Fragility and Inefficient Fire-Sales in Decentralized Asset Markets

The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management

Ehsan Ebrahimy

International Monetary Fund

eebrahimy@imf.org

Abstract

I show that decentralized and yet competitive asset markets are prone to multiplicity of equilibria and inefficient fire sales when subjected to large enough liquidity shocks and characterize conditions for the existence of such fire sales. In the model sellers are subject to liquidity shock in the present and future dates. There can be multiple equilibria: *delayed* equilibrium where some agents wait to trade in the second period and *run* equilibrium where all agents try to trade in the first period. Fire sale equilibrium, when asset price is depressed, is a *run* (*delayed*) if the number of buyers is less (more) than sellers in the market. The two types of equilibria and hence the possibility of fire sale exist when sellers' future liquidity shock is bigger than the current shock and there is a medium degree of imbalance between the buyers and sellers in the market. Moreover, fragility exists when market liquidity is neither too high nor too low. Fire sale in the form of a *run* equilibrium is always dominated in terms of welfare by its corresponding *delayed* equilibrium with higher asset price. Fire sale in the form of *delayed* is dominated by its corresponding *run* equilibrium as long as the ratio of sellers to buyers is not too low.

Introduction

Fire sale in financial markets where assets are sold at deep discounts is a prominent feature of financial crises. Two classic explanations emphasize liquidity constrained industry experts who can operate the asset productively (Shleifer and Vishny (1992)) and limited arbitrage capital by specialized investors who understand the asset (Shleifer and Vishny (1997)). Liquidity constrained experts is less applicable to financial assets and as for the limited arbitrage capital, there were non-specialized investors with abundant resources (e.g. Warren Buffet) to buy these assets and its not clear why these investors did not step in. Moreover, not all buyers which may be considered experts/specialized investors, e.g., banks, were liquidity constrained during the crisis (He and Krishnamurthy (2010)). Beside lack of liquidity or expertise, what else can help explain depressed asset prices during the crisis? Can non-fundamental factors explain at least part of asset price volatility during the crisis?

Many financial assets as well as important real assets such as property are traded in decentralized over the counter markets. I show that when market participation is endogenous, decentralized markets are intrinsically fragile and prone to inefficient fire sales when subjected to large enough liquidity shocks. Fragility and fire sale require a medium degree of imbalance between buyers and sellers and a medium degree of market liquidity.

Main Findings

1. Decentralized markets are fragile and prone to fire-sale when:
   - Medium future liquidity shocks
   - Medium imbalance between buyers and sellers
   - Medium degree of market liquidity
2. Fire-sale may happen as a *run* or *delayed*
3. Fire-sale features lower (higher) sales volume when sellers (buyers) are the short side of the market
4. A *run* fire-sale is always a dominated equilibrium in terms of welfare
5. A *delayed* fire-sale is dominated when seller/buyer ratio not too low

Model Setup

A three period economy $t = 0, 1, 2$ and two types of agents B (buyers) and S (sellers) with the following preferences:

$$\begin{cases} \boldsymbol{U}_S = \mathbb{E}_0\{\delta_0 C_0 + \delta_1 C_1 + C_2\}, \\ \boldsymbol{U}_B = \mathbb{E}_0\{C_0 + C_1 + C_2\}, \end{cases}$$

δ_0 and δ_1 capture liquidity shock today, e.g., need to liquidate assets to pay off debt, or an expected liquidity shock tomorrow. All agents receive a constant endowment of consumption good in $t = 0, 1$. There is a measure 1 of buyers and $m > 0$ of sellers who can trade an indivisible asset in $t = 0, 1$, which pays off $d_2 > 0$ at $t = 2$. Each seller initially has one unit of the asset and buyers can buy at most one unit in $t = 0, 1$.
Markets are decentralized and subject to search and matching frictions: search is competitive and matching is random. At each date $t = 0, 1$, buyers and sellers first decide whether to wait/participate. Buyers post prices and form submarkets consisting of buyers with the same posted price and sellers choose which submarket to go to. In each submarket, measures b and s of buyers and sellers meet in $t = 0, 1$ to form the following number of matches:

