The Governance of Perpetual Financial Intermediaries

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In this paper we re-examine the risk sharing potential of inter-generational financial intermediaries taking into account their governance structure. We argue that asset buffers of perpetual institutions are limited by the temptation of the living stakeholders to renegotiate contributions and distributions. We characterize the renegotiation constraint and show that it severely limits intergenerational risk sharing. Without renegotiation frictions, intermediaries cannot provide higher welfare than a market. The existence of (self-imposed) renegotiation costs relaxes the constraint. By forming a single monopolist intermediary, agents can further improve welfare.

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1. Introduction

Providing insurance against liquidity risk is one of the main tasks of financial intermediaries. Seminal papers of Edgeworth (1888), Bryant (1980) and Diamond and Dybvig (1983), show how intermediaries can share risk in economies were production comes with gestation lags and depositors face stochastic liquidity needs. Diamond and Dybvig (1983) show that if agents face the risk of having to consume before a long term production technology pays off, a financial intermediary is able to offer a consumption schedule in which early consumers are ex post subsidized by late consumers, and make all ex ante better off. Jacklin (1987) and Bhattacharya and Gale (1987) show that the presence of a market constrains the risk sharing ability of intermediaries. An extensive literature now exists on bank risk sharing.¹

In this paper we analyze financial intermediaries in a Diamond (1965) overlapping generations (OG) economy, where agents of every cohort face liquidity risk.² We investigate whether institutions that collect agents´ endowments, hold a capital buffer that offers a perpetual income stream, and offer agents contingent claims, can improve welfare vis-à-vis the market mechanism. Unlike many related papers in the literature, we do not a priori rule out type verifiability, and thus include insurance companies and pension plans as the object of our analysis.

We argue that perpetual institutions can only be governed by the living stakeholders, and that these will be tempted to renegotiate the extant investment and distribution schedules

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

² Samuelson (1958) investigates an OG economy where agents are born with a consumption deficit and need to borrow from the old.
if they can increase the utility of all incumbent depositors. We show that the temptation to renegotiate constrains the size of the intermediary’s asset buffer to the combined wealth of its depositors if they would not have joined. In other words, we show that, in the absence of renegotiation costs or altruism, perpetual intergenerational intermediaries cannot be overfunded and cannot do better than finitely-lived *intra*-generational intermediaries.

We arrive at this conclusion by modeling the perpetual intermediaries' governance by periodic meetings where members decide whether to either maintain the status quo distribution and investment regime, or to disband and offer all living members an alternative payoff schedule. We argue that if there exists a feasible disbandment proposal that improves the welfare of all living members, then it will be accepted and executed. Not surprisingly, the threat of disbandment limits the perpetual payoff schedule an intermediary can offer to its members. We characterize the *renegotiation constraint* as the frontier of the allocations that do not lead to disbandment.

We find that the market allocation just satisfies the renegotiation constraint. Furthermore, the market allocation corresponds to the constrained optimal allocation for *bank*-intermediaries, which are defined as institutions that can only issue demandable debt securities, because they cannot verify agents' types.

Non-bank intermediaries, such as insurance mutuals, defined benefit pension plans, and government social security schemes, are able to increase welfare vis-à-vis an exchange mechanism. Such intermediaries (costlessly) verify types and redistribute consumption between early and late consumers.\(^3\) However, due to the renegotiation constraint,

\(^3\) The type of ex-post redistribution depends on the depositors’ utility functions. We believe a desirable transfer from late to early consumers, as in Diamond Dybvig (1983) to be most realistic.
perpetual non-bank institutions cannot offer better schedules than finitely lived *intra*-generational intermediaries.

A surprising way around the renegotiation constraint is the existence of renegotiation frictions, such as transaction costs that come with selling illiquid assets, disbandment conflicts, or administrative procedures. We show that in the presence of renegotiation costs perpetual intermediaries can maintain higher asset buffers and can hence offer their participants higher levels of welfare. Our model thus explains why many perpetual OG institutions voluntarily inflict disbandment costs upon themselves. Mutual insurance companies often stipulate in their charters that surpluses in case of disbandment accrue to one or more designated charitable institutions. Mutually owned pension funds typically include specific constitutional provisions of what to do with surpluses and stipulate the kind of benefit increases that are allowed and when they can occur. These provisions burden potential disbandment proposals with significant legal costs, thus increasing the renegotiation proof asset buffer.

An alternative way to overcome the threat of renegotiation is to establish a single monopolist intermediary for all agents. If all goods are channeled through a government agency, no active market will exist where the potentially disbanding subjects can sell the institution's assets. There will however be a shadow market where the ostracized younger generations will be potential buyers. We find that a monopolist configuration relaxes the renegotiation constraint compared to the competitive case, and can significantly increase welfare if early consumers value consumption higher than late consumers.
Earlier papers that consider risk sharing in similar OG models include Qi (1994), Bhattacharya and Padilla (1996), and Fulghieri and Rovelli (1998).\(^4\) Qi presents a model where a perpetual Diamond-Dybvig bank carries an asset buffer over time so as to take maximum advantage of available investment opportunities. Banks are shown to offer a better allocation than the market because of higher perpetual investment levels.\(^5\) Bhattacharya and Padilla (1996) point out that Qi’s allocation, where banks offer two-period returns that are higher than the return on the productive asset, is subject to interbank arbitrage. They then show that a government can improve on the market economy by using tax-and-subsidy schemes. Fulghieri and Rovelli (1998) show that intermediaries that can identify depositors’ ages or types can attain the maximum investment. We find that the allocations suggested by Qi (1994), Bhattacharya and Padilla (1996) and Fulghieri and Rovelli (1998) are not renegotiation proof: in all suggested equilibria, living depositors can make themselves uniformly better off by liquidating the intermediaries’ asset buffers.

