LSF Research Working Paper Series

N°. 12 – 10

Date: May, 2012

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JEL Classification : G21, D91

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The Governance of Perpetual Financial Intermediaries

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This version: March 2011

The Governance of Perpetual Financial Intermediaries

In this paper we investigate the risk sharing potential of financial intermediaries in an overlapping generations economy. We find that the intermediaries' allocations are constrained by the temptation of the living to liquidate their intermediary's assets and share the proceeds amongst themselves. We characterize this constraint set, and show that only intermediaries that can avoid side trading and the rolling over of deposits can improve on the market allocation. Furthermore, intermediaries may not achieve the constrained optimal allocation because the living are not willing to build a sufficiently large asset buffer.

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1. Introduction

One of the main services that financial intermediaries—such as banks, pension funds, and insurance companies—are purported to provide is insurance against liquidity risk. In the OLG Diamond and Dybvig model (Qi, 1994), this insurance is provided via promises guaranteed by buffers of productive assets. This insurance mechanism allows for a more efficient use of productive assets by insulating them from the liquidity needs of depositors. However, we find that the size of these asset buffers is limited because the intermediary's living members can opt to sell all (or part of) these buffers and reallocate the proceeds amongst themselves. Furthermore, the selection of a (constrained) efficient asset buffer is only one of many possible equilibria. We find other equilibria in which financial intermediaries have inefficiently low (underfunded) buffers which generate lower social welfare than what could be achieved without intermediaries.

This paper extends the literature initiated by Edgeworth (1888), Bryant (1980) and Diamond and Dybvig (1983), who study how financial intermediaries can share risk in economies where assets are illiquid due to gestation lags, and consumers face stochastic consumption needs. Nevertheless, the benefits from such intermediaries is limited by the presence of a market as pointed out by Jacklin (1987) and Bhattacharya and Gale (1987).¹ We focus on the literature that considers the role of financial intermediaries in overlapping generations (OLG) economies where financial intermediaries hold buffers of liquid and illiquid assets to smooth consumption (Allen and Gale, 1997), or to take better advantage of productive technologies, Qi (1994), Bhattacharya and Padilla (1998), and Fulghieri and Rovelli (1998), among others. Like them, we analyze the conditions under which a financial intermediary can improve on the allocation that obtains in a dynamic market economy.

The novel feature of this paper is that we take seriously the characterization of intermediaries as “mutually owned” (Diamond-Dybvig 1983), and study the decisions of

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¹ E.g. Haubrich and King (1990), Hellwig (1994) and von Thadden (1997, 1998) provide an additional critique of Diamond Dybvig risk sharing. Wallace (1988), Gorton and Penachi (1990), and Diamond (1997) suggest conditions under which banks can offer superior risk sharing.

such intermediaries when controlled by their living members. This control takes the form of periodic decisions as to whether to continue the status quo payoff and investment regime, disband the intermediary, or adopt a feasible alternative schedule. We show that the status quo is not sustainable if the intermediary offers payments that are too generous. The reason is that the only way to sustain generous payments is to hold a large asset buffer, and large asset buffers can be turned into consumption by the current owners of the intermediary (depositors). Depositors can disband the intermediary, sell the assets to non-depositors, and share the proceeds amongst themselves. As we show, such disbandment is an out of equilibrium event but the possibility of it occurring generates a constraint on the set of feasible payment schedules that can be offered by the intermediary.

We characterize the set of feasible payment schedules, the no-disbandment constraint, and find that it is a very restrictive constraint in the sense that it is not met by several allocations suggested in the incumbent literature. In particular the intermediary payments suggested in Qi (1994), those attained via tax-subsidy schemes in Bhattacharya and Padilla (1996), or those attained by intermediaries who can discriminate on age in Fulghieri and Rovelli (1998) do not satisfy the no-disbandment constraint.

We find that the market allocation does satisfy the no-disbandment constraint. Furthermore, this allocation corresponds to the constrained optimal allocation for a certain type of intermediaries (which we call banks). The intermediaries are described in Qi (1994) by the constraints that they cannot avoid (i) the rolling over of deposits and (ii) side trading. Other intermediaries that can avoid such depositor strategies (insurance mutuals, defined benefit pension plans, government social security schemes) and who cater to risk averse agents can improve on the market allocation. Nevertheless, we also find that the owners of the intermediary may fail to agree to increase the asset buffer, even if it is (constrained) inefficiently low (underfunded intermediaries), and hence such intermediaries will not be able to provide depositors with the constrained optimal allocation. Thus, welfare gains from financial intermediaries in our model depend on the size of the asset buffer selected in equilibrium, and may even be negative.

2. Financial Intermediation and their Governance

The object of our study is a standard infinite horizon overlapping generations Diamond-Dybvig economy with financial intermediaries. In this economy, financial intermediaries are governed by their depositors and decisions regarding the intermediary are made at each point in time by the generations of depositors that are currently alive.