$$\mathbb{M}(\boldsymbol{s}, \boldsymbol{b}) = \gamma s^{1-\alpha} b^{\alpha}$$

Agents' Problem

Let V_1^B and $\bar{U}_1^S$ be continuation utility of buyers if participating and maximum utility of sellers at $t = 1$ respectively. Then at $t = 1$ buyers solve:

$$\begin{cases} V_1^B = \max_{\sigma_1, p_1} q_1^B(\sigma_1)(d_2 - p_1) \\ s.t. \quad \bar{U}_1^S \leq q_1^S(\sigma_1)\delta_1 p_1 + (1 - q_1^S(\sigma_1))d_2 \end{cases}$$

where σ_1 is the queue length in a submarket with trade probability of $q_1^S(\sigma_1)$ for any seller. And using the utilities at $t = 1$ we compute the values at $t = 0$:

$$\begin{cases} V_0^B = \max_{\sigma_0, p_0} \{q_0^B(\sigma_0)(d_2 - p_0) + (1 - q_0^B(\sigma_0))\bar{U}_1^B\} \\ s.t. \quad \bar{U}_0^S \leq q_0^S(\sigma_0)\delta_0 p_0 + (1 - q_0^S(\sigma_0))\bar{U}_1^S \end{cases}$$

$\bar{U}_1^B = \max(V_1^B, R_1^B)$ is the maximum utility for buyer if she waits until $t = 1$. And $\bar{U}_0^S$ is the maximum utility for sellers at $t = 0$.

Existence of Fragility and Fire-Sale

There can be two types of equilibria, *delayed* and *run*. In a *delayed* equilibrium some agents wait to trade in the second period while in a *run* equilibrium all agents try to trade in the first period. Consider a set of parameters for which both types of equilibria, *run* and *delayed*, exist. If $m > 1$ ($m < 1$), asset price is lower (higher) in the *run* equilibrium relative to the *delayed* equilibrium. Trade volume is always higher in the *run* equilibrium than the *delayed* equilibrium in $t = 0$.

Holding other parameters constant, the conditions for the existence of both types of equilibria, *delayed* and *run* for each parameter are as follows. Both types of equilibria exist if:

- $\underline{\epsilon} \leq |m - 1| \leq \bar{\epsilon}$,
- $\gamma\left(\frac{\delta_1}{\delta_0}\right)^{-\alpha} < \frac{\delta_0 - 1}{\delta_1 - 1}$
- $\underline{\gamma} \leq \gamma \leq \bar{\gamma}$,

where $\underline{\epsilon}$, $\bar{\epsilon}$, $\underline{\gamma}$, and $\bar{\gamma}$ are functions of other parameters.