Also related to this paper is the model of Gordon and Varian (1988) which considers an OG economy where wages are stochastic and liquidity needs are fixed. The authors show that a government can improve welfare vis-à-vis a market economy by overcoming adverse selection and imposing wealth-transfers from the lucky to the unlucky agents. In a similar vein, Allen and Gale (1997) show how a buffer-holding banking system can

\(^4\) Other papers using this model include Bhattacharya et al. (1998), who investigate the starting up of a bank economy, Qian et al. (2004), who analyze how transactions costs affect the equilibriums, and Bencivenga and Smith (1991), who are concerned with economic growth.

\(^5\) Or, the market equilibrium does not obtain the (Phelps, 1961) “golden rule” investment level, where the marginal return equals the marginal utility. In all abovementioned papers, it is assumed that the exogenously given maximum periodic (“golden rule”) investment equals the agents’ endowments.
achieve intergenerational income smoothing by holding an asset buffer which is depleted whenever the risky dividends falls short of their expectation, and replenished otherwise. Using a result of Schechtmann (1976), they show that such a system can offer its stakeholders the expected value of the stochastic output in all except a negligible number of periods.

Allen and Gale also point out that a buffer holding financial system is fragile because agents will abandon it as soon as it becomes underfunded. We argue that even if newborns can be forced to join underfunded schemes (as is the case for most government pension schemes and social security plans), a plan cannot sustain unlimited overfunding, because living beneficiaries will press for an increase in distributions or decrease in contributions.

Our renegotiation constraint is reminiscent of the no restart condition of Prescott and Rios-Rull (2000), who analyze an OG model where the young are tempted to ostracize old generations and restart the economy. In our model, parent coalitions are in control, and the danger looms that future generations are abandoned.

Our findings are relevant to the literature that investigates the sustainability of intergenerational pension schemes. Krueger and Kubler (2006), Gollier (2008), Bohn (2009), and others argue that defined benefit pension schemes are superior to defined contribution schemes by enabling intergenerational transfers.\(^6\) Their schemes are typically optimized from the viewpoint of a benevolent social planner. The problem with these models is that they silently assume that the contracts are fixed, and that there exists an infinitely lived enforcer who can avoid renegotiation. While we acknowledge that well-designed pension plans can increase welfare, we show that since perpetual

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\(^6\) See also Gottardi and Kubler (2006), Cui et al. (2011) and Beetsma and Bovenberg (2009) for analyses of intergenerational social security and defined benefit pension schemes.
institutions are governed only by the living, intergenerational transfers are seriously limited by the temptation of renegotiation.

In the next section we describe the economy and the operating mode of perpetual intermediaries. In section 3 we describe how these institutions are governed, and model potential disbandment. Section 4 presents our main result, the renegotiation constraint, and discusses the relevance of the constraint to the banking literature. In section 5 we consider the renegotiation constraint of a monopolist intermediary, such as a government. We find that the renegotiation constraint is slightly less severe because monopolist intermediaries will suffer a price impact upon disbandment and selling secondary assets. Section 6 summarizes and concludes.

2. The economy and operating rule of perpetual intermediaries

The object of our study is an infinite horizon overlapping generations (OG) model. On every date \( t \in \mathbb{Z} \), a generation of infinitely many agents is born, each with an equal endowment of a homogeneous good that can be used for consumption or as input into riskless production. The economy features a market where risk-free assets accrue value at a per period rate \( r \). There is no uncertainty regarding this interest rate, and for the time being we assume that a single bank’s clientele does not affect \( r \). In section 5 we relax this assumption and will consider monopolist intermediaries with a market impact.

Agents who enter the economy at date \( t \) can be of two types: with probability \( \varepsilon \) agents are impatient and live for one period only; with probability \( 1-\varepsilon \) they are patient and live for two periods. Impatient agents consume only on their first birthday, patient agents only consume on their second birthday. Agents born on date \( t \) learn their type some time before their first birthday. An agent’s allocation is defined as a pair \( \{C_1,C_2\} \).
Financial intermediaries cater to stable non-growing clienteles that are large enough for there to be no uncertainty on the aggregate distribution about agent types.\footnote{This is usually justified in terms of the law of large numbers. Duffie and Sun (2007) provide a formulation of independent random matching so that the aggregate distribution of individually random types is certain.} We normalize the size of each generation of an intermediary’s clientele to unity so that, at any date $t$, every intermediary has $3-\varepsilon$ clients in different stages of their life: $1-\varepsilon$ two year olds, $1$ one-year-olds ($1-\varepsilon$ patient, $\varepsilon$ impatient), and $1$ newborns. In between dates the intermediary has $2-\varepsilon$ depositors: $1$ young, and $1-\varepsilon$ old.

Clearly, if agents only depend on the market to share risk, their allocation is $\{C_1,C_2\}=\{(1+r),(1+r)^3\}$. The key question of this paper is whether better allocations are attainable if agents organize to form buffer-carrying financial intermediaries that offer demandable debt securities in exchange for their endowments.

These securities are earmarked to give impatient depositors the right to withdraw $R_1$ units of consumption good on their first birthday, and offer patient consumers $R_2$ units on their second birthday. We limit our attention to intermediaries of constant size with stationary payout schedules and use $Y$ to denote the corresponding stationary investment in risk free assets. We define an intermediary's operating rule as $\{Y,R_1,R_2\}$.

Naturally, intermediaries are subject to an internal budget constraint that requires that withdrawals and investments are financed with new deposits and returns on earlier investments:

$$\varepsilon R_1 + (1-\varepsilon) R_2 \leq 1 + Yr$$

(1)

It can be easily seen that the periodic outflows to impatient and patient members is increasing in the intermediary’s buffer $Y$. Indeed, an intermediary wishing to maximize
the welfare of its members will try to reach the highest level of investment possible. Without exogenously specifying a maximum “golden rule” investment level, there is no limit on the intermediary’s perpetual buffer. In the next section we will show that $Y$ is endogenously limited by its governance: if only the living depositors determine the intermediary’s operating rule, the obtainable allocations are severely limited.

