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Time vs. Risk Preferences, Bank Liquidity Provision and Financial Fragility

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Abstract
How important is it to distinguish relative risk aversion (RRA) from the intertemporal elasticity of substitution (IES) to understand bank liquidity provision and financial fragility? To answer this question, I develop a banking theory in which depositors feature Epstein-Zin preferences. In equilibrium, banks provide liquidity when RRA is sufficiently high (low) only for IES larger (smaller) than 1. Under the same conditions, banks might be fragile, i.e. subject to possible self-fulfilling depositors' runs. A time-consistent deposit freeze resolves banks' fragility if RRA is sufficiently low and IES is sufficiently larger than 1.

JEL: D81, G21, G28

Keywords: Financial intermediation, risk vs. time preferences, liquidity, financial fragility, deposit freezes.

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1. Introduction

Since the seminal contribution by Diamond and Dybvig (1983), banks have been seen as a mechanism to insure risk-averse depositors against idiosyncratic uncertainty, that forces them to consume before the maturity of a risky investment (Allen and Gale 2007). Because of depositors' high risk aversion banks provide them liquidity by engaging in maturity transformation, i.e. by issuing short-term liabilities backed by long-term assets. The risk of this investment makes banks subject to fundamental uncertainty. Furthermore, the balance-sheet mismatch resulting from maturity transformation also makes them subject to self-fulfilling runs: All depositors might withdraw their deposits only because they expect everybody else to do that, and are afraid that the banks completely liquidate their assets to serve them, thus leaving little or nothing if they do not withdraw, too. This coordination failure justifies a deposit freeze, that might or might not calm depositors' expectations depending on the government commitment to a tough freeze (Ennis and Keister 2009).

To sum up, this narrative highlights the role of idiosyncratic uncertainty (driving time preferences) and fundamental uncertainty (driving risk preferences) for the existence and stability of the banking system. In decision theory, time preferences are summarized by the intertemporal elasticity of substitution (IES) and risk preferences by relative risk aversion (RRA). With the homogenous, time- and risk-separable preferences generally employed in the banking literature (like those represented by CRRA utility) these two measures are one the reciprocal of the other. Yet, an established empirical evidence shows that this assumption is unfounded (Attanasio and Weber 1989; Epstein and Zin 1991).

These arguments raise the question of how important it is to distinguish RRA from IES to understand bank liquidity provision and financial fragility. To provide an answer, I develop a banking theory with idiosyncratic and aggregate shocks, in which depositors exhibit preferences à la Epstein and Zin (1989). These allow a useful separation of RRA from IES, and have been employed in macroeconomics to analyze issues like precautionary savings and the equity premium (Backus *et al.* 2004). I start in section 2 by studying bank liquidity provision. Then, in section 3 I study financial fragility stemming from a government lack of commitment to a tough deposit freeze. Finally, in section 4 I conclude.

2. Bank liquidity provision with Epstein-Zin preferences

The basic environment comes from Diamond and Dybvig (1983). The economy lives for three dates, $t = 0, 1, 2$. The available investment technology yields:

$$Z = \begin{cases} R & \text{with probability p,} \\ 0 & \text{with probability 1-p,} \end{cases} \tag{1}$$

at $t = 2$ for each unit invested at $t = 0$. The probability of success of the investment is uniformly distributed over the interval $[0, 1]$, and satisfies $\mathbb{E}[p]R > 1$.[1] Moreover, the investment technology can be liquidated at $t = 1$ at zero costs.

The economy is populated by a unitary continuum of agents, with endowments $e = 1$ at $t = 0$ and zero afterwards. At $t = 1$, each agent observes a private idiosyncratic shock θ, taking value 0 with probability π and 1 with probability $1 - \pi$. The shock affects the date when the agent wants to consume, according to the Epstein-Zin preferences:

$$U(c_1, c_2, \theta) = \Big[\mathbb{E}\big[(c_1 + \theta c_2)^{1-\gamma}\big]\Big]^{\frac{1-\frac{1}{\psi}}{1-\gamma}}, \tag{2}$$

where $\gamma \in (0, 1)$ is RRA, and I will show that ψ is IES.[2]

To hedge against the idiosyncratic shocks, the agents deposit their endowments at $t = 0$ in a competitive bank. The bank maximizes depositors' welfare by offering a deposit contract that state the "early" consumption c_1 and the "late" consumption $c_2(R)$ that they can withdraw at $t = 1$ and $t = 2$ (in case of successful investment), respectively. As the shocks are private, the deposit contract must be incentive compatible, i.e. $c_1 \leq c_2(R)$.

