}_{td}^m = \begin{cases} 0 & \text{if } p_t \phi_t^m < \phi_t^s \\ a_t^m + p_t a_t^s & \text{if } \phi_t^s < p_t \phi_t^m \end{cases}$$

$$\hat{a}_{td}^s = \begin{cases} a_t^s + \frac{1}{p_t} a_t^m & \text{if } p_t \phi_t^m < \phi_t^s \\ 0 & \text{if } \phi_t^s < p_t \phi_t^m \end{cases}$$

Dealer-investor trade: formulation

Investor with type ε and (a^m_{ti}, a^s_{ti}) contacts dealer with (a^m_{td}, a^s_{td})

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- w.p. θ investor offers $\left\langle\left(\bar{a}^m_{ti*}, \bar{a}^s_{ti*}\right), \left(\bar{a}^m_{td}, \bar{a}^s_{td}\right)\right\rangle$, solves:

$$\max_{\bar{a}^m_{ti*}, \bar{a}^s_{ti*}, \bar{a}^m_{td}, \bar{a}^s_{td}} \left[\varepsilon y \bar{a}^s_{ti*} + W^I_t\left(\bar{a}^m_{ti*}, \bar{a}^s_{ti*}\right)\right]$$

$$\bar{a}^m_{ti*} + \bar{a}^m_{td} + p_t\left(\bar{a}^s_{ti*} + \bar{a}^s_{td}\right) \leq a^m_{ti} + a^m_{td} + p_t\left(a^s_{ti} + a^s_{td}\right)$$
$$\hat{W}^D_t\left(\bar{a}^m_{td}, \bar{a}^s_{td}\right) \geq \hat{W}^D_t\left(a^m_{td}, a^s_{td}\right)$$

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$$\bar{a}^m_{ti*} + \bar{a}^m_{td} + p_t (\bar{a}^s_{ti*} + \bar{a}^s_{td}) \le a^m_{ti} + a^m_{td} + p_t (a^s_{ti} + a^s_{td})$$
$$\hat{W}^D_t \left(\bar{a}^m_{td}, \bar{a}^s_{td} \right) \ge \hat{W}^D_t (a^m_{td}, a^s_{td})$$

- w.p. $1-\theta$ dealer offers $\langle (\bar{a}^m_{ti}, \bar{a}^s_{ti}), (\bar{a}^m_{td*}, \bar{a}^s_{td*}) \rangle$, solves:

$$\max_{\bar{a}^m_{ti}, \bar{a}^s_{ti}, \bar{a}^m_{td*}, \bar{a}^s_{td*}} \hat{W}^D_t \left(\bar{a}^m_{td*}, \bar{a}^s_{td*} \right)$$

$$\bar{a}^m_{ti} + \bar{a}^m_{td*} + p_t (\bar{a}^s_{ti} + \bar{a}^s_{td*}) \le a^m_{ti} + a^m_{td} + p_t (a^s_{ti} + a^s_{td})$$
$$\varepsilon y \bar{a}^s_{ti} + W^I_t \left(\bar{a}^m_{ti}, \bar{a}^s_{ti} \right) \ge \varepsilon y a^s_{ti} + W^I_t \left(a^m_{ti}, a^s_{ti} \right)$$

Dealer-investor trade: solution when investor offers

$$\bar{a}^m_{ti^*} = \begin{cases} 0 & \text{if } \varepsilon^*_t < \varepsilon \\ a^m_{ti} + p_t a^s_{ti} & \text{if } \varepsilon < \varepsilon^*_t \end{cases}$$

$$\bar{a}^s_{ti^*} = \begin{cases} a^s_{ti} + \frac{1}{p_t} a^m_{ti} & \text{if } \varepsilon^*_t < \varepsilon \\ 0 & \text{if } \varepsilon < \varepsilon^*_t \end{cases}$$

where

$$\varepsilon^*_t \equiv \frac{p_t \phi^m_t - \phi^s_t}{y}$$

Dealer-investor trade: solution when dealer offers

$$\bar{a}^m_{ti} = \begin{cases} 0 & \text{if } \varepsilon^*_t < \varepsilon \\ a^m_{ti} + p^o_t(\varepsilon)\, a^s_{ti} & \text{if } \varepsilon < \varepsilon^*_t \end{cases}$$

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where

$$p^o_t(\varepsilon) \equiv \left(\frac{\varepsilon y + \phi^s_t}{\varepsilon^*_t y + \phi^s_t} \right) p_t$$