3. The governance of perpetual institutions

To model the governance of the perpetual intermediary, we assume that its living depositors decide on the operating rule during a periodic general meeting. Without loss of generality, this meeting takes place between dates, after all agents learn their type, so that 1 young and 1-ε old members attend. In these meetings depositors vote to either (a) support the current operating rule, $\{Y, R_1, R_2\}$, or (b) disband the institution, liquidate all assets and distribute the proceeds. We require unanimous support for a motion to be accepted.

We characterize a proposal to disband by the payout vector $\{R_{2\text{pat}}, R_{1\text{imp}}, R_{1\text{pat}}\}$, representing the distributions to the intermediary’s members at the date following the meeting: $R_{2\text{pat}}$ denotes the amount offered to the old, $R_{1\text{imp}}$ and $R_{1\text{pat}}$ give the payoffs to young impatient and patient respectively.

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8 Notice that we do not specify a starting or an ending date. Bhattacharya et al. (1998) show how intermediaries can reach stationarity from a starting date.

9 It can be shown that our key results holds if stakeholder meetings are held before types are known, or on dates, when 3-ε depositors, of three different cohorts, are present.

10 Restricting renegotiation to full disbandment is without loss of generality. Providing for increased temporary payouts and partial asset sales generates the same renegotiation constraint (derived in section 4). We require consensus because to avoid agents being expropriated. Clearly, if a majority can ex-post expropriate a minority, the intermediary will not attract depositors ex-ante.
We further assume that there is a dead-weight disbandment cost \( kY \), where \( k \in [0,1) \).\(^{11}\) The disbandment costs \( k \) can be interpreted in different ways. They may be the costs of overcoming charters of constitution, pure transaction costs that come with selling assets, or they may constitute search costs of finding the disbandment allocation. Finally, we can interpret \( k \) as feelings of remorse vis-à-vis all unborn future generations, who due to disbandment will not have access to the extant allocation \( \{R_1, R_2\} \).

A disbandment proposal will only be voted on if it is feasible. A proposal is feasible if the liquidation value of the assets on the next date is sufficient to finance the disbandment schedule. Or:

\[
(1 - \varepsilon)(R_2^{pat} + R_1^{pat}) + \varepsilon R_1^{imp} \leq Y(1 + r)(1 - k) \quad (2)
\]

Expression (2) gives, on the left hand side, the disbanding intermediary’s payouts to its members on the date following the governance meeting. On the right hand side we find the net proceeds of the liquidation on that date.

4. The renegotiation constraint

For a disbandment motion to be successful it has to improve the payments received by both cohorts: for the young to support disbandment we need \( R_1^{imp} \geq R_1 \) and \( (1 + r)R_1^{pat} \geq R_2 \), for the old to support the disbandment proposal we need \( R_2^{pat} \geq R_2 \).

Combining these inequalities with the feasibility constraint we find the following renegotiation constraint:

\[
(1 - \varepsilon)R_2 \left[1 + (1 + r)^{-1}\right] + \varepsilon R_1 \geq Y(1 + r)(1 - k) \quad (3)
\]

\(^{11}\) The linearity assumption is without loss of generality. Making the disbandment cost non-linear in \( Y \) or tying them to assets sold in the market would complicate the analysis without adding additional insights.
For any policy that does not satisfy (3) there is a feasible disbandment proposal that will receive unanimous support. The intuition behind this constraint is straight-forward: the left hand side represents the present value of the intermediary’s liabilities. On the right hand side we find the liquidation value of the intermediary’s assets. When the value of the assets is greater than the present value of the liabilities we have an overfunded intermediary. If the funding ratio is greater than \((1-k)^{-1}\) the living can liquidate the asset buffer and pay themselves more than what the extant operating rule offers them.

Equation (3) can be used to characterize the relationship between \(R_1\) and \(R_2\) by substitution into it the internal budget constraint. We find:

**Proposition 1 (renegotiation constraint with markets):**

*The withdrawal rights of perpetual intermediaries that earn a periodic return of \(r\) on their investments and face a disbandment cost \(k\), are limited by the following renegotiation constraint:*

\[
(1 - \varepsilon)R_2 \left( \frac{1}{(1 + r)^2} - k \right) + \varepsilon R_1 \left( \frac{1}{(1 + r)} - k \right) \leq 1 - k
\]  

(4)

This renegotiation constraint is similar to a budget constraint as it limits the allocation that perpetual intermediaries can offer. Notice that for the special case \(k = 0\), we have the budget constraint that holds for intragenerational Diamond-Dybvig (1983) banks that pool their clients’ assets and offers withdrawal rights of either \(R_1\) or \(R_2\) so as to maximize ex-ante expected utility.

Indeed, the key finding of this paper is that, in the absence of renegotiation costs, perpetual intergenerational intermediaries cannot accumulate more assets than the present value of their liabilities, and cannot improve on the allocation of intragenerational intermediaries:
Corollary (renegotiation constraint with costless disbandment):

In the absence of disbandment costs, the renegotiation constraint of intergenerational intermediaries that operate in a market economy is given by:

\[
\frac{\varepsilon R_1}{(1 + r)} + \frac{(1 - \varepsilon)R_2}{(1 + r)^2} \leq 1
\]  
(5)

This result, which implies that in the absence of frictions, intergenerational intermediaries cannot increase welfare relative to intragenerational intermediaries, is important, as it is not yet recognized in the literature. Instead, articles of Qi (1994), Bhattacharya and Padilla (1996), Allen and Gale (1997), Fulghieri and Rovelli (1998) and others argue that intergenerational intermediaries (banks, governments, or financial systems) are able to increase welfare over and above intra-generational intermediaries by carrying overfunded asset buffers. Our analysis shows that, due to the fact that intermediaries are governed only by the living, none of these intergenerational intermediaries would survive unless significant disbandment costs exist. The incumbent literature by and large ignores generational incentive compatibility and mostly postulates an infinitely lived welfare maximizer.