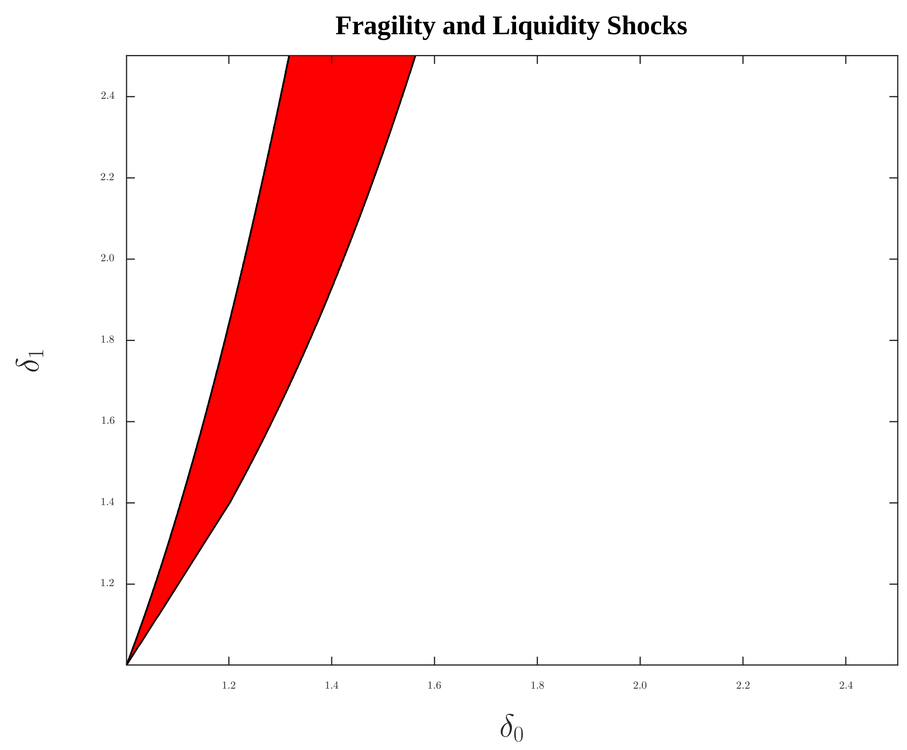

Figure 1: The region with red illustrates the values of liquidity shocks for which markets are fragile for $\alpha = 0.55$ and $\gamma = 0.3$.

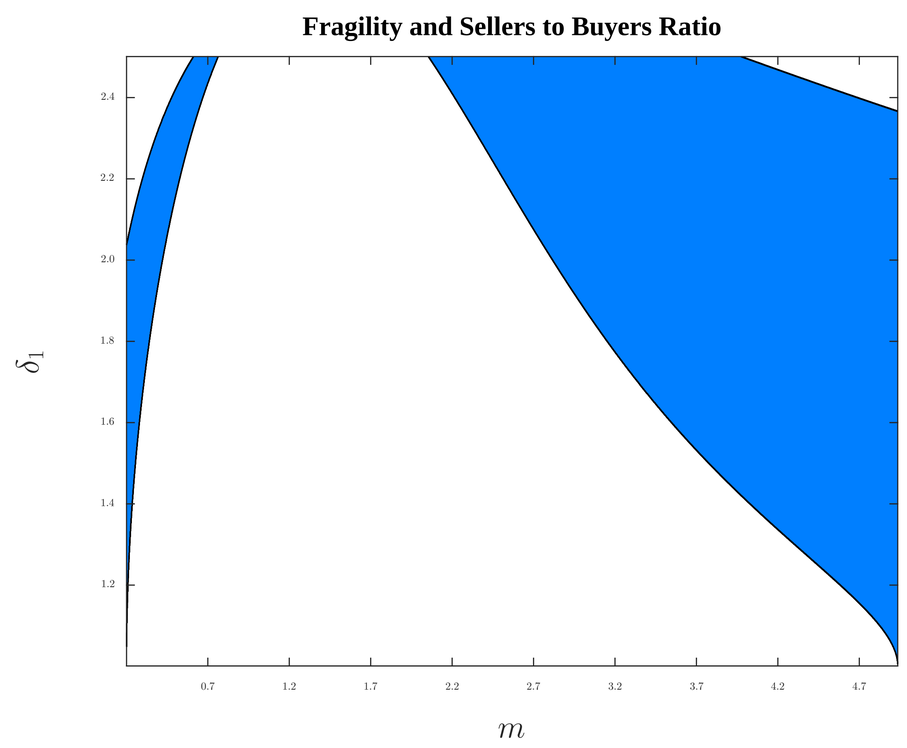

Figure 2: The blue region illustrates the values of m for any level of δ_1 for which markets are fragile. Note that $\delta_0 = 1.6$, $\alpha = 0.5$ and $\gamma = 0.45$.

Welfare

There exists $0 < \xi < 1$ such that when market is fragile, the equilibrium with fire-sale is dominated in terms of welfare for all $m > \xi$:

- All fire-sale equilibria in the form of *run* are Pareto dominated by their corresponding *delayed*.
- Moreover, fire-sale equilibria in the form of *delayed* are Pareto dominated by their corresponding *run* as long as m is not too low.

Why Coordination Failure and Inefficiency?

In centralized competitive market trade takes place with certainty: The effect of each agent's decision to enter the market on others' entry is fully priced. In decentralized and competitive market, on the other hand, agent's decision to participate affects the probability of trade at current and future dates. Competitive market at $t = 0$ can price at most one of the two margins but not both. This leaves room for the presence of non-priced externalities and coordination failure which is at the heart of market fragility and inefficiency.