Euler equations: dealers

$$\phi_t^m \geq \beta \max\left(\phi_{t+1}^m, \phi_{t+1}^s / p_{t+1}\right)$$

$$\phi_t^s \geq \beta\pi \max\left(p_{t+1}\phi_{t+1}^m, \phi_{t+1}^s\right)$$

Euler equations: investors

$$\phi_t^m \geq \beta \left[\phi_{t+1}^m + \delta\theta \int_{\varepsilon_{t+1}^*}^{\varepsilon_H} \left(\frac{\varepsilon_i y + \phi_{t+1}^s}{p_{t+1}} - \phi_{t+1}^m \right) dG\left(\varepsilon_i\right) \right]$$

Euler equations: investors

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$$\phi_t^s \geq \beta\pi \left[\bar{\varepsilon} y + \phi_{t+1}^s + \delta\theta \int_{\varepsilon_L}^{\varepsilon_{t+1}^*} \left[p_{t+1}\phi_{t+1}^m - \left(\varepsilon_i y + \phi_{t+1}^s \right) \right] dG\left(\varepsilon_i\right) \right]$$

Nonmonetary equilibrium

Proposition

(i) A nonmonetary equilibrium exists for any parametrization.

(ii) In the nonmonetary equilibrium:

- *there is no trade in the OTC market*
- $A_I^s = A^s - A_D^s = A^s$ *(only investors hold equity shares)*
- *the equity price is:*

$$\phi^s = \frac{\beta\pi}{1-\beta\pi}\bar{\varepsilon}y.$$

Monetary equilibrium

Proposition

(i) *If* $\mu \in (\beta, \bar{\mu})$, *there is one stationary monetary equilibrium.*

(ii) *For any* $\mu \in (\beta, \bar{\mu})$, $\varepsilon^* \in (\varepsilon_L, \varepsilon_H)$ *is the unique solution to*

$$\frac{(1-\beta\pi)\int_{\varepsilon^*}^{\varepsilon_H}[1-G(\varepsilon)]\,d\varepsilon}{\varepsilon^*+\beta\pi\left[\bar{\varepsilon}-\varepsilon^*+\delta\theta\int_{\varepsilon_L}^{\varepsilon^*}G(\varepsilon)\,d\varepsilon\right]\mathbb{I}_{\{\hat{\mu}<\mu\}}}-\frac{\mu-\beta}{\beta\delta\theta}=0.$$

(iii) *As* $\mu \to \bar{\mu}$, $\varepsilon^* \to \varepsilon_L$ *and* $\phi^s \to \frac{\beta\pi}{1-\beta\pi}\bar{\varepsilon}y$.

(iv) *As* $\mu \to \beta$, $\varepsilon^* \to \varepsilon_H$ *and* $\phi^s \to \frac{\beta\pi}{1-\beta\pi}\varepsilon_H y$.

Stationary monetary equilibrium

Low Inflation	High Inflation
$A_D^s = \pi A^s$	$A_D^s = 0$
$A_I^s = (1-\pi)A^s$	$A_I^s = A^s$
$A_{It}^m = A_t^m$	$A_{It}^m = A_t^m$

μ: β — $\hat{\mu}$ — $\bar{\mu}$

$$\phi^s = \frac{\beta\pi}{1-\beta\pi}\varepsilon^* y \quad > \quad \phi^s = \frac{\beta\pi}{1-\beta\pi}\left(\bar{\varepsilon} + \delta\theta \int_{\varepsilon_L}^{\varepsilon^*} G(\varepsilon)\,d\varepsilon\right)$$

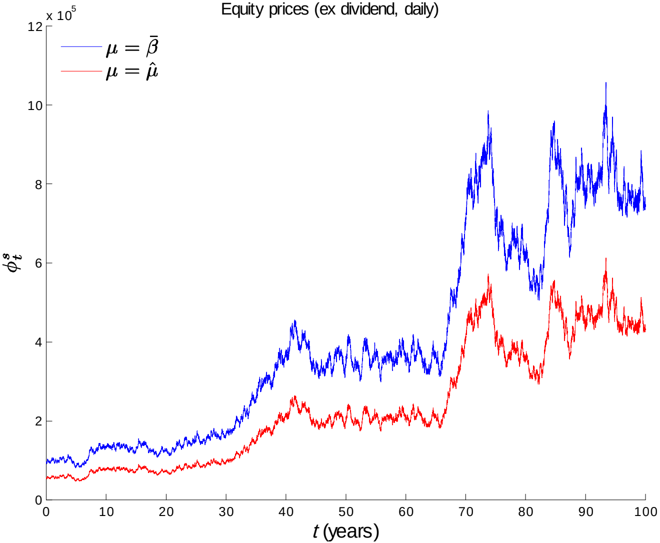
$$Z = \frac{A_D^s + \delta G(\varepsilon^*) A_I^s}{\delta\theta[1-G(\varepsilon^*)]\frac{1}{\varepsilon^* y + \phi^s} + \delta(1-\theta)\int_{\varepsilon^*}^{\varepsilon_H} \frac{1}{\varepsilon y + \phi^s}\,dG(\varepsilon)}$$