Despite the stringent renegotiation constraint it may still be possible that intermediaries can improve on the market allocation. Whether such improvements are possible depends on the nature of the institutions. Intermediaries who offer simple demandable debt securities, such as banks, need to avoid that their patient clients roll over their deposits and that impatient clients sell their (securitized) deposits (in the market or to newborns). This means that for unconditional demandable debt securities, the following bank constraint needs to hold:

\[
R_1^2 = R_2
\]  
(6)
If we have $R_1^2 > R_2$, patient depositors can increase their welfare by playing “withdraw and redeposit”. If $R_1^2 < R_2$ impatient depositors could increase their utility by selling their deposits to newborns as in Jacklin (1987). From (5) and (6) we find that, without disbandment costs, $R_1 \leq (1+r)$ and $R_2 \leq (1+r)^2$, implying that bank intermediaries cannot improve on the market allocation.

Unlike previous papers in the literature, we also consider intermediaries that can condition payouts on types, identities, or age. For example, insurance mutuals and social security schemes can condition payouts on the identity and type of depositors, and pension funds condition payouts on age. Such intermediaries are not constrained by (6).

We also recognize that in the economy’s population different client classes (with different impatient risks and different preferences) exist, so that intermediaries can offer a variety of $\{R_1, R_2\}$ contracts. Still, because non-bank intermediaries are governed by the living generations only, their payout schedules have to abide renegotiation constraint (4).

We depict the renegotiation constraint for our simple model in figure 1 for a payout vector targeted at clients with $\varepsilon = \frac{1}{3}$, in an economy with $r = 100\%$. Line $a$ gives the renegotiation constraint in the absence of disbandment cost. The market allocation $M$ is on this line. $M$ is unlikely to be the optimal allocation on $a$ for all agents. It may well be that some agents have higher utility for consumption in the impatient state than in the patient state, as is implied by the indifference curves in the figure. In such a case a non-bank intermediary that offers allocation $A$ may form.

Theoretically also a pure exchange mechanism could achieve allocations on line $a$. In such a market we would need the same number of contingent claim securities as there are agents, each agent would need to hold a sufficiently large number of these contingent claims to be sufficiently diversified, and each agent needs to monitor the resulting
claims. Whether obtained by a market or by an intermediary, equilibrium allocations are constraint by line \( a \), the renegotiation constraint of proposition 1.

Line \( b \) gives the renegotiation constraint of the perpetual intermediary if its disbandment costs are \( k = 5\% \). As can be seen from the figure, the existence of disbandment costs enlarges the set of feasible allocations that perpetual intermediaries can offer. The relative improvement increases in the \( R_2 / R_1 \) ratio because with a higher \( R_2 / R_1 \) comes a higher \( Y \), and a larger frictional loss in case of disbandment.

Line \( c \) depicts the \( \epsilon R_1 + (1-\epsilon)R_2 = (1+r)^2 \) “golden rule” of Qi (1994), Bhattacharya and Padilla (1996), Fulghieri and Rovelli (1998) and later papers that exogenously (and arbitrarily, as pointed out by to Bhattacharya and Padilla) assume an optimal investment of one unit of good invested for two periods. Qi (1994) suggests allocation \( Q \), because agents could potentially roll over claims or engage in side trade, so that the bank-constraint, depicted by line \( d \), binds.

Bhattacharya and Padilla (1996) point out that \( Q \) is not feasible because it tempts competing banks to open accounts with each other instead of investing in the production technology. They argue that an “interbank deposit constraint”, depicted by line \( e \), needs to hold to avoid such interbank arbitrage. They then suggest ways by which a government, through a tax-and-subsidy scheme, could potentially attain the Pareto optimal allocation \( C \). Fulghieri and Rovelli (1998) point out that \( C \) can also be obtained if agents’ ages are verifiable. Our analysis suggests that neither of these allocations are renegotiation proof.

12 To reduce the number of marketable contracts, Malinvaud (1972, 1973) and Penalva-Zuasti (2008) suggest that insurance companies rather than markets deal with individual risks.

13 In our model this is equivalent to a periodic one-period investment of \( Y = (1+r) \).

14 All these cited papers assume equal preferences for the consumption in the impatient and patient states, so that the Pareto optimal allocation would be given by point \( C \).
5. The monopolist intermediary

In this section we consider a closed economy with a single collectively governed intermediary that collects deposits from all agents in the population. The governance structure, and the basic idea of the renegotiation constraint is the same: if, in a candidate equilibrium, a disbandment allocation exists where all living agents increase their welfare by liquidating the asset buffer, disbandment will obtain, thus rendering the candidate equilibrium invalid.

The presence of a monopolist complicates our analysis, as there no longer exists a market where the intermediary can sell its assets, and hence no unequivocal source with which to pin down the liquidation value of the asset buffer. There exists however a shadow-market, because newborns will be ready to purchase assets in case they are not invited to join the intermediary. To properly understand the workings of this shadow market and identify the resulting out of equilibrium shadow-prices, it is important to model the available production technologies that represent the alternative investment opportunities for the newborns.

It can be easily seen that if the basic primary production technology has a gestation lag of one period, all assets will be priced at a yield of $r$, so that the analysis is the same as that of the previous section. It is however unrealistic that the periodic yield that we assumed in the previous sections is generated by one-periodic production only.

To model long term production, we follow the extant literature and assume that the periodic interest rate $r$ is generated by a stationary sequence of two-period technologies, henceforth called *projects*, of which the payoff is $R \equiv (1+r)^2$ two periods after the investment of one unit of consumption good.\(^{15}\)

\[^{15}\text{To see that a stationary sequence of such projects generate a market interest rate of } r, \text{ denote } p_t, \text{ the price at which seasoned (one-year-left-to-maturity) projects are bought and sold. To avoid arbitrage, we need } p_t = R/p_{t-1} \text{ for all } t. \text{ The stationary equilibrium thus has } p = R/p, \text{ for an interest rate of } r.\]
Now consider a monopolist intermediary that offers its members a schedule \( \{ R_1^*, R_2^* \} \), and periodically invests \( Y^* \) in new projects. If the operating rule is stationary, the following internal budget constraint will be:

\[
\varepsilon R_1^* + (1 - \varepsilon) R_2^* + Y^* \leq 1 + Y^* R
\]

(7)

On the left hand side we see the periodic outflows to depositors and new investments. On the right hand side we have the inflows: the new deposits and the project payoffs. On every potential disbandment date the intermediary hold \( Y^* \) maturing projects and \( Y^* \) projects with one year left to maturity.

