Market opacity and fragility

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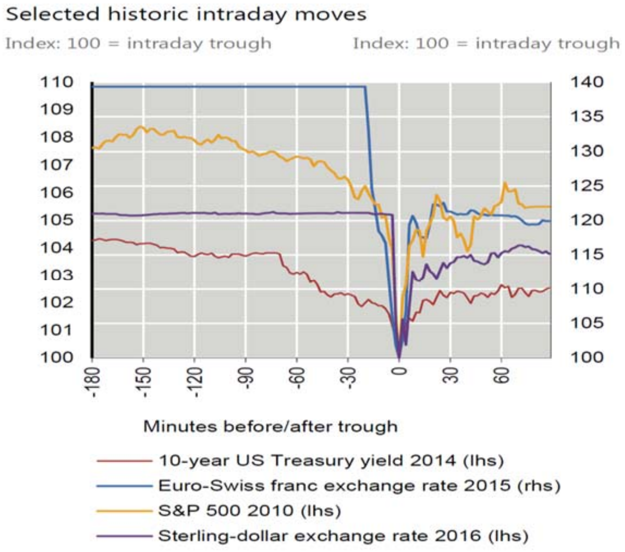
Flash events



BIS (2017)

Introduction

Flash event: sudden evaporation of liquidity *in conjunction* with strong liquidity demand and extreme price changes over short time intervals, *followed by quick recovery*–all this *in the absence of any fundamentals news.*

- Concern for crashes has recently revived, in the wake of the sizeable number of "flash events" (equities, FX, bonds. . .).
- Aldrich et al. (2017), Aquilina et al. (2018): traders attempt to consume liquidity in spite of liquidity "evaporating" $\implies$ jamming of the rationing function of market illiquidity.

Why do traders fail to internalize higher trading costs?

The structural change in market organization

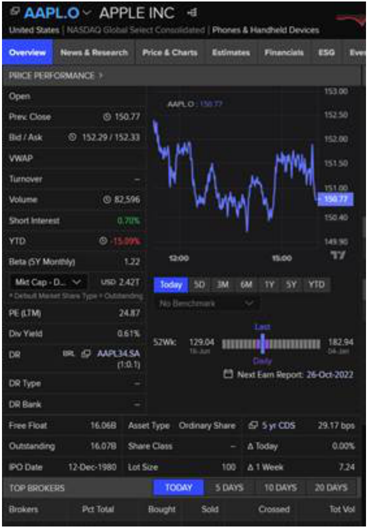
Over the past 20 years exchanges have undergone a substantial transformation

- Foucault (2022): "Electronification" $\Longrightarrow$ Markets have moved from floor trading to "all to all" structure.
- Ding at al. (2014): Electronification introduces an informational friction

Market information has become vital to facilitate liquidity provision.

Change in market structure

(a) Trading floor: liquidity supplied by professional agents.



(b) LOB: all-to-all trading

All to all trading and liquidity supply

Evidence:

- Brogaard, Hendershott and Riordan (2014) HFTs on NASDAQ

  > *"[. . .] trade (buy or sell) in the direction of permanent price changes and in the opposite direction of transitory pricing errors. This is done through their liquidity demanding (marketable) orders"*

- Biais et al. (2017): similar effect for "slow" prop traders on Euronext.
- Therefore, liquidity "demanding" HFTs orders *de-facto* supply liquidity.

What does this imply for market stability?

This paper

Dynamic (3-period) model of liquidity provision with symmetric information, competitive CARA hedgers and dealers:

- Imperfect observability of market information (market opacity) prevents the participation of non-standard liquidity providers.
- This may cause liquidity demand to become increasing in illiquidity.
- *Strategic complementarities:* $\downarrow$ liquidity $\Longrightarrow$ $\uparrow$ liquidity demand $\Longrightarrow$ $\downarrow$ liquidity, generating: (i) liquidity dry-ups, (ii) flash-events.
- Our model rationalizes momentum and the assumption that noise trading follows an AR(1) process.