Asset prices and inflation

Proposition

In the stationary monetary equilibrium: $\partial\phi^s/\partial\mu < 0$

Asset prices and inflation: equity



Asset prices and OTC frictions (delays and market power)

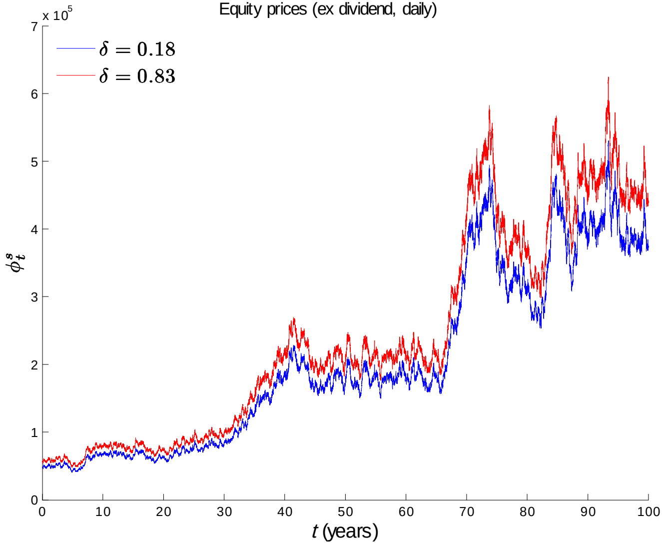
Proposition

In the stationary monetary equilibrium:

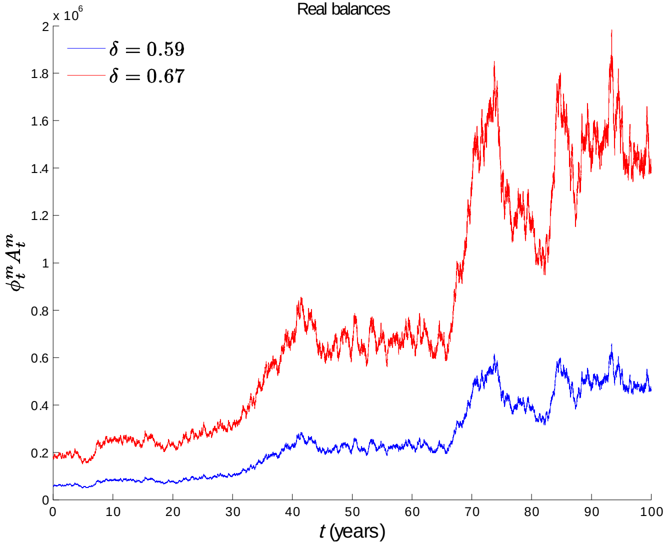
(i) $\partial\phi^s / \partial\left(\delta\theta\right) > 0$

(ii) $\partial Z / \partial\delta > 0$, *for* $\mu \in \left(\hat{\mu}, \bar{\mu}\right)$

Asset prices and OTC frictions: equity



Asset prices and OTC frictions: real balances



Measures of financial liquidity

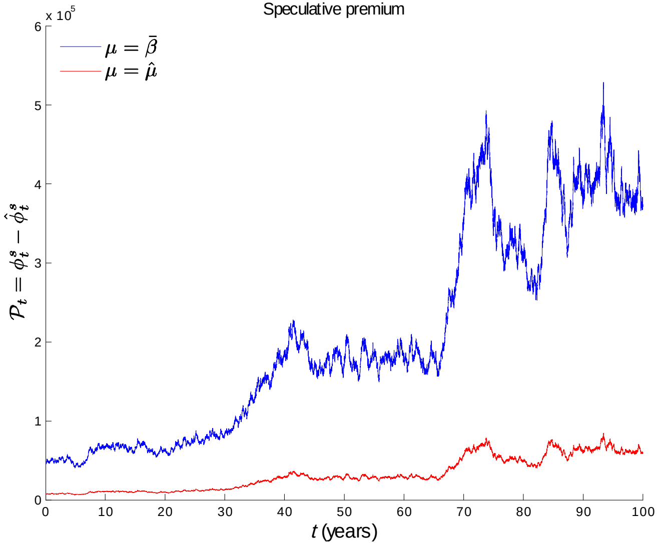
- Trade volume
- Bid-ask spreads
- Liquidity provision by dealers