2.1. The OLG Economy

In this economy there is a boundless sequence of overlapping generations of atomistic agents, of size one. On every date $t \in \{\dots, -1, 0, 1, 2, \dots\}$, agents are born with an endowment of one unit of a homogeneous good that can be used for consumption or as an input into production. Agents who enter the economy at date t can be of two types: with probability ε agents are *impatient* and live for one period only; with probability $1-\varepsilon$ they are *patient* and live for two periods. When born (at date t) they make their decisions before knowing their type which is revealed just before date $t+1$. Impatient agents consume at $t+1$, while patient ones consume at $t+2$. All agents have expected utility preferences represented by an instantaneous utility function $U(\cdot)$ that is increasing, strictly concave and twice-continuously differentiable. Let C_t^i denote the consumption of an i -year old at time t . Then the ex-ante expected utility of an agent born at date t from the consumption allocation $\{C_{t+1}^1, C_{t+2}^2\}$ is:

$$\varepsilon U(C_{t+1}^1) + (1-\varepsilon)U(C_{t+2}^2)$$

We assume that the population is large enough for there to be no uncertainty on the aggregate distribution of agents in the population. Hence, at any date t , the population contains $3-\varepsilon$ agents in different stages of their life: $1-\varepsilon$ two year old agents, 1 one-year-olds who know their type ($1-\varepsilon$ are patient, and ε are impatient), and 1 newborns who do not know their type yet. In between dates there are $2-\varepsilon$ agents: 1 young, and $1-\varepsilon$ old.

The economy is endowed with two technologies to produce goods over time. The first technology, *storage*, allows agents to transfer consumption costlessly from one period to the

next. The second technology, the *long term* (illiquid and productive) technology, is a constant returns to scale technology that allows agents to convert one unit of consumption at date t into $R > 1$ units of consumption at $t+2$. This technology cannot be interrupted at $t+1$. In the remainder we use y to denote investment in the productive technology. The maximum amount per period that can be invested in the productive technology is $Y \geq 1$.

2.2. Pareto Efficiency

Consider a benevolent social planner who can select the optimal investment strategy and freely allocate output. We focus on optimal stationary levels of investment, $y_t = y^*$. The socially optimal allocation with a stationary level of investment has the property that consumption risks are smoothed out: $C_t^1 = C_t^2 = y^*(R-1) + 1 \quad \forall t$. The social planner maximizes welfare by scaling up the investment level to its maximum Y and giving agents the allocation $C_t^1 = C_t^2 = Y(R-1) + 1 \quad \forall t$.

The existing literature has generally ignored the issue of the scale of production and, for the most part, assumes an implicit bound of $Y = 1$. Our assumption of $Y \geq 1$ has the advantage of clarifying differences between allocations which would otherwise be confounded as we will see below.

Notice that if there is a starting date to the economy the Pareto optimal allocation cannot be obtained immediately. The reason for this is that the first generation does not have enough endowment to build a sufficiently large investment buffer to generate the Pareto optimal consumption for all present and future generations.²

2.3. Financial Intermediaries

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² We analyze how an economy with a starting date can converge into the stationary equilibrium in section 5. Bhattacharya, Fulghieri and Rovelli (1998) suggest schedules to smooth the economy to the Pareto optimal allocation.

Lacking a benevolent social planner, we consider how a decentralized economy can try to share consumption risk between agents and generations. There are two basic market-based solutions: (i) *Intermediated economy*: allow intermediaries to issue promises of future payments guaranteed by productive assets; and (ii) *Market economy*: allow a secondary market to function where agents can sell their investments in productive assets if they require early consumption. While we focus on the first of these, we allow for the existence of a parallel secondary market for asset transfers (which need not be active in equilibrium). Thus, while we will focus on the intermediated solution we also allow agents the possibility of investing on their own and reselling the unfinished production (*young assets*) in the next period. This raises additional issues that are discussed as the analysis develops.

Having intermediaries that can issue promises guaranteed by productive assets generates social benefits that have been readily recognized in the banking literature, but it also produces intergenerational conflicts which have not been generally recognized. The way intermediaries/financial institutions help share risks and increase the economy's productivity in our setting is by building an investment buffer of the productive but illiquid long-term technology. Using the output from these investment buffers and cash deposits from newborns, financial institutions can meet the liquidity needs of their impatient depositors as well as provide higher returns to patient ones than in the market economy.

We follow the literature in defining a financial intermediary as an institution that offers newborns at date t a demandable debt security in exchange for their endowments. This security provides depositors with the right to obtain either r^{t+1}_1 units of consumption in the next period ($t+1$), or wait and receive r^{t+2}_2 two periods later (at $t+2$). We limit our attention to intermediaries of constant size with stationary payout schedules and use y to denote the corresponding stationary investment policy of the intermediary. We also assume the number of depositors of each intermediary is sufficiently large that intermediaries do not face any

uncertainty.³ Thus, an intermediary is described by its *operating rule*: its investment policy and the returns it offers its depositors $\{(y_t), (r'_1, r'_2)_t\} = \{y, r_1, r_2\}$.