Related literature

- Liquidity fragility: Brunnermeier and Pedersen (2009), Gromb and Vayanos (2002), Cespa and Foucault (2014), Cespa and Vives (2015), Menkveld and Yueshen (2019). We propose a liquidity *demand* theory of liquidity fragility.
- Liquidity provision via contrarian marketable orders: Brogaard et al (2014), Biais et al (2017), Anand et al (2013, 2021). We show how liquidity supply via market(able) orders arises in equilibrium.
- HFT consuming liquidity during flash crashes: Brogaard et al. (2018) and Bellia et al. (2022). When ME occur, dealers speculate more aggressively (supply less liquidity) along the equilibrium with higher illiquidity.
- Early literature on price crashes: Gennotte and Leland (1990), Jacklin et al. (1992), Madrigal and Scheinkman (1997). Differently from these papers, in our setup all traders are rational and the crash occurs because of the self-sustaining loop triggered by traders' liquidity demand.

The model

Two classes of agents trade a single risky asset with liquidation value $v \sim N(0, \tau_v^{-1})$, and a risk-less asset with unit return in $t \in \{1, 2\}$:

- A continuum (of unit mass) of competitive, CARA dealers with risk-tolerance γ who submit price-contingent orders x_t^D, $t = 1, 2$.
- CARA liquidity traders with risk-tolerance γ_H who hedge an endowment shock in a non-tradable security that they receive at $t = 3$.

1

– Liquidity traders receive $u_1 \sim N(0, \tau_u^{-1})$ and submit market order x_{11}.

– Dealers submit limit order x_1^D.

2

– 1st period liquidity traders submit market order x_{21}.

– New cohort of liquidity traders receives $u_2 \sim N(0, \tau_u^{-1})$, observes $s_{u_1} = u_1 + \eta$, $\eta \sim N(0, \tau_\eta^{-1})$, and submits market order x_2.

– Dealers submit limit order x_2^D.

3

– Asset liquidates.

Polar benchmarks

Two polar benchmarks:

(a) "Fully" transparent: $\tau_\eta \to \infty$, where second period traders can perfectly anticipate the impact of u_1 on p_2.

(b) "Fully" opaque: $\tau_\eta \to 0$, where second period traders cannot anticipate *at all* the impact of u_1 on p_2.

Fully transparent benchmark

There exists a unique equilibrium in linear strategies where

- Prices:

$$p_2 = -\boxed{\Lambda_2} u_2 - \boxed{\Lambda_{21}} u_1 = -\boxed{\Lambda_2} \underbrace{\theta_2}_{=u_2+\beta u_1}, \ \beta \equiv \Lambda_{21}/\Lambda_2,$$

$$p_1 = -\boxed{\Lambda_1} u_1, \ 0 < \Lambda_1 < \Lambda_{21} < \Lambda_2.$$

  price impact coefficients reflect limited risk bearing capacity, our measure of liquidity supply.

- Liquidity traders' strategies:

$$x_1 = \boxed{a_1} u_1, \ x_{21} = \boxed{a_{21}} u_1, x_2 = \boxed{a_2} u_2 + bu_1$$

  with $-1 < a_{21} < a_1 < 0$, $a_2 \in (-1, 0)$, $b > 0$, $|a_t|$ our measure of liquidity demand.