Speculation (e.g., Harrison and Kreps, 1978)

Define the speculative premium as

$$\mathcal{P} = \phi^s - \frac{\beta\pi}{1-\beta\pi}\bar{\varepsilon}y$$

Speculative premium



The "Fed Model"

- Log *dividend yield* in the nonmonetary equilibrium:

$$\log \bar{D}_{t+1} - \log \phi_t^s = \log\left[(1+r) - \bar{\gamma}\pi\right]$$

where $D_t = \bar{\varepsilon} y_t$ and $\bar{D}_{t+1} \equiv \bar{\gamma}\pi D_t$

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- Modigliani-Cohn hypothesis:

$$\log \bar{D}_{t+1} - \log \phi_t^s = \log \left[(1 + \iota) - \bar{\gamma}\pi \right]$$

"Explanation" of positive relation between
nominal bond yield $\iota = (\mu - \beta\bar{\gamma}) / \beta\bar{\gamma}$ and *dividend yield*

- Log *dividend yield* in the nonmonetary equilibrium:

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- Liquidity/monetary considerations + resale option:

$$\log \bar{D}_{t+1} - \log \phi_t^s = \log \left[(1+r) - \bar{\gamma}\pi \right] - \log \epsilon\left(\iota\right)$$

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- Liquidity/monetary considerations + resale option:

$$\log \bar{D}_{t+1} - \log \phi_t^s = \log\left[(1+r) - \bar{\gamma}\pi\right] - \log \epsilon(\iota)$$

$$\epsilon(\iota) \equiv \max\left\{\varepsilon^*, \bar{\varepsilon} + \delta\theta \int_{\varepsilon_L}^{\varepsilon^*} G(\varepsilon)\, d\varepsilon\right\} \text{ with } \epsilon'(\iota) < 0$$

Endogenous trading delays: dealer entry

- $\delta(v)$: probability investor contacts a dealer
- $\kappa(v) \equiv \delta(v)/v$: probability dealer contacts an investor
- $\kappa'(v) < 0 < \delta'(v)$
- Free entry: to participate in OTCM of $t+1$ dealer must pay $k > 0$ general goods in the CM of t

Free-entry equilibrium

Equilibrium conditions as before, plus the free-entry condition

$$\Phi_{t+1} - k \leq 0, \text{ with } ``="\text{ if } v_{t+1} > 0$$

where

$$\Phi_{t+1} = \beta\kappa\left(v_{t+1}\right)\left(1-\theta\right)\left\{G\left(\varepsilon^*_{t+1}\right)\mathcal{S}^b_{t+1} + \left[1-G\left(\varepsilon^*_{t+1}\right)\right]\mathcal{S}^a_{t+1}\right\}\bar{\phi}_{t+1}$$

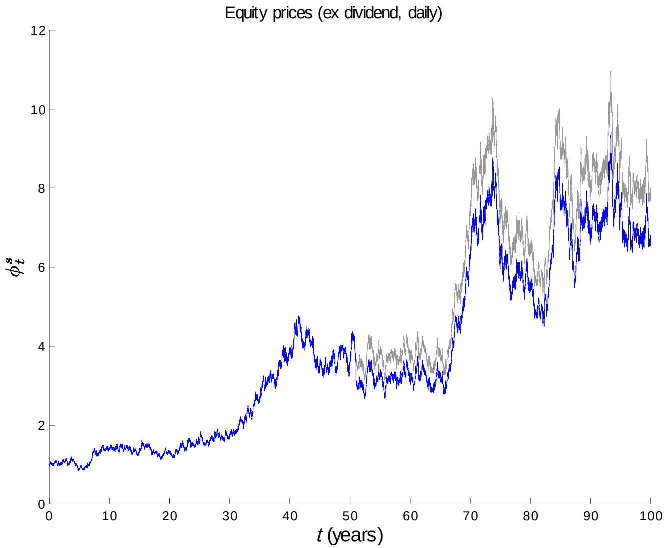
$$\mathcal{S}^b_{t+1} \equiv \int_{\varepsilon_L}^{\varepsilon^*_{t+1}} [p_{t+1} - p^o_{t+1}\left(\varepsilon\right)] A^l_{t+1} \frac{dG\left(\varepsilon\right)}{G\left(\varepsilon^*_{t+1}\right)}$$

