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Liquidity runs with endogenous information acquisition

Sanne Zwart *

Department of Economics, European University Institute, Via della Piazzuola 43, 50133 Florence, Italy

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Abstract

This paper analyzes a liquidity run model in which investors strategically acquire private information. The *availability* of information can eliminate the multiplicity typical for models without private information. Even for intermediate priors equilibria without private information can now be unique.

Keywords: Bank runs; mes

JEL classification: C73; D82; F34

1. Introduction

The liquidity run models of Diamond and Dybvig (1983) and Morris and Shin (2001) show the crucial importance of the information structure. This paper presents a liquidity run model in which private information acquisition is endogenous: investors optimally decide whether to acquire a signal about the fundamentals taking its cost as given. The value of information depends on the uncertainty about the investment return, which itself depends on the investors' prior. Information acquisition is thus related to the fundamentals of the investment project — a point raised by Rey (2001) in her comments on Morris–Shin models. In addition to fundamentals and self-fulfilling prophecies as causes of liquidity runs, the model of this paper thus also analyzes how the availability and cost of private information affect the occurrence and extent of runs.

2. The liquidity run model with fixed information structures

Consider the coordination problem at the heart of the Diamond–Dybvig and Morris–Shin models. A continuum of identical investors with measure 1 has previously invested in a project. Each investor is now faced with the decision whether to withdraw her money or to remain invested. When running, she receives a normalized return of 0; when staying, her return equals $\theta-\ell$, where θ is a random variable summarizing the fundamentals of the project and $\ell\in[0,1]$ is the fraction of running investors. The idea is that if investors withdraw their money, the project has to be downsized, which negatively affects the return of the remaining investors. Hence, the return function combines the fundamentals and the cost of premature liquidation. The fundamental θ is normally distributed with *ex ante* expectation (or prior) $\hat{\theta}\in\mathbb{R}$ and precision $\alpha>0$, which are public knowledge.

In the Diamond–Dybvig world, investors only have common information about the project. Denote the two symmetric (pure) strategy profiles "all-run" and "all-stay" by R and S respectively. Staying in the S profile where all investors stay gives an expected return of $\hat{\theta}$, so the S profile is an equilibrium if $\hat{\theta}\geq 0$. Likewise, the R profile is an equilibrium only for $\hat{\theta}\leq 1$. Note that for $\hat{\theta}\in[0, 1]$ both profiles are equilibria. Since there is only common information, investors have no means of coordination which invites multiple equilibria. The model thus captures sudden big jumps in investments observed in the real world. However, for $\hat{\theta}$ close to the borders of the interval, one of the equilibria is intuitively much more appealing than the other: for a relatively low $\hat{\theta}$ investors are more likely to run, while for a relatively high $\hat{\theta}$ they are more likely to stay.

* Tel.: +39 055 4685 927; fax: +39 055 4685 902.
E-mail address: Sanne.Zwart@eui.eu.

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In the Morris–Shin world, investors also have noisy private information about the realized fundamental θ. Investor i has a signal $x_i = \theta + \varepsilon_i$, where ε_i is white noise with precision $\beta > 0$. The focus on noisy private information instead of complete information reflects the idea that different investors combine information from different noisy sources which leads to different private information. To measure the informativeness of the public information relative to the private information define $\gamma = (\alpha^2/\beta)(\alpha+\beta)/(\alpha+2\beta)$. Morris and Shin (2001) then show that when $\gamma \leq 2\pi$ there is a unique equilibrium in which all investors have the same switching point strategy characterized by the solution x^* of $E[\theta - \ell | x^*] = 0$. Hellwig (2002) shows that $\gamma \leq 2\pi$ is a necessary condition for a unique equilibrium when no assumptions about $\hat{\theta}$ are made. The equilibrium "all-use-switching-point-x^*" is denoted by I. Since there is a unique equilibrium, the economic outcomes are fully determined by the parameters. The model has the intuitively appealing property that for better fundamentals fewer investors run. However, the smooth response to changes in the *ex ante* expectation of the fundamental in Morris–Shin models bars sharp changes in investments, which is one of the appealing results of Diamond–Dybvig models.

3. The liquidity run model with endogenous information acquisition

Now suppose that before making the investment decision, investors simultaneously decide upon acquiring private noisy information about the realization θ of the fundamental. When investor i acquires information, she receives a signal $x_i = \theta + \varepsilon_i$, where, as before, ε_i is white noise with precision β. The cost c of this information is assumed to be exogenously determined. It can be seen as a purely monetary cost, but it may also indicate the efforts needed to collect the information. The exogenous cost reflects that investors have access to better information about the return, but that they should spend time or resources to obtain it. When they make their investment decisions, investors do not know the information acquisition decisions of other investors.