- Dealers' strategies:

$$X_2^D(p_1, p_2) = -\gamma\tau_v p_2, \ X_1^D(p_1) = \frac{\gamma}{\gamma_H} a_1 u_1 - \gamma\tau_v p_1.$$

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Liquidity supply

$\Lambda_2(a_2)$

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Liquidity demand

$|a_2(\Lambda_2)|$

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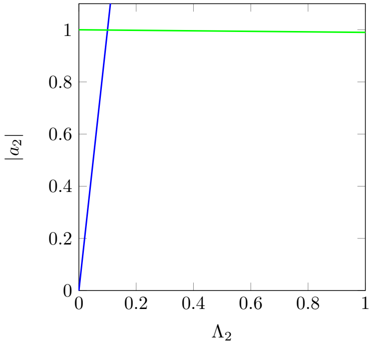
Downward sloping demand for liquidity

$$\Lambda_2 \uparrow \xrightarrow{\text{Expected return from hedging}\downarrow} |a_2| \downarrow$$

Fully transparent benchmark

$\tau_u = \tau_v = 0.1,\ \tau_\eta \to \infty,\ \gamma = 1,\ \gamma_H = 0.1$



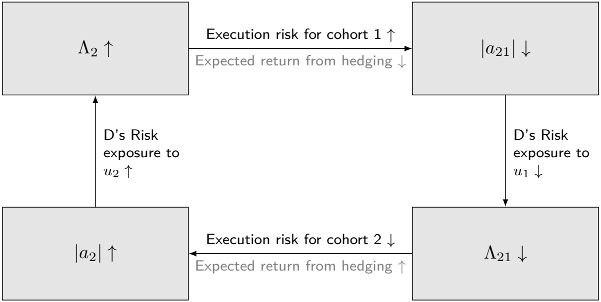
$$\frac{\partial |a_2|}{\partial \Lambda_2} < 0 \text{ and } \frac{\partial \Lambda_2}{\partial |a_2|} > 0$$

Illiquidity increases in liquidity demand and works as a rationing device: a higher price impact reduces liquidity traders' hedging aggressiveness.

Fully opaque benchmark

When the market is fully opaque, at the second round:

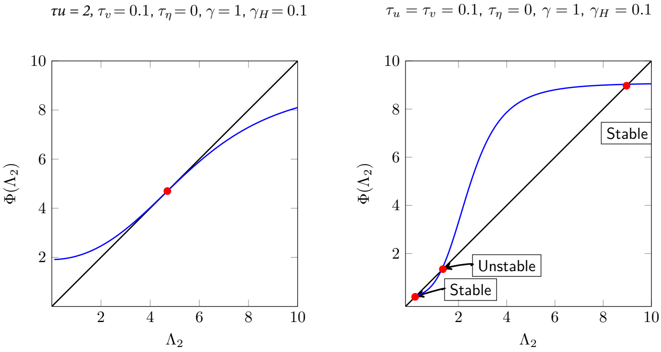
- 2nd period hedgers stop posting contrarian orders: $b = 0$ and $x_2 = a_2 u_2$. They face execution risk that increases in the price impact Λ_{21}.
- 1st period hedgers trade $x_{21} = a_{21} u_1$ and face execution risk that increases in the price impact Λ_2.



Strategic complementarity

The equilibrium values of Λ_2 are determined by fixed points of the "aggregate" best response function to an exogenous change in Λ_2:

$$\Lambda_2 = \Phi(\Lambda_2), \Phi'(\Lambda_2) > 0$$



(a) Unique equilibrium

(b) Multiple equilibria

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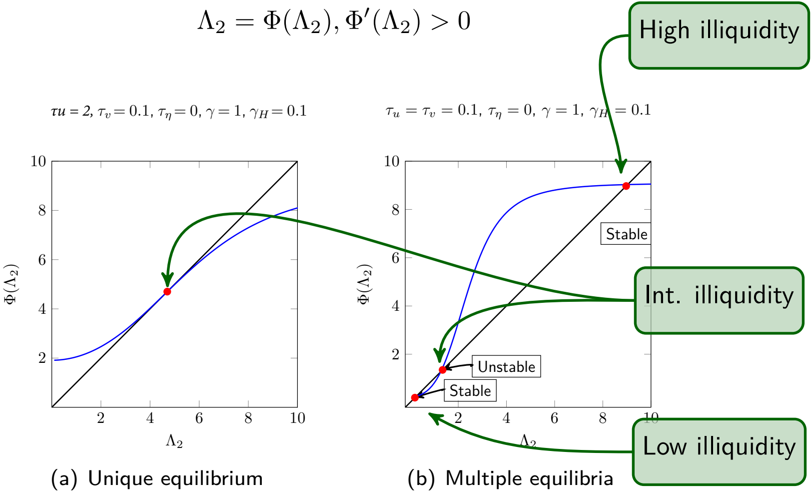