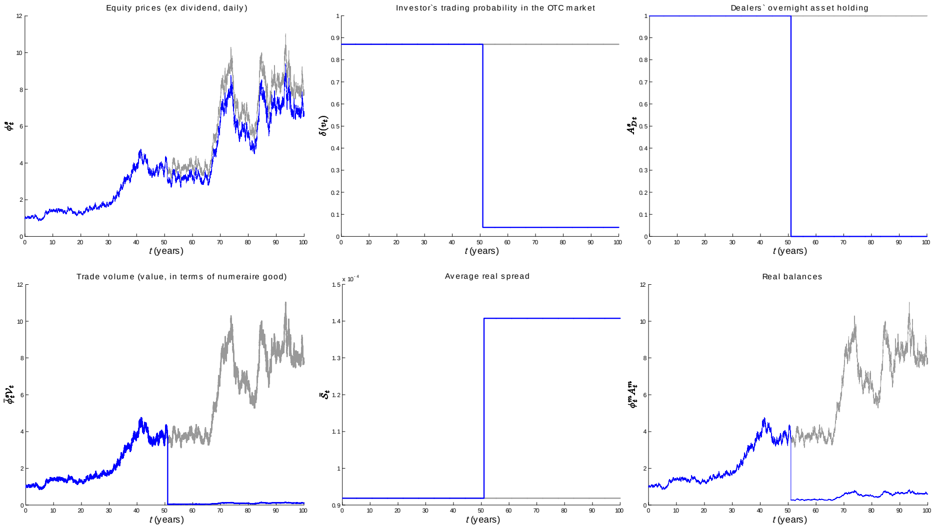
$$\mathcal{S}^a_{t+1} \equiv \int_{\varepsilon^*_{t+1}}^{\varepsilon_H} [p^o_{t+1}\left(\varepsilon\right) - p_{t+1}] \frac{A^m_{lt+1}}{p^o_{t+1}\left(\varepsilon\right)} \frac{dG\left(\varepsilon\right)}{1-G\left(\varepsilon^*_{t+1}\right)}$$

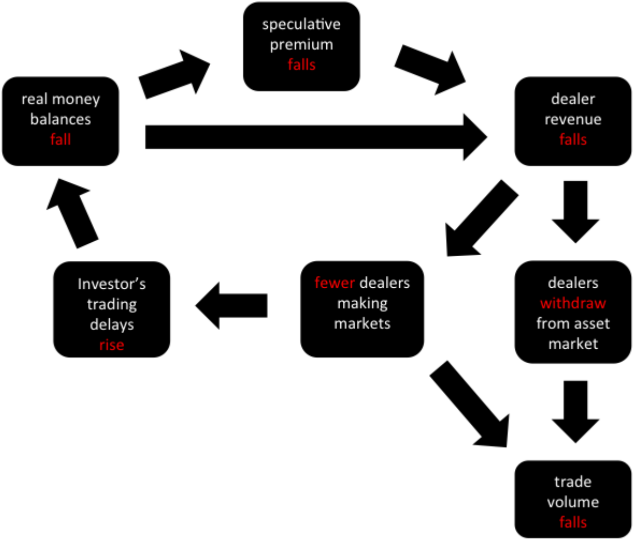
$$\bar{\phi}_{t+1} \equiv \max\left(\phi^m_{t+1}, \phi^s_{t+1}/p_{t+1}\right)$$