Each intermediary is subject to an *internal budget constraint (iBC)* that arises out of the need to finance withdrawals and investments with new deposits and the returns on earlier investments:

$$\varepsilon r_1 + (1 - \varepsilon) r_2 + y \leq 1 + yR \quad (\text{iBC})$$

This inequality will be binding in equilibrium. The left hand side of (iBC) gives the periodic outflows: payments to impatient and patient depositors, and new investment. The right hand side gives the periodic inflows: new deposits and the payoff from maturing projects. Between periods, the intermediary holds y *young* assets, investment projects that have just been started, and y *mature* assets, that are about to realize a return of R . In addition to the internal budget constraint, any stationary investment level must also satisfy the *external budget constraint*, $y \leq Y$, which arises from the limited scalability of the production technology.

As the internal budget constraint is increasing in y , an intermediary wishing to maximize the welfare of its members will try to reach the highest level of investment consistent with the external constraint. This implies that the financial intermediary could potentially provide the first best allocation. But, these institutions are subject to a number of constraints that limit the deposit rates they can offer. As we will show, the fact that the intermediary's operating rules are determined by the agents that are alive poses strong limitations to the risk sharing and productive potential of these institutions. We want to focus on this aspect and the intergenerational conflicts it produces.

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³ This is usually justified in terms of the law of large numbers. Duffie and Sun (2007) provide a rigorous formulation of independent random matching for a continuum population such that the law of large numbers holds exactly.

2.4. The Governance of Financial Intermediaries

In the three period Diamond-Dybvig model, withdrawal rights are fixed in advance, so that an intermediary can be interpreted as a cash dispenser and its governance is not an issue.⁴ For perpetual intermediaries that operate in OLG economies, the cash dispenser interpretation is inappropriate as intermediaries must not only dispense cash to current and future generations, but also make investments and accept new deposits. More importantly, an overlapping generations economy does not have infinitely lived agents who can enforce operating rules. Hence, the governance of the intermediary and the operating rules that are enforceable becomes an issue. We want to focus exclusively on intergenerational conflicts, and therefore ignore intragenerational conflicts that may arise within different groups. Thus, we select a simple governance structure designed to facilitate the adoption of operating rules that are Pareto optimal (for generations that are alive): we assume that only policies that attain unanimous agreement can be enforced.

The details of the governance mechanism for an intermediary are as follows: the intermediary's living members periodically decide on the operating rule to be used during a general depositor meeting which takes place between dates, so that only 1 young and $1-\varepsilon$ old depositors attend.⁵ In these meetings depositors vote for motions that propose (a) either to support the current operating rule, $\{y, r_1, r_2\}$, or (b) disband the institution, liquidate all assets and share the proceeds.⁶ We assume that, every period, one randomly selected chairman submits a proposal to disband. A proposal to disband, $\{r_2^t, r_1^t, r_2^{t+1}\}$, calls for closing the intermediary to new depositors and allocate the intermediary's assets amongst current depositors, where r_2^t denotes the amount received by the old on the date following the meeting, and r_1^t and r_2^{t+1} give the payoff to young depositors conditional on becoming impatient and on remaining patient respectively. A proposal that does not support the status quo is implemented only if it obtains unanimous support.

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4 The cash dispenser interpretation was first suggested by Wallace (1988).

5 It can be shown that our key results holds if stakeholder meetings are held on dates, with $3-\varepsilon$ depositors, of three different cohorts, present.

6 The possibility of selling part of the asset buffer while accepting new deposits is considered below.

We require that proposals be *feasible*, that is, that they can be financed by the dividends of the current asset buffer and either new deposits (the internal budget constraint, Equation (iBC)) or the sale of some of the assets owned by the intermediary (and no new deposits). In the following let ξ stand for the number of assets sold by a disbanding intermediary, and $p(\xi)$ the price obtained from the sale of assets in the secondary market.

Hence, for a disbandment proposal to be feasible it has to satisfy the following two constraints:

$$(1 - \varepsilon)r_2^t + \varepsilon r_1^t \leq yR + \xi p \quad (\text{DPa})$$

$$(1 - \varepsilon)r_2^{t+1} \leq (y - \xi)R \quad (\text{DPb})$$

Expression (DPa) gives, on the left hand side, the liquidating intermediary's payout to those who want to consume at date t , and the right hand side gives the available funds if ξ assets are sold. Expression (DPb) gives, on the left hand side the final payout of the liquidating intermediary, to those who want to consume at $t+1$ (the patient young), and on the right hand side, the dividends obtained from the assets in the buffer that were not sold.

In addition, for a disbandment motion to be successful it has to improve the payments received by each of the stakeholder groups: for the patient young to support disbandment $r_2^{t+1} \geq r_2$; similarly, for the impatient young and old to support it $r_2^t \geq r_2$ and $r_1^t \geq r_1$ respectively.