To avoid a feasible disbandment proposal to be successful we again need that the liquidation value of the assets be lower than the present value of the liabilities to the living, or:

\[
(1 - \varepsilon) R_2^* \left( 1 + \frac{p^*}{R} \right) + \varepsilon R_1^* \geq \left( Y^* p^* + R Y^* \right) (1 - k)
\]

(8)

Where \( p^* \) is the (unobservable) shadow price of intermediate projects paying \( R \) in one period. On the left hand side we have the minimum goods that the depositors require: the old require \( R_2^* \), the patient young require \( R_2^* p^* R^{-1} \), the impatient young want at least \( R_1^* \). \( p^* \) is the project price on the next date, when there are 2-\( \varepsilon \) agents that need to carry consumption-goods through time: 1-\( \varepsilon \) patient one-year-olds and 1 newborns.

We will now study two cases: first we will consider the case where the newborns form a coalition too, and hold out the intermediary controlled by their parents and grandparents, by threatening not to buy any seasoned projects if they are not invited to join the intermediary on the incumbent terms. Then we will consider the case where the newborns act competitively, and bid up the price of seasoned projects to their marginal utility.
5.1. New born generations can hold out the monopolist intermediary

If new born generations can credibly threaten not to buy any assets sold by the incumbent monopolist, the shadow price of seasoned projects will be zero. In this case the intermediary could still disband and make all its living depositors better off, if its asset buffer is large enough. The chairperson can offer the patient young seasoned projects, but needs to offer the impatient young and the patient old consumption goods generated by its maturing projects. Since, by the internal budget constraint we always have \( RY^* > (1-\varepsilon)R^*_2 \), the scarce resource will be goods, not projects. A feasible disbandment proposal thus exists if we have:

\[
RY^*(1-k) > (1-\varepsilon)R^*_2 + \varepsilon R^*_1
\]  

(9)

On the left hand side we have the goods generated by the maturing projects, on the right hand side we have the consumption needs of the old and the impatient young. Notice that if (9) just binds, the intermediary can offer the patient young all its \( Y^* \) projects, which will more than satisfy them.

To find the set of feasible \( \{R_1,R_2\} \) allocations we only need (9) and substitute \( Y^* \) using the internal budget constraint (7). After some algebra we find:

**Proposition 2:** (Monopolist intermediary catering to colluding newborns)

The withdrawal rights of a perpetual intermediary that invests in two-year projects earning a per-period return of \( r \), face a disbandment cost \( k \), and caters to overlapping generations that can credibly threaten not to purchase any assets, are limited by the following condition:

\[
(1-\varepsilon)R^*_2 + \varepsilon R^*_1 \leq R \frac{1-k}{1-Rk} \quad \text{if } k < \frac{1}{R}
\]  

(10)
For $k = 0$, we obtain $(1-\varepsilon)R_1^* + \varepsilon R_2^* \leq R$, which implies $Y^* \leq 1$. This happens to be the golden rule constraint considered by Qi (1994). The intuition of this analysis is that if a perpetual intermediary invests $Y^* > 1$, it can always make its living members better off by not inviting new depositors but instead distributing the payoffs from the maturing assets, $Y^* R$, to its old and patient young members and the $Y^*$ projects to its patient members. In contrast, a perpetual intermediary with $Y^* < 1$ depends on cash inflows from new members to pay its consuming members and thus cannot disband, even if there are no associated costs.

If the disbandment costs are high enough (i.e. if $k \geq R^{-1}$), there is no renegotiation bound on the consumption schedules that can be offered by perpetual intermediaries. Only an exogenous Golden Rule would be able to limit the intermediary's asset buffer.

The assumption that newborns - who are certain to live an additional period - collectively threaten not to buy (at any price) seasoned projects that pay $R$ after one period may not be very realistic. The next section investigates the more natural case which assumes that newborns would act competitively, and bid up the price of seasoned assets to their competitive value in case the intermediary decides to disband.

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16 However, Qi (1994) does not give this argument for his assumption of a maximum investment limit $Y^* \leq 1$. Bhattacharya and Padilla (1996) refer to the golden rule of Phelps (1961) that implies $Y^* \leq 1$, and recognize that it is arbitrary.

17 To see this, define $D = \varepsilon R_1^* + (1-\varepsilon) R_2^* = 1 + Y^*(R-1)$ as the periodic distributions of perpetual intermediaries (the latter equality follows from the internal budget constraint (7)). We immediately see that $Y^* > (\leq) 1 \iff D > Y^* R$, implying that intermediaries with $Y^* > 1$ can, and those with $Y^* < 1$ cannot pay $D$ out of its project payoffs.

18 Indeed, the disbandment subgame is not intuitive in the sense of Cho and Kreps (1987).
5.2. The monopolist intermediary that faces competitive newborns

The case where newborns act competitively introduces the additional complication that the price per project depends on the number of projects that the disbanding intermediary offers for sale. Since the patient young can be given projects rather than goods, the number of projects that a disbanding intermediary needs to sell is:

\[ X = Y^* - (1 - \varepsilon)R_2R^{-1} \]  

(11)

The final term of the left hand side gives the minimum number of projects that the disbanding intermediary needs to offer its patient young depositors get their vote.