Sunspots

$$
\begin{aligned}
\sigma_{ij} &\equiv \Pr\left(S_{t+1} = S_j | S_t = S_i\right) \ \ (S_i \text{ is a sunspot}) \\
\tilde{Z}_i &= \frac{\beta\bar{\gamma}}{\mu} \sum_j \sigma_{ij} \left[1 + \delta\theta \int_{\varepsilon_j^*}^{\varepsilon_H} \tfrac{\varepsilon - \varepsilon_j^*}{\varepsilon_j^* + \tilde{\phi}_j^s} dG(\varepsilon)\right] \tilde{Z}_j \\
\tilde{\phi}_i^s &= \beta\bar{\gamma}\pi \sum_j \sigma_{ij} \left[\tilde{\phi}_j^s + \max\left(\varepsilon_j^*, \bar{\varepsilon} + \delta\theta \int_{\varepsilon_L}^{\varepsilon_j^*} (\varepsilon_j^* - \varepsilon) dG(\varepsilon)\right)\right] \\
k &= (1-\theta)\,\beta\bar{\gamma}\frac{\delta(v_j)}{v_j} \left[A_{Ij}^s \int_{\varepsilon_L}^{\varepsilon_j^*} (\varepsilon_j^* - \varepsilon) dG(\varepsilon) + \tilde{Z}_j \int_{\varepsilon_j^*}^{\varepsilon_H} \tfrac{\varepsilon - \varepsilon_j^*}{\varepsilon + \tilde{\phi}_j^s} dG(\varepsilon)\right] \\
A_{Ij}^s &= A^s \text{ if } \varepsilon_j^* < \bar{\varepsilon} + \delta\theta \int_{\varepsilon_L}^{\varepsilon_j^*} (\varepsilon_j^* - \varepsilon) dG(\varepsilon) \ \left(= (1-\pi)\, A^s \text{ otherwise}\right) \\
\tilde{Z}_j &= \frac{A_{Dj}^s + \delta(v_j) G(\varepsilon_j^*) A_{Ij}^s}{\delta(v_j)\theta\left[1 - G(\varepsilon_j^*)\right] \frac{1}{\varepsilon_j^* + \tilde{\phi}_j^s} + \delta(v_j)(1-\theta) \int_{\varepsilon_j^*}^{\varepsilon_H} \frac{1}{\varepsilon + \tilde{\phi}_j^s} dG(\varepsilon)}
\end{aligned}
$$


Equity prices (ex dividend, daily)
ϕ_t^s
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
100
t (years)


Equity prices (ex dividend, daily)
ϕ_t^s
t (years)
Investor`s trading probability in the OTC market
$\delta(v_t)$
t (years)
Dealers` overnight asset holding
A^s_{Dt}
t (years)
Trade volume (value, in terms of numeraire good)
$\bar{\phi}^s_t \mathcal{V}_t$
t (years)
Average real spread
x 10^{-4}
$\bar{S}_t$
t (years)
Real balances
$\phi^m_t A^m_t$
t (years)


speculative premium falls
real money balances fall
dealer revenue falls
Investor's trading delays rise
fewer dealers making markets
dealers withdraw from asset market
trade volume falls

Summary

- A model of monetary exchange in OTC markets
- Liquidity and asset prices in OTC markets
  - Inflation:
    - distorts the asset allocation across investors
    - reduces trade volume
    - reduces dealers' incentives to provide liquidity
    - increases ask-spreads
  - Asset prices contain a *speculative premium* that:
    - decreases with inflation
    - decreases with OTC frictions (trading delays, power of dealers)

Summary

Dynamic stochastic equilibria with episodes that resemble crises:

- *speculative premium "bursts"*
  - sudden, sharp decline in asset price
- *liquidity "dries up"*
  - sudden, sharp decline in marketmaking and trade volume
  - sudden, sharp increase in trading delays and spreads per share

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end.

Sunspots example

$\beta = (0.99)^{1/365}$	$\bar{\gamma} = E\left(\frac{y_{t+1}}{y_t}\right) = (1.04)^{1/365}$
$\varepsilon \sim U[0.01, 20]$	$\Sigma = SD\left(\frac{y_{t+1}-y_t}{y_t}\right) = \frac{0.12}{\sqrt{365}}$
$\delta(v) = 1 - e^{-(0.1)v}$	$\pi = (0.9)^{1/365}$
$k = 0.1$	$\theta = 0.5$
$y_{t+1} = \bar{\mu} e^{x_{t+1}} y_t$	$\mu = (1.03)^{1/365}$
$x_{t+1} \sim \mathcal{N}\left(-\Sigma^2/2, \Sigma^2\right)$	$\sigma_{00} = (0.996)^{1/365}$; $\sigma_{11} \approx 1$

ϕ_0^s/ϕ_1^s	$\delta(v_0)$	$\delta(v_1)$	Z_0/Z_1	$\varepsilon_0^*/\varepsilon_1^*$	A_{D0}^s	A_{D1}^s
1.17	0.87	0.04	12.9	2.90	1	0

The “Fed Model”