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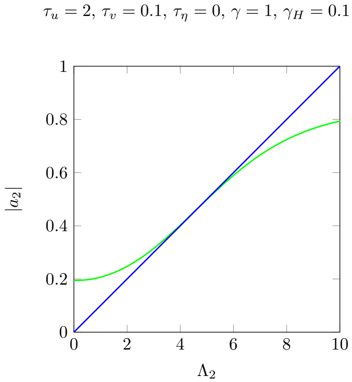
(b) Multiple equilibria

Liquidity demand and supply with opacity



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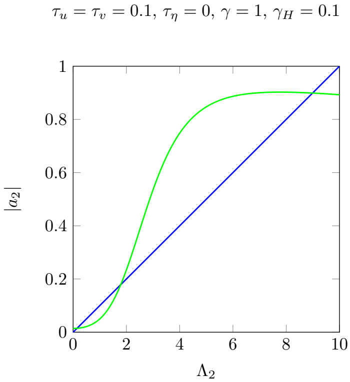

(b) Multiple equilibria

$$\frac{\partial |a_2|}{\partial \Lambda_2} \lesseqgtr 0 \text{ and } \frac{\partial \Lambda_2}{\partial |a_2|} > 0$$

Illiquidity increases in liquidity demand and stops working as a rationing device: a higher price impact may increase liquidity traders' hedging aggressiveness.

Equilibrium properties with opacity

If

- $0 < \tau_u \tau_v < \gamma/(4(\gamma + \gamma_H)^3)$, three equilibria arise.
- $\tau_u \tau_v \geq \gamma/(4(\gamma + \gamma_H)^3)$, unique equilibrium with $\Lambda_2 = \Lambda_{21}$.
- Equilibria can be ranked in terms of the price sensitivity to first and second period endowment shocks and liquidity consumption:

$$\Lambda_2^* < \Lambda_2^{**} < \boxed{\Lambda_2^{***}},\ \Lambda_{21}^{***} < \Lambda_{21}^{**} < \boxed{\Lambda_{21}^*},\ \Lambda_1^{***} < \Lambda_1^{**} < \boxed{\Lambda_1^*}.$$

$$-1 < \boxed{a_2^{***}} < a_2^{**} < a_2^* < 0,$$
$$-1 < \boxed{a_{21}^*} < a_{21}^{**} < a_{21}^{***} < 0,$$
$$-1 < \boxed{a_1^*} < a_1^{**} < a_1^{***} < 0.$$

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$$-1 < \boxed{a_2^{***}} < a_2^{**} < a_2^* < 0,$$
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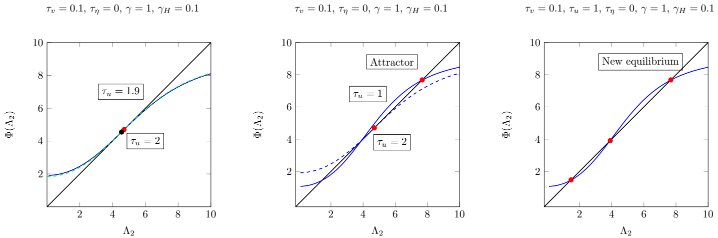
$$-1 < \boxed{a_1^*} < a_1^{**} < a_1^{***} < 0.$$

Traders consume more liquidity when it costs the most.