Combining these inequalities with (DPa) and (DPb) we obtain the following condition:

$$\varepsilon r_1 + (1 - \varepsilon)r_2 \left[1 + \frac{p}{R} \right] \geq y[p + R] \quad (\text{N-D C})$$

We refer to this condition as **the no-disbandment constraint**.⁷ For any policy that does not satisfy (N-D C) there is a feasible disbanding proposal that will receive unanimous

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⁷ Condition (DPmax) is obtained as follows: condition (DPb) determines the maximum number of assets the intermediary can sell without losing the vote of the patient young: $\xi = y - \frac{1}{R}[(1 - \varepsilon)r_2]$. Substituting this back into (DPa), rearranging and using $r_2^t = r_2$ and $r_1^t = r_1$ we obtain (DPmax).

support. The intuition behind this constraint is straight-forward: the LHS represents the present value of the intermediaries' liabilities: Short-term liabilities are $\varepsilon r_1 + (1 - \varepsilon)r_2$, which need to be paid out immediately; and, $\frac{p}{R}(1 - \varepsilon)r_2$ represents the present value (at market prices) of “long-term” liabilities—the promises to the patient young for consumption one period from today. On the RHS we find the market value of young and maturing assets. When the RHS is greater than the LHS we have an “overfunded” intermediary, and the living can liquidate the asset buffer and pay themselves more than what the intermediary offered them.

Equation (N-D C) can be used to characterize the relationship between r_1 and r_2 by substituting into it the internal budget constraint (that will always be tight), Equation (iBC) to obtain:

$$\varepsilon r_1 \geq \frac{R + p}{1 + p} \left[\frac{R - (1 - \varepsilon)r_2}{R} \right]. \quad (r1-r2)$$

To fully characterize the disbandment constraint, we need to identify the price function $p(\cdot)$ that liquidating intermediaries fetch for their young assets in the secondary market. As we will see, this is an *out of equilibrium* (shadow) price as in equilibrium there are (a) no sales of assets, and (b) no active secondary asset market.

2.5. The Secondary Market and the Shadow Price of Young Assets

Suppose an agent (born at $t-1$) decides to avoid financial intermediaries, that is to invest on his own and reap the benefits from the long-term production technology if he lives for two periods. He does this in the knowledge that if he lives for only one period, he can sell young assets (at price p_t). The resulting utility is

$$\varepsilon U(p_t) + (1 - \varepsilon)U(R).$$

Alternatively, he could purchase young assets today in the secondary market (at price p_{t-1}). If he lives for one period, he consumes the proceeds. If he lives for two periods, he can invest the proceeds, knowing that he can resell the unfinished projects (at price p_{t+1}). The resulting utility is

$$\varepsilon U(R / p_{t-1}) + (1 - \varepsilon) U(p_{t+1} R / p_{t-1}).$$

In a stationary and competitive equilibrium $p_{t-1} = p_t = p_{t+1}$. As in equilibrium both of the above investment strategies have to be actively used for the market to function (active buying and selling of young assets), and agents have to be indifferent between the two. As date $t+1$ consumption is the same for both strategies (R), so that date t consumption must also be the same:

$$p = \frac{R}{p} \Leftrightarrow p = \sqrt{R}.$$

Clearly, the implied equilibrium market allocation, $\{\sqrt{R}, R\}$, is not the Pareto optimal one obtained in Section 2.2, and provides the rationale for the study of financial intermediaries.

For our analysis, $p = \sqrt{R}$ is the price of young assets in the (possible inactive) secondary market, and enters as the shadow price for young assets in (N-D C), so that the no-disbandment constraint can be written as:⁸

$$\varepsilon r_1 + (1 - \varepsilon) r_2 \left[\frac{1 + \sqrt{R}}{\sqrt{R}} \right] \geq y \sqrt{R} [1 + \sqrt{R}]. \quad (\text{NDC-p})$$

We now turn to analyze how this contract affects the rates intermediaries offer depositors.

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⁸ The assumption that the shadow price comes from the stationary market price implies that p does not depend on ξ , the number of assets sold. Our main results hold also if we relax this assumption as we show below.

3. Equilibrium with Governance Constraints

We distinguish bank and non-bank intermediaries. We use the term *bank* loosely to refer to intermediaries that face the following constraints: (i) they cannot distinguish the identity or age of depositors; and, (ii) claims on deposits they issue can be transferred from one individual to another.⁹

3.1. Competitive *bank* intermediaries

We first consider the promises that bank intermediaries can offer. From the analysis in Qi (1994) the bank constraints lead to the following no arbitrage condition:

$$r_1^2 = r_2. \quad (\text{Bank})$$

This condition follows from the inability of banks to distinguish between different types of depositors: if $r_1^2 > r_2$ patient depositors could increase their payoffs by rolling over their deposits, that is, withdrawing early and making a new deposit; if $r_1^2 < r_2$ impatient depositors instead of withdrawing early would engage in side trading (transfer their deposits to newborns).

Then, the disbandment constraint (NDC-p) becomes:

$$yR - (1 - \varepsilon)r_1^2 + \left(y - (1 - \varepsilon)\frac{r_1^2}{R} \right) r_1 \leq \varepsilon r_1 \quad (\text{NDC-bank})$$

If we now also substitute the internal budget constraint (iBC) into (NDC-bank), we find that

the equation evaluates to $r_1^2 \leq R$, or:

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⁹ We can think of these deposits as checking accounts even though no active markets for such accounts exist. Nevertheless, most banks offer (annualized) interest rates that are independent of the live of the deposit and it is possible to use cash in certain bank accounts as collateral.

PROPOSITION 1 (competitive bank intermediaries):

Due to the threat of renegotiation by its stakeholders, the best allocation that bank intermediaries can offer is $\{\sqrt{R}, R\}$.