Guess that the latter constraint is slack. The banking problem reads:

$$\max_{c_1} \int_0^1 \left[\pi c_1^{1-\frac{1}{\psi}} + (1-\pi)\left(p\left(R\frac{1-\pi c_1}{1-\pi}\right)^{1-\gamma}\right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\right] dp. \tag{3}$$

The first-order condition of (3) yields:

$$c_1^{-\frac{1}{\psi}} = \frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma} R(c_2(R))^{-\frac{1}{\psi}}, \tag{4}$$

where $c_2(R) = R(1 - \pi c_1)/(1 - \pi)$. Notice that if $\psi = 1/\gamma$ (as with CRRA utility) we obtain a standard Euler equation:

$$c_1^{-\gamma} = \mathbb{E}[p]R(c_2(R))^{-\gamma}. \tag{5}$$

If instead $\psi \neq 1/\gamma$, (4) implies that:

$$IES \equiv \frac{\partial \ln(c_2(R)/c_1)}{\partial \ln(R)} = \psi, \tag{6}$$

as posited above. Moreover, the deposit contract is incentive compatible if:

$$\left(\frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma} R\right)^{\psi} > 1. \tag{7}$$

1. The assumption of uniform distribution comes at no loss of generality.

2. For $\gamma > 1$, I need to substitute $c^{1-\gamma}$ with $(c + F)^{1-\gamma} - F^{1-\gamma}$ to ensure that $u(0) = 0$. For F positive and asymptotically close to zero, RRA is constant and all results hold.

If $\psi = 1/\gamma$, this becomes $(\mathbb{E}[p]R)^{1/\gamma} > 1$ which is always true as $\mathbb{E}[p]R > 1$. If instead $\psi \neq 1/\gamma$, condition (7) is never satisfied for $\gamma > 2 - 1/\psi$, and it is satisfied when:

$$(1-\gamma)(R-1) > 1 - \frac{1}{\psi}. \tag{8}$$

The definition of $c_2(R)$ and (4) yield the equilibrium early consumption:

$$c_1^* = \frac{1}{\pi + (1-\pi)\frac{1}{R}\left[\frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma}R\right]^{\psi}}. \tag{9}$$

If $\psi = 1$, then $c_1^* = 1$: The bank provides no liquidity to the depositors at $t = 1$, i.e. it offers an amount of early consumption equal to their initial deposit. Assume instead that $\psi \neq 1$. Then, the bank provides liquidity when $c_1^* > 1$, which happens if the denominator of (9) is smaller than 1, i.e. if:

$$\left(\frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma}R\right)^{\psi} < R. \tag{10}$$

This can be rewritten as:

$$\gamma \lesseqgtr 1 - \frac{1-\frac{1}{\psi}}{R^{1-\frac{1}{\psi}}-1}, \tag{11}$$

depending on whether $\psi \lesseqgtr 1$. Intuitively, the locus of RRA that ensures liquidity provision is increasing in IES. This happens because, as IES increases, a one-percent increase in the real interest rate triggers an increase in consumption growth between $t = 1$ and $t = 2$ that is compatible with liquidity provision only if counterbalanced by an increase in RRA. Figure 1 highlights how this result significantly differ from the one under CRRA utility, in which $c_1^* > 1$ only if RRA is sufficiently high.[3]

Proposition 1. *Assume that $\gamma > 2 - 1/\psi$ and $\psi \neq 1$. Then, with Epstein-Zin preferences a bank provides liquidity in an incentive-compatible way if:*

$$1 < \left[\frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma}R\right]^{\psi} < R. \tag{12}$$

3. Financial Fragility

In the present environment, a bank might be fragile if subject to possible self-fulfilling "runs", when all depositors withdraw early because they expect everybody else to do that. This happens iff $c_1^* > 1$, i.e. the bank holds insufficient resources

3. The numerical example assumes $R = 5$ without loss of generality.

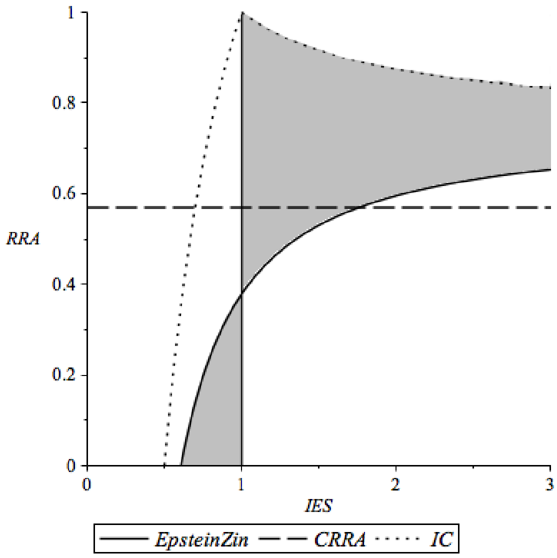

Figure 1: The parameter space for which a bank provides liquidity in an incentive-compatible way.

to pay early consumption to all depositors at a run, even by liquidating all its investments (Cooper and Ross 1998).