A liquidity “dry-up”

Suppose that unexpectedly $\downarrow \tau_u$:

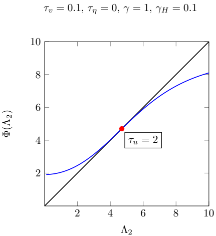


(a) Small shock (b) Large Shock (c) Low liquidity equilibrium

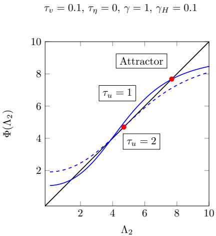
- Small shock: $\uparrow$ execution risk $\implies \downarrow |a_2|(\downarrow |a_{21}|)$ and $\downarrow \Lambda_2(\downarrow \Lambda_{21})$.
- Large(r) shock: stronger strategic complementarities $\implies$ the “old” equilibrium falls between the unstable Λ_2^{**} and the stable Λ_2^{***}, which is an attractor.

A "flash-crash"

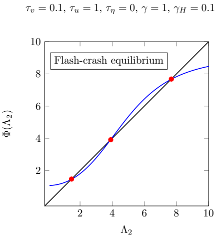
Suppose that temporarily $\tau_u \downarrow$:



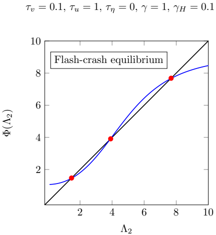
(a) Unique equilibrium



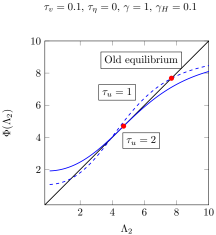
(b) Shock



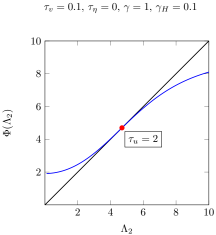
(c) Low liquidity eq.



(d) Low liquidity eq.



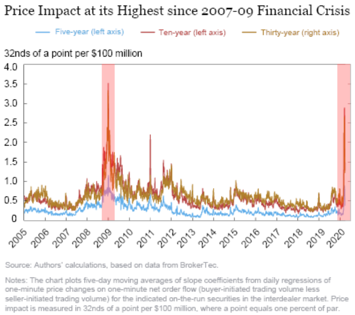
(e) Shock



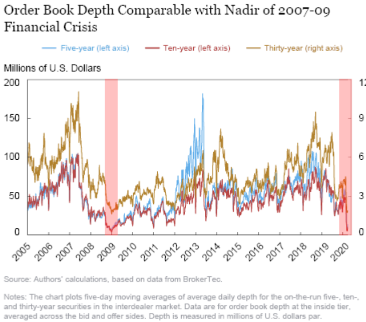
(f) Unique equilibrium

A more dispersed endowment shock

With order flow opacity, an unanticipated increase in traders' endowment shocks can lead to a liquidity crash: impact of Covid pandemic on USGov Bonds' liquidity, March 2020 (BrokerTec segment).



(a) Price impact



(b) Market depth

(Source: Federal Reserve Bank of NY)

Extensions

- Liquidity trading and noise trading: (i) endogenize persistence (ii) yields "momentum".
- The effect of an informative signal: lower opacity boosts the market risk-bearing capacity.
- The effect of restricted dealers: high non-linearity of the effect of a change in the mass of dealers.
- Welfare analysis: total welfare increases in the mass of dealers and transparency (numerical result).

Conclusions

Technological developments and regulatory changes have favored an "all-to-all" market structure:

- Availability of prompt and reliable market information fosters risk sharing, market stability, and improves welfare.
- Observability of order flow information allows "non-standard" liquidity providers to supply liquidity via contrarian marketable orders.
- Policy implication: consolidated tape has a beneficial effect on market stability.
- Empirical implications: With opacity,
  - Liquidity may be a Giffen good: its demand increases in illiquidity.
  - Small decrease in dealer market participation or increase in uncertainty (endowment dispersion) may cause liquidity crash.
  - During flash events, those who face the highest trading costs are also those who consume more liquidity (trade the most).

Thanks!