Proof: follows immediately from the preceding analysis.

Thus, the possibility of disbandment, together with the tradability of deposits and the inability of banks to discriminate between different depositors, leads to an outcome that is no different from the one attained with a secondary market for young assets (in Section 2.5.). Proposition 1 suggests that in our setting, without transaction costs for direct investment, there is little social value from having banks rather than an active secondary market for assets. Nevertheless, banks, or rather, tradable deposits that are accessible for all agents are not the only way to organize risk sharing across generations.

3.2. Competitive Non-bank Intermediaries

Intermediaries may be allowed to offer different contracting conditions to different types of agents which may allow them to avoid the rolling over of deposits and side trading. For example, an intermediary may be able to condition offers on the identity or type of depositors. We assume that non-bank intermediaries will accept deposits only from newborns, that the demandable debt securities they issue are strictly non-tradable and registered, and that the institution can verify (and contract upon) an agent's type. We have in mind intermediaries such as defined benefit pension funds, social security schemes, or life insurance companies. These non-bank intermediaries can offer $r_1^2 \neq r_2$, which allows society to improve on the outcome obtained with more limited (bank) intermediaries.

We assume that the shadow price of assets, p , is the same as with bank intermediaries, that is $p = \sqrt{R}$. It also allows us to focus on the welfare effect of allowing intermediaries more leeway in the way they contract with different types of agents.^{10 11}

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¹⁰ In equilibrium no institutions will disband and there is no active secondary market for mature assets. Thus, this price represents the price of assets in the hypothetical case that an institution would disband and auction off its asset buffer. We consider alternative assumptions for the shadow price of projects below.

¹¹ Note that lemma 1 relies on our assumption that intermediaries only offer deposits to newborns. In the Appendix we show that if intermediaries also offer deposits to one-year olds (i.e. they cannot discriminate

Using $p = \sqrt{R}$ we obtain the set of operating rules that non-bank intermediaries can use without its depositors being tempted to liquidate the intermediary and share the proceeds—substituting p into Condition (r1-r2):

$$\varepsilon r_1 \geq \frac{R - (1 - \varepsilon)r_2}{\sqrt{R}}.$$

PROPOSITION 2 (disbanding the intermediary with competition):

For the competitive economy with intermediaries, there exists a convex permissible set of intermediary allocations that do not invoke disbandment by consensus of depositors.

(i) The convex set can be described by the following linear relationship

$$r_2 \leq \Phi_c(r_1) = \frac{1}{1 - \varepsilon} (R - \sqrt{R} \varepsilon r_1) \quad (\text{NDC-NBnk})$$

(ii) The allocation $\{\sqrt{R}, R\}$ is on the frontier of this set.

The key insight of Proposition 2 is that even though the threat of disbanding the intermediary poses a serious limit on the allocations offered by intermediaries (even if these institutions can discriminate on age) these intermediaries can increase depositor welfare because having access to a broader set of contracting possibilities allows them to offer and sustain a greater set of allocations. Furthermore, the allocation obtained by bank intermediaries, $\{\sqrt{R}, R\}$, belongs to this set which implies nonbank intermediaries can emulate banks.

3.3. Equilibrium with Financial Intermediaries

We have seen that in principle financial intermediaries could set up sufficiently large financial buffers to sustain the allocations that maximize social welfare. Nevertheless this possibility is

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on age), the market price for assets is slightly higher, and significantly more complicated, than

ruled out because current depositors have the power to disband the intermediary and will do so if the asset buffer is too large. This effect is so strong that bank intermediaries cannot improve on the welfare obtained using a decentralized market for young assets. Nevertheless, non-bank intermediaries, thanks to their greater contracting possibilities, may function under a broader range of operating rules than banks and could increase welfare.

In order to see whether the additional flexibility of selecting operating rules by non-bank intermediaries leads to differences in the contracts offered in equilibrium, we need to define a notion of equilibrium:

DEFINITION: A *stationary equilibrium for an economy with sovereign depositors* is characterized by an operating rule, $\{y, r_1, r_2\}$, that meets the external budget constraint, the internal budget constraint (IBC), and the no-disbandment constraint implied by (N-D C).

An *equilibrium for a competitive economy with sovereign depositors* has the following two additional properties:

- I. The disbandment constraint (N-D C) is evaluated at $p(\xi) = \sqrt{R}$ so that $r_2 \leq \Phi_C(r_1)$, as described in Proposition 2 and Expression (NDC-NBnk).
- II. There is no feasible proposal that a chairman can put forth that will be approved and is more attractive to new depositors than those offered by the competing intermediaries.

For now, we are focusing on the case where the chairman can only make disbandment proposals. Further extensions are considered below.

What we find in equilibrium is:

THEOREM 1

The set of equilibrium deposit rates for a competitive economy with sovereign depositors are on or less than (in the sense of the vector order) the disbandment constraint described by $r_2 = \Phi_C(r_1)$.