Under the conditions of Proposition 1, $c_1^* > 1$ and the bank might indeed be fragile. Against this scenario, here I study a time-consistent deposit freeze à la Ennis and Keister (2009), implemented by a benevolent government who cannot commit to a tough freeze that would completely resolve fragility. The government solves:

$$\max_{\pi_s} \int_0^1 \left[\pi_s c_1^{*1-\frac{1}{\psi}} + (1-\pi_s)(1-\pi)\left(p\,(c_2(\pi_s))^{1-\gamma}\right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right] dp, \tag{13}$$

where:

$$c_2(\pi_s) = R\frac{1-\pi_s c_1^*}{(1-\pi_s)(1-\pi)}. \tag{14}$$

Intuitively, at $t = 1$, the depositors arrive at the bank in random order and are served sequentially. The government chooses the fraction $\pi_s \geq \pi$ of depositors (that might be early or late consumers) that are served at $t = 1$ before the freeze and get c_1^*, and the remaining $1-\pi_s$ depositors among whom only $1-\pi$ are late consumers and get $c_2(\pi_s)$, and the others get zero. The optimal freeze point π_s^* is implicitly characterized by the first-order condition:

$$c_1^{*1-\frac{1}{\psi}} - \frac{(1-\pi)(1-\gamma)}{1-\gamma+1-\frac{1}{\psi}}(c_2(\pi_s))^{1-\frac{1}{\psi}} + \frac{\left(1-\frac{1}{\psi}\right)(1-\gamma)}{1-\gamma+1-\frac{1}{\psi}}(c_2(\pi_s))^{-\frac{1}{\psi}}R\frac{1-c_1^*}{1-\pi_s} = 0. \tag{15}$$

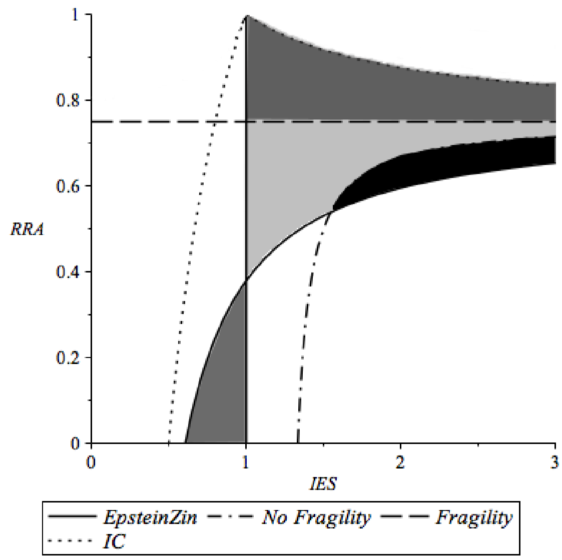

Figure 2: The parameter space for which a bank is never or always fragile.

From here, I can prove the following:

Proposition 2. *Under a time-consistent deposit freeze, a bank is fragile iff:*

$$\pi \geq \frac{\psi - 1}{1 - \gamma}\Big[(R-1)(1-\gamma) - 1\Big] \equiv \bar{\pi}. \tag{16}$$

Proof (Ennis and Keister 2009). A bank is fragile iff the deposit freeze arrives too late to stop a run, i.e. iff $\pi_s \geq \pi^T$, defined as $c_1^* = c_2(\pi^T)$. For that to happen, the left-hand side of (15) must be non-negative at $\pi_s = \pi^T$, which is true iff (16) holds. □

From (16), it is immediate to see that $\bar{\pi}$ is decreasing in γ and increasing in ψ. Put differently, financial fragility is increasing in RRA and decreasing in IES. Hence, a bank providing liquidity can be never fragile if IES is sufficiently larger than 1 and RRA sufficiently low, so that $\bar{\pi} \geq 1$ and (16) is never satisfied. In contrast, a bank can also be always fragile if $\bar{\pi} \leq 0$. This happens if RRA is either large or small enough, depending on whether IES is larger or smaller than 1.

Corollary 1. *Under a time-consistent deposit freeze, a bank is never fragile if ψ is sufficiently larger than 1 and γ is sufficiently low. A bank is always fragile if $\gamma < (R-2)/(R-1)$ when $\psi < 1$, and if $\gamma > (R-2)/(R-1)$ when $\psi > 1$.*

Figure 2 shows that, among the combinations of RRA and IES for which a bank provides liquidity in an incentive-compatible way as in Figure 1, there are cases in which the bank is always fragile (dark grey area) when either RRA is sufficiently high or IES is lower than 1, but also cases in which it is never fragile (black area), despite the government lack of commitment to a deposit freeze.

4. Conclusions

The distinction between depositors' RRA and IES provides a novel perspective to understand bank liquidity provision and financial fragility. In particular, high depositors' RRA turns out to be not necessary to rationalize the two phenomena, especially if the depositors exhibits low IES. This calls for a reconsideration of some foundational results in the banking literature, that could be extended to the analysis of banks' liquidity management and endogenous financial fragility. I leave these issues for future research.

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