Because the potentially disbanding monopolist is the only supplier of projects, the competitive project price will depend on the number of projects it offers for sale to the only potential buyers, the newborns. The following lemma gives the equilibrium price that ostracized newborns would pay if they are offered \( X \) projects in a competitive auction:

**LEMMA**

*If \( X \) projects are sold to competitive newborns, the clearing price per project will be:*

\[ p = \frac{\varepsilon R}{X(R-1)+\varepsilon} \]  

(12)

The derivation of (12) follows from an analysis of the equilibrium that obtains when newborns start a new market economy. In the appendix we show that if a generation restarts without seasoned projects, the market return during the first period will be zero, while the second and consecutive even periods will see a return of \( R \). Or, if no projects

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19 Also if ostracized newborns decide to start a new intermediate economy, the first generations will receive allocations that are not better than those obtained in the market economy. See Bhattacharya *et al.* (1998) for details on how an intermediated economy can be started up.
are offered, the ostracized first and consecutive odd generations consume \( \{1, R\} \), while even generations consume \( \{R, R\} \).\(^{20}\) Hence, if \( X \approx 0 \) projects are offered for sale, the equilibrium price will be \( p^* = R \), for a zero yield. We show that if the economy is restarted with an auction of \( X > 0 \) seasoned projects, the cyclicality will be progressively dampened and then reversed.\(^{21}\)

Plugging (12) with (11) and the binding budget constraint (7) into (8) gives the renegotiation constraint for the monopolist case. It is a quadratic equation in \( R^*_z(1-\varepsilon) \), of which the positive root is given by the following proposition:

**Proposition 3 (Monopolist intermediary facing competitive newborns):**

The withdrawal rights of a perpetual intermediary that invests in projects paying \( R \) goods two periods after investment, face a disbandment cost \( k \), and cater to overlapping generations of competitive agents, are limited by the following condition:

\[
R^*_z \leq \frac{R}{(1-Rk)} - \frac{\varepsilon R^*_z (R+1)}{2(1-\varepsilon)} + \frac{\sqrt{D - Rk(1+R-2\varepsilon R)}}{2(Rk)(1-\varepsilon)}
\]  

(13)

where

\[
D = \varepsilon^2 R^*_z (R-1)^2(1-Rk)^2 + 4\varepsilon^2 R^2
\]

\[
+ Rk(R-1-2\varepsilon R)(2\varepsilon R^*_z (1-Rk)(R-1)+R(k(R-1-2\varepsilon R)+4\varepsilon))
\]

(14)

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\(^{20}\) This cyclical equilibrium is first mentioned in Bhattacharya et al. (1998).

\(^{21}\) Notice that if more than \( \varepsilon \) projects are sold, they will fetch less than on one good per project, so that the restarting and consecutive odd generations consume more on their first birthday than on their second birthday. This curious allocation is due to the assumption that there is no storage technology. With a storage technology the price function would be a step-function that unnecessarily complicates the derivation of the renegotiation constraint. In the appendix we derive the renegotiation constraint for the case where there is a storage technology.
It can be verified that for \( k = 0 \), the market allocation \( \{ \sqrt{R}, R \} = \{ 1 + r, (1 + r)^2 \} \) is on the monopolist’s renegotiation constraint, which shows that in the absence of disbandment costs, a monopolist bank, that needs to offer \( R_2 = R_1^2 \) to avoid rolling over of deposits and side trading, cannot offer a better allocation than a market economy or an economy with competing banks.

A non-bank monopolist that can make their payoffs contingent on type or age, can do better than competing institutions, even in the absence of transactions costs. The following corollary formalizes these conclusions and gives the renegotiation constraint for the zero disbandment case.

**Corollary (costless disbandment):**

In the absence of disbandment costs \( (k = 0) \), the renegotiation constraint of a monopolist intermediary is given by:

\[
R_2^* \leq R + \varepsilon \left( \frac{4R^2 + R_1^2 (R-1)^2 - R_1^* (R+1)}{2(1-\varepsilon)} \right)
\]  

(15)

The schedule \( \{ \sqrt{R}, R \} \) just satisfies this condition.

For all \( R, \varepsilon \), there exist:

(i) Allocations that meet the renegotiation constraint for the disbandment-cost-free monopolist’s (15) and do not meet the renegotiation constraint for the disbandment-cost-free intermediary in competition (5). These schedules have \( R_1^2 > R_2 \).

(ii) Allocations that meet the renegotiation constraint for disbandment-cost-free competing intermediaries (5) and do not meet the renegotiation constraint for the disbandment-cost-free monopolist intermediaries (15). These schedules have \( R_1^2 < R_2 \).
We thus find that in the absence of disbandment costs \((k = 0)\), bank intermediaries cannot improve on the market equilibrium, whether they are monopolist or operate in competition with other banks. Non-bank intermediaries on the other hand can increase welfare, by shifting consumption between types. A monopolist non-bank intermediary can further increase welfare if agents place relatively more value on early consumption than on late consumption. The reason for this is that a monopolist can hold a larger asset buffer without being subject to renegotiation.

Agents who favor a high \(R_2\) and low \(R_1\) may be better off with competing institutions. The reason for this is that intermediaries that offer high \(R_2/R_1\) need to sell relatively few assets upon disbandment, and the monopolist can obtain a higher price for its seasoned assets, making it more vulnerable to disbandment.

Figure 2 illustrates the renegotiation constraint for the monopoly case. Lines \(a\) and \(b\) give the renegotiation constraints if the intermediaries compete, and disbandment costs are \(k = 0\) and \(k = 5\%\) respectively. Lines \(a^*\) and \(b^*\) are the renegotiation constraints if newborns can threaten not to purchase any assets from the monopolist intermediary controlled by their parent and surviving grandparent generations. Lines \(a^{**}\) and \(b^{**}\) give the renegotiation constraints if the monopolist intermediary faces competitive newborns who bid up the price of liquidated assets to their marginal utility. We clearly see that a monopolist non-bank intermediary who sets \(R_1^2 > R_2\) can significantly improve on the allocation obtained in an economy with competing intermediaries.

6. Summary and conclusion

In this article we have re-examined risk sharing in overlapping generations economies. Ideally, wealth is redistributed consumption to early dying agents while maximizing the periodic investment and output. Incumbent models show how perpetual financial
intermediaries can improve on the market economy by accumulating buffers of productive assets to smooth consumption and exploit production technologies.

In this paper we model the governance of such intermediaries and ask what happens if they are governed by the living generations only. We argue that investment and distribution schedules may be renegotiated if this benefits the living depositors at the cost of future generations. We find that the threat of renegotiation represents a major limitation on intergenerational institutions' asset buffers.