That is, in equilibrium, intermediaries cannot offer allocations above the disbandment constraint. This result follows directly from the definition of equilibrium and its importance lies in that it rules out most of the equilibrium allocations for Diamond-Dybvig economies

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(nonBankPrice). However, as is also shown in the Appendix, the key insights of the paper do not change

with intermediaries proposed in the literature¹². We will refer to equilibrium allocations on the disbandment constraint as frontier equilibria.

Frontier equilibria have the following properties:

PROPOSITION 3 *Equilibria for a competitive economy with sovereign depositors are welfare ranked and there is a unique socially optimal one (y^*, r_1^*, r_2^*) . If agents' relative risk aversion is equal to one (logarithmic preferences) the unique social optimum is $\{C_t^1, C_t^2\} = \{\sqrt{R}, R\}$. If agents' relative risk aversion is everywhere greater than one, the unique social optimum is located on the disbanding constraint, between the competitive market allocation $\{C_t^1, C_t^2\} = \{\sqrt{R}, R\}$ and the allocation on the intersection of the disbandment constraint and the 45 degree line, described by $r_1 = r_2 = \frac{R}{1 - \varepsilon + \varepsilon\sqrt{R}}$.*

The intuition for this result is obtained by interpreting the no-disbandment constraint as a budget constraint in a standard consumption problem. Then, it is clear that the unique optimum is where the depositors' indifference curves are tangent to the frontier. Let $\{r_1^*, r_2^*\}$ denote this constrained optimum pair. The location of the social optimum is determined by agents' risk aversion and the productivity of the illiquid technology. The productivity of the technology ($R > 1$) makes it worthwhile to have an asset buffer and offer more consumption on date 2 than on date 1. With logarithmic preferences the unique equilibrium is at the maximal policy obtained by banks, while a bit more risk aversion will imply agents prefer to give up some date 2 consumption in exchange for more consumption on date 1, and the optimum moves to the right—towards the riskless allocation on the 45 degree line.

Proposition 3 suggests that there are many equilibria, and we find this despite the fact that Condition (II) in the definition of equilibrium for a competitive economy enforces competitive pressure between intermediaries, that is, in a competitive market setting institutions competing for depositors can make themselves more attractive by selecting an operational policy that generates greater welfare. But, introducing an operational policy that

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¹² In particular, we refer to the payments suggested in Qi (1994), Bhattacharya and Padilla (1996), and Fulghieri and Rovelli (1998).

generates greater welfare for new depositors has to be approved by the governing body that represents the interests of current depositors. These new “better” policies may involve sacrifices on the part of the current generation, which they will try to veto. We now consider the trade-offs faced by members of the intermediary when deciding on the institution’s operating rule.

3.4. Reorganizations and Underfunded Intermediaries

To illustrate the trade-offs faced by the intermediary and its depositors, we make the chairman’s job easier by allowing for the possibility of making proposals not only to sustain the status quo and to disband the institution but also to change the operating rule. We refer to these new types of proposals as *reorganization* proposals $\{r_2^t, r_1^t, r_2^{t+1}; y', r_1', r_2'\}$. These proposals call for a temporary change in payouts for the living, and changing the current operating rule for all future generations. The first three variables specify the payments to the depositors who attend the meeting; the final three variables describe the operating rule for the reorganized intermediary.

A feasible reorganization proposal needs to ensure that it achieves the approval of all its members, and in addition that there are enough resources to implement it:

$$(1 - \varepsilon)r_2^t + \varepsilon r_1^t + y' \leq 1 + yR + \xi p(\xi) \quad (\text{DPa2})$$

$$(1 - \varepsilon)r_2^{t+1} + \varepsilon r_1' + y' \leq 1 + (y - \xi)R \quad (\text{DPb2})$$

$$(1 - \varepsilon)r_1' + \varepsilon r_1' + y' \leq 1 + y'R \quad (\text{iBC2})$$

The set of possible reorganizations can be of two forms: (i) payoff adjustments, and (ii) investment (and payoff) adjustments. The first type of reorganization is of the form: $\{r_2^t, r_1^t, r_2^{t+1}, y, r_1', r_2'\}$. That is, only the payouts are changed. Then, the resources available to the intermediary (the LHS of (iBC) and (iBC2)) are kept constant during the reorganization, and immediate payments to depositors (to the current old patient and young impatient) cannot be increased. The only current depositors that can benefit from such reorganizations

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are the young patient, and this requires that r_1 , the first period return for new depositors, be lowered. As the iBC has slope equal to $-\varepsilon/(1-\varepsilon)$, any risk averse newborn depositor optimizes at $r_1 = r_2$, hence any changes in the operating rule that lowers r_1 while increasing r_2 along the iBC towards $r_1 = r_2$ will allow the young patient to increase their future payments, respect the iBC, and attract new depositors.

The second type of reorganization suggests a different investment level: $y' \neq y$. Clearly, if the investment level is adjusted upwards ($y' > y$) at least some of the incumbent depositors' payoffs have to be sacrificed. Such proposals will not be approved under the unanimity rule. But they could approve lower buffers, which opens up the possibility that an intermediary has an inefficiently low (underfunded) asset buffer.

