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On the welfare equivalence of asset markets and banking in Diamond Dybvig economies☆

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HIGHLIGHTS

- The second best allocation of a Diamond Dybvig economy is characterized.
- Asset markets with highly rational agents can implement this allocation.
- Asset markets are therefore Pareto-equivalent to demand deposit contracts.
- This finding is in contrast to the mainstream literature.

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ABSTRACT

Why do people choose bank deposit contracts over a direct participation in asset markets? In their seminal paper, Diamond and Dybvig's (1983) answer this question by claiming that bank deposit contracts can implement allocations that are welfare superior to asset markets equilibria. The present paper demonstrates that this claim is false whenever the asset market participants are highly rational.

1. Introduction

Diamond and Dybvig (1983) (=DD) claim that "bank deposit contracts can provide allocations superior to those of exchange markets" (p. 401). As the reason for this welfare superiority of financial intermediation over asset markets, DD identify asymmetric information about the agents' liquidity preferences:

> "Because only the agent ever observes the private information state, it is impossible to write insurance contracts in which the payoff depends directly on private information, without an explicit mechanism for information flow. Therefore, simple competitive markets cannot provide this liquidity insurance. [. . .] Banks are able to transform illiquid assets by offering liabilities with a different, smoother pattern of returns over time than the illiquid assets offer". (p. 403)

This claim of welfare superiority of financial intermediation has been widely accepted within the literature. For example, in their leading textbook Freixas and Rochet (2008) write:

> "[. . .] the market economy does not provide perfect insurance against liquidity shocks and therefore does not lead to an efficient allocation of resources. This is because individual liquidity shocks are not publicly observable, and securities contingent on these shocks cannot be traded [. . .]. The following discussion shows how a financial intermediary can solve this problem". (p. 23)

The above argumentation refers to the well known fact that any asset market equilibrium is Pareto optimal if this market is complete in the sense that arbitrary trading strategies for state contingent Arrow–Debreu securities are feasible. Consequently, as a necessary condition any welfare superiority of financial intermediation over asset markets could only be possible in an incomplete market environment. However, in the context of a DD economy this information asymmetry argument is not convincing since the information constraints are not binding in the DD economy so that

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the first best (under publicly observable information) and the second best (under private information) solutions actually coincide. It is therefore far from obvious that asset markets shall not be able to generate the first best solution, i.e., the Pareto optimal allocation.

As this paper's main contribution, we prove that the optimal allocation of the original DD economy can be alternatively implemented through an intermediate asset market whenever the agents' ex ante investment decisions correctly anticipate the equilibrium on this market. That is, under the assumption that the agents fully understand how future equilibrium prices depend on today's investment decisions, even an idealized financial intermediary cannot outperform asset markets in terms of welfare generation.

2. The optimal allocation

This section derives the optimal allocation of the original DD economy. Suppose that all agents of the economy pool their wealth with a financial intermediary, i.e., an idealized bank, which maximizes each agent's ex ante expected utility subject to the bank's budget constraint. Formally, in period 0 every agent $i \in [0, 1]$ deposits his initial wealth $W_i = 1$ with the bank. The bank decides in period 0 which fraction of the accumulated wealth

$$W = \int_{i\in[0,1]} W_i di = 1 \tag{1}$$

to hold as cash, C, and which fraction to hold as assets, A. The bank will earn in period 2 the certain return $R > 1$ per unit of asset. In the intermediate period 1, every agent learns whether he has a low, L, or a high, H, patience for consumption. Denote by c_t, $t = 1, 2$, period t consumption of an agent and consider the following type-dependent utility function over consumption streams

$$U(c_1, c_2, \theta) = \begin{cases} u(c_1) & if \theta = L \\ u(c_1 + c_2) & if \theta = H \end{cases} \tag{2}$$

for some continuously differentiable, strictly increasing, and strictly concave function $u : \mathbb{R} \to \mathbb{R}$.