We characterize a renegotiation constraint, and find that it is so demanding that perpetual intergenerational intermediaries cannot improve welfare beyond that obtained by finitely lived intragenerational intermediaries. In particular, we find that perpetual institutions cannot be overfunded, because this leads to renegotiation.

We find that the renegotiation constraint is relaxed by incorporating frictions. We show that intermediaries are able to provide higher perpetual allocations if they commit to high disbandment costs.

We also analyze an economy with a single monopolist intermediary. We find that a mutually owned monopoly can improve welfare compared to a market economy if agents value consumption in the bad (early consumption) state high enough. The reason is that a monopolist intermediary faces a serious market impact if it wants to ostracize the future generations by liquidating its assets to the benefit of the living. The disbandment hurdle, makes the out of equilibrium renegotiation subgame less attractive so that a larger asset buffer can be maintained.

For simplicity, and without loss of generality, our results are obtained assuming that renegotiation only occurs in the form of an outright shutdown of the scheme to new generations and a distribution of the assets to its existing members. In practice,
renegotiation may take place in the form of benefit increases, contribution holidays, or lump sum distributions. Such renegotiations, which occurred regularly in defined benefit pension plans during the 90s, are seen as key causes for the fact that most pension funds are currently underfunded. See Armstrong and Selody (2006) or Andonov et al. (2012).

Another simplifying assumption in our model is the lack of uncertainty. In reality returns on assets and liabilities are stochastic, making it impossible to maintain a funding ratio of exactly 100%. Renegotiations in real life are expected, and ex-ante contracted. Most insurance mutuals have statuary profit sharing schemes which effectively cap institutions’ surpluses (Hansman, 1985). Cooperatives and other endowment-carrying institutions renegotiate in the form of increased salaries or other benefits for its living beneficiaries, or equity redemptions of exiting members (Hansmann, 1999). Our claim that in the absence of frictions, intermediaries cannot be overfunded, is thus consistent with empirical observations.

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22 Hansman (1985) argues that the competitive advantage of mutuals in the life insurance business lies in the moral hazard problem that life insurance sellers have vis-à-vis locked-in policy holders. Since in mutuals this shareholder policy holder conflict is resolved, mutuals are particularly dominant in the life insurance business. See also Smith and Stutzer (1995).

23 Also related to our renegotiation constraint is the horizon problem, which causes underinvestment in LT projects by cooperatives (Oleson, 2007), and the access problem, which refers to limiting access to new generations and disbandment (Rey and Tirole, 2007).
References


Figure 1. This figure depicts the various constraints and allocations for the case where \( r = 100\% \) and \( \varepsilon = \frac{1}{3} \). Line \( a \) is the budget constraint of the intra-generational Diamond Dybvig intermediary, and the renegotiation constraint of the perpetual intermediary with no disbandment costs. Line \( b \) is the renegotiation constraint with disbandment costs \( k = 5\% \). Line \( c \) is the golden rule constraint suggested by Qi (1994) and others, \( d \) is the bank-constraint due to the roll over and side trade threat, and \( e \) is the no-interbank-deposits constraint suggested by Bhattacharya and Padilla (1996). \( M \) is the market allocation, \( Q \) is the allocation suggested by Qi (1994). \( A \) is the constrained optimal allocation for an intra-generational non-bank intermediary, \( B \) is the optimal allocation for the perpetual intermediary with disbandment costs, and \( C \) is the optimal allocation if only the golden rule binds and agents have equal preferences in the impatient as in the patient state.
Figure 2. We depict the monopolist intermediary’s renegotiation constraints, for $r = 100\%$ and $\varepsilon = \frac{1}{3}$. Line $a^*$ is the renegotiation constraint if the intermediary has no disbandment costs and faces newborns who can threaten not to buy any seasoned projects. Line $a^{**}$ the renegotiation constraint if the monopolist faces competitive newborns. Market allocation $M = \{2, 4\}$ is on this line. Lines $b^*$ and $b^{**}$ give the renegotiation constraints for monopolist intermediaries with disbandment costs $k = 5\%$, who face newborns threatening with not purchasing any liquidated assets and competitively behaving newborns respectively. Lines $a$ and $b$ give the best-possible allocations that can be obtained in competition, for disbandment costs 0 and 5% respectively.
Proofs

Proof of proposition 1

From (1) we have \( Y \geq \frac{\varepsilon R_i + (1-\varepsilon)R_2 - 1}{r} \). Substituting this into (3) gives

\[
(1-\varepsilon)R_2 \left(1+(1+r)^{-1}\right)+\varepsilon r R_i \leq \left(\varepsilon R_i + (1-\varepsilon)R_2 - 1\right)(1+r)(1-k),
\]

(A1)

and after some algebra, (4). \( Q.E.D. \)

Proof of proposition 2

Similarly, from (7) we find

\[
Y^* \geq \frac{\varepsilon R_i^* + (1-\varepsilon)R_2^* - 1}{R - 1}.
\]

(A2)

Substituting this into (9) gives (10) \( Q.E.D. \)

Proof of LEMMA

Let \( \tau \) denote the date of the competitive sale of \( X \) assets by a disbanding intermediary. Potential buyers are newborns and the patient one-year olds who have been given \( R_{i}^{pat} \) goods to vote in favor of disbandment. Since these survivors have no consumption needs, they can buy (i) primary assets that cost unity and pay \( R \) on date \( \tau+2 \) or (ii) secondary assets that pay \( R \) on date \( \tau+1 \). We are looking for the equilibrium price of these assets, \( p_{t} \). Because there is no uncertainty, they also correctly anticipate all future prices \( p_{t+\tau} \). In competitive equilibrium we need \( R/p_{t} = p_{t+1} \) for all \( t \), to rule out arbitrage.

The market clearing condition for time \( \tau \) is:

\[
p_{t} = \frac{1-Y_{t}}{X}
\]

(A3)

where \( Y_{t} \) denotes the amount that the survivors invest in the production technology.