Competition amongst intermediaries implies that if one intermediary were to unilaterally lower his investment level, it would not be able to attract new depositors unless its new operating rule generates greater welfare. ^[13] Is this possible? In the discussion of the welfare properties of equilibria (following Proposition 3) we observed that the no-disbandment constraint is below the internal budget constraint to the right of $\{\sqrt{R}, R\}$. This indicates that there are circumstances where non-bank intermediaries can offer more attractive (higher welfare) deposit rates (higher consumption when young and lower consumption when old) with smaller investment buffers.

3.5. Equilibrium with Reorganization

We now consider how the potential for reorganization narrows down the set of possible equilibria.

THEOREM 2 [underfunded intermediaries]

There are two types of renegotiation-proof equilibria for an economy with a competitive market for financial intermediaries with reorganization proposals: (A) $\{\hat{y}, \hat{r}_1, \hat{r}_2\}$ such that $\hat{r}_1 = \hat{r}_2$; and (B) $\{\hat{y}, \hat{r}_1, \hat{r}_2\}$ such that

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¹³ If a reorganization proposal to adjust payoffs exists, there also exist reorganization proposals that translate the additional surplus for newborns into reorganization proposals that reduce both the investment level and the payoff to the young patient in favor of the young impatient and/or the old patient. These are

$r_2 = \Phi_C(r_1)$ and $\hat{r}_1 \geq r_1^*$. All except the constrained optimal one, $\{y^*, r_1^*, r_2^*\}$, are underfunded, that is intermediaries have investment buffers that are lower than the (constrained) efficient one.

First, competition between intermediaries rules out operating policies with the same investment buffer that offer lower welfare. Second, the possibility of making reorganization proposals eliminates operating rules that use too much investment (to the left of $\{y^*, r_1^*, r_2^*\}$). But, even with reorganization proposals, intermediaries can have too little capital.

Equilibria of type A, are referred to as symmetric, underfunded equilibria. These arise because the investment buffer is so low depositors are not tempted to disband the intermediary and redistribute the intermediary's assets amongst current members. But, the low investment buffer cannot be increased, as the internal reorganization constraint is binding. Thus, the best option for depositors in this situation is to optimize along the internal budget constraint. The optimal deposit rates given the internal budget constraint are rates that offer the same return whether the deposit is left for one period or for two ($\hat{r}_1 = \hat{r}_2$).

Equilibria of type B are frontier equilibria, and they arise when the disbandment constraint becomes binding.¹⁴ These are characterized by returns at date one that are greater, and asset buffers that are smaller than the (constrained) efficient ones (and hence are underfunded). As we have discussed, these are sustained in equilibrium because no intermediary can (given their current asset buffer) unilaterally and credibly offer more date two consumption. Also, the intermediary cannot increase its asset buffer as the current generation will not accept the necessary consumption loss.

Remark: So far we have restricted our analysis of competition to that between financial intermediaries, which could allow for the existence of underfunded intermediaries that provide lower welfare than in the market economy. Nevertheless, as we are assuming that there is a shadow secondary market for assets, competition from this shadow market implies

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not discussed in the main body of the text as they only complicate the discussion while leaving the resulting characterization of equilibrium unchanged.

14 Naturally, there is one equilibrium of both types, at the point where the disbanding constraint meets the 45 degree line.

that underfunded intermediaries cannot sustain returns that provide lower welfare than what can be attained using this secondary market, as depositors can abandon the intermediary and invest directly in projects.

This also implies that there is an underfunded equilibrium in an active secondary asset market can coexist with non-bank intermediaries, namely, when non-bank intermediaries offer deposit rates that generate the same utility as that obtained from trading in the secondary market.

It is important to emphasize that non-bank intermediaries can improve welfare because they can offer the more risk averse consumers higher consumption when young in exchange for lower consumption when old (relative to that in equilibrium for the market economy). This possibility is crucially dependent on the ability of non-bank intermediaries to observe the depositor's type at the time of withdrawing (when young). Otherwise, all depositors will want to rollover their deposits via the secondary market, that is, withdraw when young and, if they are going to live for another period, use the secondary market to reinvest in assets and

obtain a higher per-period return of $\sqrt{R} > \frac{r_2}{r_1}$.

4. Discussion and Extensions

There are a number of aspects of the model that can be modeled differently but do not change the qualitative predictions of the model, namely that the risk sharing abilities of intermediaries in the OLG Diamond-Dybvig is severely limited by the possibility the current generation has of liquidating all or part of the intermediary's asset buffer. In this section we discuss alternative modeling assumptions and how they affect our conclusions in the previous section.

4.1. A Monopolistic Intermediary

Intergenerational risk sharing is sometimes implemented using government run monopolistic intermediaries, such as public pension schemes, sovereign investment funds, etc. In such settings fund participation can be imposed but the fund still needs to ensure that it can avoid the possibility that late consumers withdraw early and reinvest in alternative investment vehicles (such as direct investments or a parallel banking system). Nevertheless, even if the rolling over of deposits is avoided, the public nature of the intermediary does not ensure that it is not subject to the same governance restrictions that in the competitive settings. After all, governments (at least democratic ones) are responsive to pressure from living constituents and hence tempted to cash in an asset buffer that is too large. Also, any attempt to increase the buffer of an underfunded intermediary will face opposition from voters.