Suppose that a low, resp. high, type agent receives in period 1 amount C_L, resp. C_H, of cash from the bank which he immediately consumes. Further suppose that the bank allocates to a low, resp. high, type agent the amount A_L, resp. A_H, of assets such that the agent consumes in period 2 the returns generated by these assets. Denote by $\pi(L) \in (0, 1)$, resp. $\pi(H) = 1 - \pi(L)$, the probability that an agent has low, resp. high, patience for consumption. Then the agent's period 0 expected utility from the allocation (C_L, A_L, C_H, A_H) is given as

$$\begin{aligned} EU[C_L, A_L, C_H, A_H] &= U(c_1, c_2, L) \cdot \pi(L) + U(c_1, c_2, H) \cdot \pi(H) \\ &= u(C_L) \cdot \pi(L) + u(C_H + R \cdot A_H) \cdot \pi(H). \end{aligned} \tag{3}$$

Let us stipulate that the law of large numbers works to the effect that in the intermediate period 1 a mass $\tau = \pi(L)$ of agents will have low and a mass $1 - \tau = \pi(H)$ of agents will have a high patience for consumption.[1] Under the assumption that the agent's types are observable by the bank, the bank thus maximizes

$$EU[C_L, A_L, C_H, A_H] = u(C_L) \cdot \tau + u(C_H + R \cdot A_H) \cdot (1 - \tau). \tag{4}$$

subject to

$$\tau \cdot (A_L + C_L) + (1 - \tau) \cdot (A_H + C_H) = 1. \tag{5}$$

For the optimal allocation $(C_L^*, A_L^*, C_H^*, A_H^*)$ it must obviously hold that $A_L^* = C_H^* = 0$. By (5),

$$A_H^* = \frac{1 - \tau \cdot C_L^*}{1 - \tau} \tag{6}$$

whereby C_L^* is characterized by the following first order condition:

$$\frac{d}{dC_L}(EU) \equiv u'(C_L^*) \cdot \tau - \tau \cdot R \cdot u'\left(R \cdot \frac{1 - \tau \cdot C_L^*}{1 - \tau}\right) = 0 \tag{7}$$

$$\Leftrightarrow$$

$$u'(C_L^*) = R \cdot u'\left(R \cdot \frac{1 - \tau \cdot C_L^*}{1 - \tau}\right) \tag{8}$$

or, equivalently expressed (cf. Eq. (1b) in DD) as

$$u'(c_1^*) = R \cdot u'(c_2^*) \tag{9}$$

where $c_1^* = C_L^*$ denotes the optimal period 1 consumption of the low patience and $c_2^* = R \cdot \frac{1-\tau \cdot C_L^*}{1-\tau}$ denotes the optimal period 2 consumption of the high patience type. The following proposition collects the above results.

Proposition 1 (Diamond and Dybvig, 1983). *Suppose that the agents' types are publicly observable. Then the (first best) optimal allocation $(C_L^*, A_L^*, C_H^*, A_H^*)$ of the DD model is characterized by the following equations:*

$$A_L^* = C_H^* = 0, \tag{10}$$

$$A_H^* = \frac{1 - \tau \cdot C_L^*}{1 - \tau}, \tag{11}$$

$$u'(C_L^*) = R \cdot u'\left(R \cdot \frac{1 - \tau \cdot C_L^*}{1 - \tau}\right). \tag{12}$$

Now suppose that the agents' types are private knowledge and, therefore, not observable by the bank. In this situation of asymmetric information, the bank's optimization problem would have to take account of incentive compatibility constraints for each type. It is easy to see that the first best allocation of Proposition 1 satisfies the corresponding incentive compatibility conditions: first, a low patience type does not care about assets allocated to the high patience type. Second, the high patience type strictly prefers his allocated assets A_H^* to C_L^* because (12) implies $c_2^* > c_1^*$ since $R > 1$ and u' is (by strict concavity of u) strictly decreasing. Consequently, the information constraints are not binding in this economy.[2]

Corollary. *Suppose that the agents' types are not publicly observable. Then the (second best) optimal allocation of the original DD economy coincides with the (first best) optimal allocation $(C_L^*, A_L^*, C_H^*, A_H^*)$ of Proposition 1.*

[1] That the individual probability of a depositor to turn out as a high type coincides (almost surely) with the fraction of high types in the population is for a countably infinite population justified by the law of large numbers together with the assumption that depositors' types are independently and identically distributed. While such justification is not at hand for the continuous population of our model (Judd, 1985; Duffie and Sun, 2007), we simply follow here the literature and misquote the law of large numbers in the 'usual way'.

[2] Diamond and Dybvig (1983) consider *very* concave u, i.e., u has to satisfy

$$\frac{-cu''(c)}{u'(c)} > 1 \quad \text{for all } c \in \mathbb{R}_+, \tag{13}$$

which excludes, e.g., log-utility. The above analysis shows that strict concavity is already a sufficient condition for the results in Proposition 1 and the Corollary.