The market clearing condition for all \( t > \tau \) is:
\[ p_t = \frac{1 - Y_t + (1 - \varepsilon)(1 - Y_{t-1})}{\varepsilon Y_{t-1}} \]  \hspace{1cm} (A4)

The denominator gives the supply of projects. They come from the impatient who invested in the two year production technology. The numerator gives the goods that purchase the projects. It is the aggregate endowment less the investment, plus the goods paid to the agents who in the previous period bought projects and remained patient. Expression (A4) shows that both \( Y_t \) and \( p_t \) are two-periodic. After some algebra using \( p_{t-1} = p_{t+1}, \ Y_{t+1} = Y_{t-1} \), and \( p_{t} = p_{t-1}/R \), we find:

\[ Y_t = 1 - \varepsilon \frac{R - p_t}{R - 1} \]  \hspace{1cm} (A5)

Substituting (A5) in (A3) gives (12) of the LEMMA. \textit{Q.E.D.}

Notice that for \( X > \varepsilon \) we would have \( p_t < 1 \), which cannot be the case if a storage technology exists. If, in such a case, more than \( \varepsilon \) projects are offered, the price will be unity, and the first and consecutive odd generations will consume \( \{R,R\} \) while even generations will consume \( \{1,R\} \)

\textit{Proof of Proposition 3}

Substituting the binding internal budget constraint (A2) into (11) and rewriting gives:

\[ X = \frac{\varepsilon R^*_1 + (1 - \varepsilon)R^*_2 - 1 - (1 - \varepsilon)R^*_t}{R - 1} \]  \hspace{1cm} (A6)

Substituting (A6) into (12) gives

\[ p^* = \frac{\varepsilon R^2}{\varepsilon RR^*_1 + (1 - \varepsilon)R^*_2 - (1 - \varepsilon)R} \]  \hspace{1cm} (A7)

Substituting (A2)-binding and (A7) into (8) gives:

\[ (1 - \varepsilon)R^*_2 \left( 1 + \frac{\varepsilon R}{\varepsilon RR^*_1 + (1 - \varepsilon)R^*_2 - (1 - \varepsilon)R} \right) + \varepsilon R^*_1 \]
\[
\frac{\left(\varepsilon R_1^* + (1-\varepsilon) R_2^* - 1\right)\varepsilon R^2 (1-k)}{\varepsilon R R_1^* + (1-\varepsilon) R_2^* - (1-\varepsilon) R} R - 1) + \frac{\left(\varepsilon R_1^* + (1-\varepsilon) R_2^* - 1\right) R (1-k)}{R - 1} \geq 0
\]

Multiplying both sides by \((\varepsilon R R_1^* + (1-\varepsilon) R_2^* - (1-\varepsilon) R) R - 1)\) gives:

\[
(1-\varepsilon) R_2^* \left(\varepsilon R R_1^* + (1-\varepsilon) R_2^* - (1-2\varepsilon) R\right) R - 1) + \varepsilon R_1^* \left(\varepsilon R R_1^* + (1-\varepsilon) R_2^* - (1-\varepsilon) R\right) R - 1) \geq 0
\]

Collecting terms, changing sign and simplifying gives:

\[
\left(R_1^*(1-\varepsilon)\right)^2 (1-Rk) + R_2^*(1-\varepsilon) \left(\varepsilon R_1^* (R+1)(1-Rk) - 2R(1-\varepsilon) + Rk (1+R-2\varepsilon R)\right) + R_1^* \varepsilon^2 R (1-Rk) - R_1^* \varepsilon R (1-\varepsilon + R - \varepsilon R - 2Rk (1-\varepsilon)) + (1-2\varepsilon) R^2 (1-k) \leq 0
\]

The discriminant of this quadratic equation is:

\[
D = R_1^* \varepsilon^2 (R-1)^2 (1-Rk)^2 + 4R^2 \varepsilon^2 + Rk (R-1-2\varepsilon R) \left(2R_1^* (1-Rk) \varepsilon (R-1) + Rk (R-1-2\varepsilon R) + 4\varepsilon \right)
\]

Of which the positive root is:

\[
R_2^*(1-\varepsilon) = \frac{2R(1-\varepsilon) - R_1^* \varepsilon (R+1)(1-Rk) - Rk (1+R-2\varepsilon R) + \sqrt{D}}{2(1-Rk)}
\]

\[
R_2^* = \frac{2R(1-\varepsilon) - R_1^* \varepsilon (R+1)(1-Rk) - Rk (1+R-2\varepsilon R) + \sqrt{D}}{2(1-Rk)(1-\varepsilon)}
\]

\[
R_2^* = \frac{R}{(1-Rk)} \frac{\varepsilon R_1^* (R+1)}{2(1-\varepsilon)} + \frac{\sqrt{D-Rk (1+R-2\varepsilon R)}}{2(1-Rk)(1-\varepsilon)}
\]

Which gives renegotiation constraint (13). \textit{Q.E.D.}
In case there is also a storage technology in the economy, the relevant shadow price is unity if \( X > \varepsilon \). Substituting (A2)-binding and \( p^* = 1 \) into (8) we find:

\[
(1 - \varepsilon)R_2^+(1 + \frac{1}{R}) + \varepsilon R_1^* \leq \frac{R + 1}{R - 1} \left( \varepsilon R_1^* + (1 - \varepsilon)R_2^* - 1 \right)(1 - k)
\]

Which after some algebra evaluates to:

\[
R_2^* \geq \frac{R}{(1 - \varepsilon)(1 - R k)} \left( 1 - k - \varepsilon R_1^* \left( \frac{2}{R + 1} - k \right) \right)
\]

In the presence of a storage technology the renegotiation constraint both (13) and (A16) must hold. Figure 2 would change as follows:

**Figure A1.** The renegotiation constraints in the presence of a storage technology. Due to the storage technology, renegotiation constraints \( a^{**} \) and \( b^{**} \) are more strict than in Figure 2, because a disbanding intermediary can always sell its assets for unity.