4.2. The Shadow Price of Young Assets

In our analysis, the liquidation price of young assets was obtained from the shadow price of projects in a parallel, possibly inactive, secondary competitive asset market. There are a number of alternative ways to determine shadow prices and we have explored two, each corresponding to different market structures. The first, in economies with competitive intermediaries, is to obtain the price of young assets from the implied return obtained from depositors investing in other intermediaries. The second, more complex alternative (and more suitable for monopolistic intermediaries) is to consider the price as the result of bilateral bargaining between the generations surviving from the last period and the newborn generation. This bargaining is based on the outside options of preserving the intermediary as is versus reverting to an economy starting from autarky. Both these options complicate the analysis substantially; in particular, they add curvature to the frontier. Nevertheless, the frontier is concave in the range of returns offered by intermediaries under analysis, so that all the results obtained with a linear frontier in the analysis above are preserved. The main difference is that the monopolist intermediary can improve on the outcome obtained with a competitive market for intermediaries (Penalva and vanBommel (WP)).

4.3. Alternative Governance Mechanisms

We have assumed that the intermediary's policy is determined by unanimous consent. This assumption has the effect of reducing the set of circumstances under which an asset buffer can be liquidated, as well as those under which the asset buffer can be increased. If one were to consider a less stringent majority rule, it would be possible for said majority to increase their welfare at the expense of the losing minority. This can take the form of liquidating asset buffers more frequently (liquidating a smaller buffer is more attractive as the proceeds are shared amongst fewer depositors, the majority); as well as building bigger buffers using the resources extracted from the minority. The latter does not lead to policies with greater investment buffers as the majority is always made up of living generations, and although in some circumstances they may require more young assets than those in the investment buffer, they would only serve to increase the payoff of the young and patient depositors (in the majority), and not to build a greater asset buffer for future, unborn generations.

4.4. Altruism and Renegotiation Costs

In our model we assume that as soon as a small surplus for the incumbent depositors becomes available, they will seize it through renegotiation, even though it hurts subsequent generations. A natural conjecture is that if depositors were to have some degree of altruism, they would resist the temptation to renegotiate which would then allow for larger asset buffers to exist, and hence higher periodic investment levels and increased payout rules. The logic is the same as in Barro (1974) only in our setting generations are linked not through cash bequests, but through implicit bequests represented by higher investment buffers. Along the same lines, the dynamic entry of new participants (dynasties) would dampen this effect, as in Weil (1989).

4.5. Aggregate Risk

In our model we assumed away aggregate risk which allowed us to focus our analysis on deterministic operating policies. The price we pay is that voluntary liquidations will never happen: disbandment and reorganizations are out of equilibrium events.

Introducing aggregate risk gives intermediaries additional usefulness if they can tailor their deposit rates to incorporate an additional risk sharing element across generations. Solving our model with a stochastic instead of a fixed production level R is beyond the scope of this paper. Nevertheless, it can be conjectured that market values of intermediary's asset buffers will be stochastic too. If intermediaries hold on to fixed payoff schedules while attempting to maintain fluctuating asset buffers disbandment or renegotiation is bound to obtain after a sequence of periods with high returns as the buffer swells, even in the presence of finite dead weight renegotiation costs. Clearly, when such a renegotiation eventually obtains, it leads to enhanced payoff rules for the living generations. Similarly, a sequence of periods with low returns will drain the asset buffer, and the intermediary will be forced into involuntary liquidation (crises in bad times).

4.6. Side Trading Constraints

In the above analysis we have underlined the importance for enhanced welfare of limiting depositor's ability to withdraw early and reinvest, thus corroborating the problem for risk sharing of the side trade constraint (Jacklin, 1987). In our setting, the possibilities for side trading are enhanced by the presence of the secondary market for assets. If agents are risk averse, the social optimum stipulates a wealth transfer from late to early consumers. However, if agents circumvent the intermediary through side trading the best feasible allocation is that achieved in the market economy.

5. Summary and conclusion

In this article we re-examine risk sharing in overlapping generations economies. Such risk sharing obtains through intergenerational asset market trading or through financial intermediaries. Incumbent models in the literature show how financial intermediaries can improve on the market economy by accumulating buffers to smooth consumption or exploit productive technologies. We argue that such buffers may tempt the intermediary's

contemporary stakeholders to renegotiate the payoffs, to the detriment of successive generations.

We show that perpetual financial intermediaries are severely constrained in the allocations they can offer by this possibility. We characterize a no disbandment constraint, and find that it is so demanding that it implies that bank intermediaries cannot improve welfare beyond that obtained in a market economy. This is because banking intermediaries are also constrained by the ability of late consumers to mimic early consumers, and withdraw their claim early, either for redepositing or for purchasing secondary assets in the market.

Non-banking intermediaries, that is those that can avoid side trading and the rolling over of deposits, can improve welfare for sufficiently risk averse depositors. Nevertheless, financial intermediaries may not provide the (constrained) optimal level of welfare, as the internal governance of the intermediaries may block attempts to increase the asset buffer, and leave underfunded intermediaries.

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