When investors do not acquire information, the Diamond–Dybvig world arises. Let the profiles R and S now refer to "no-information/all-run" and "no-information/all-stay" respectively. Similarly, let the profile I now refer to "information/all-use-switching-point-x^*", which represents the Morris–Shin world that arises when investors acquire information.[1] For a fixed information structure, it was shown in the previous section when these profiles are equilibria. With endogenous information there is an additional equilibrium condition since investors acquire information if and only if the value of information is higher than its cost.

Loosely speaking, the value of information is the difference of the expected return with and without information. Let for given private information and candidate equilibrium the

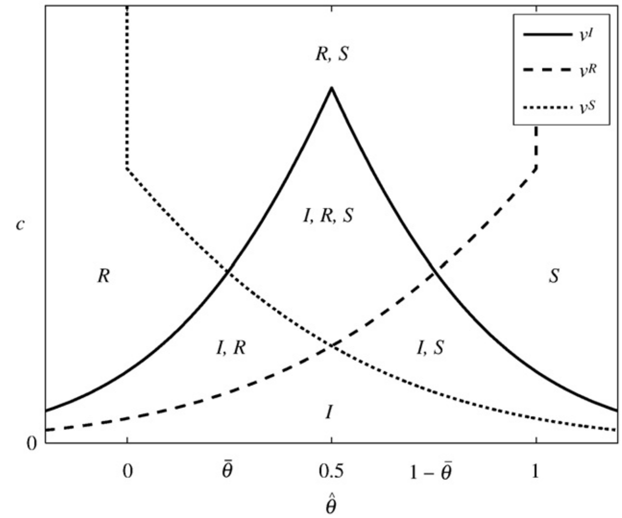

Fig. 1. The value of information as function of the *ex ante* expectation of the fundamental and the equilibrium regions ($\alpha = 1, \beta = 1$). The vertical lines starting at $(0, v^S(0))$ and $(1, v^R(1))$ are included to indicate that for $c > v^S(0) = v^R(1)$ the S and R equilibrium cannot exist for $\hat{\theta} < 0$ and $\hat{\theta} > 1$ respectively.

function $r: \emptyset \cup \mathbb{R} \times \{I,R,S\} \to \mathbb{R}$ denote the expected return for an investor who reacts optimally to the strategies of the other investors. The profiles I, R and S are thus loosely interpreted as prescribing the strategies of all investors but one. For $Q \in \{I,R,S\}$ the expected return is then defined as

$$r(\emptyset, Q) = \max\{0, \mathbb{E}[\theta - \ell | Q]\}, \tag{1}$$

$$r(x_i, Q) = \max\{0, \mathbb{E}[\theta - \ell | x_i, Q]\}. \tag{2}$$

Let the random variable X_i denote the unrevealed information of investor i. It has a normal distribution with mean $\hat{\theta}$ and precision $\alpha\beta/(a+b)$. The value of private information v^Q is now the difference of the expected return with and without private information, so

$$v^Q = \mathbb{E}[r(X_i, Q)] - r(\emptyset, Q). \tag{3}$$

Working out the conditional expectations using Bayesian updating gives explicit formulas for v^Q, $Q \in \{I,R,S\}$, in $\hat{\theta}$, α, β and the switching point x^*.

4. Equilibrium implications

To understand how the *ex ante* expectation of the fundamental $\hat{\theta}$ affects the equilibria it is key to understand how if affects the value of information $v^Q(\hat{\theta})$ in each profile $Q \in \{I, R,S\}$.

Proposition 1. *Assume that* $\gamma < 2\pi$.

i) $(\partial/\partial\hat{\theta})v^I(\hat{\theta}) > 0$ *if and only if* $\hat{\theta} < \frac{1}{2}$; $(\partial/\partial\hat{\theta})v^R(\hat{\theta}) > 0$ *and* $(\partial/\partial\hat{\theta})v^S(\hat{\theta}) < 0$

ii) $v^I\left(\frac{1}{2} - \delta\right) = v^I\left(\frac{1}{2} + \delta\right)$ *for* $\delta \geq 0$ *and* $v^R\left(\frac{1}{2} - \delta\right) = v^S\left(\frac{1}{2} + \delta\right)$ *for* $\delta \geq -\frac{1}{2}$

[1] Mixed equilibria are discarded since, as in the original Diamond-Dybvig model, they have inverse properties.