行政院國家科學委員會專題研究計畫　成果報告

金融結構、總體衝擊與跨時避險

計畫類別：個別型計畫
計畫編號：NSC93-2415-H-004-010-
執行期間：93 年 08 月 01 日至 94 年 07 月 31 日
執行單位：國立政治大學金融系

計畫主持人：江永裕

報告類型：精簡報告
報告附件：出席國際會議研究心得報告及發表論文
處理方式：本計畫可公開查詢

中　華　民　國 94 年 11 月 7 日

行政院國家科學委員會補助專題研究計畫 ■ 成果報告
□期中進度報告

金融結構、總體衝擊與跨時避險

計畫類別：■ 個別型計畫 □ 整合型計畫
計畫編號：NSC 93－2415－H－004－010
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共同主持人：
計畫參與人員：

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執行單位：國立政治大學金融學系

中 華 民 國 94 年 10 月 30 日

Intermediaries, Markets, and Consumption Smoothing

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Version 2005.11.02
(First upload: Version 2005.10.31)

Abstract

This paper provides an overlapping generation model with aggregate shocks to examine how a profit-driven financial intermediary (FI) play its role in smoothing out consumption fluctuations due to aggregate shocks. In this setup profit-driven financial intermediaries provide state-contingent contracts, and agents could share their risks between generations through the contracts; moreover, the consumption fluctuation due to aggregate shocks could be smoothed out. Financial intermediaries accumulate profits, and it is these accumulated profits that make the functions of consumption smoothing workable. Adequate monopoly power is required to induce intermediaries to provide the Pareto superior deposit contract. The government certainly has a role in regulating the banking industry.

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Keywords: Intermediary, Market, Consumption Smoothing
JEL classification: G00, G21, G23

1 Introduction

The welfare comparison between the market-based and the bank-based systems has been investigated extensively in the recent literature. Allen and Gale (1995) take the U.S. and Germany as two opposite cases to illustrate the difference in risk-sharing between both systems. The market-based financial system allows an agent to diversify his portfolio through trade and, then, to eliminate his idiosyncratic risk. Nevertheless, aggregate shocks cannot be diversified and, thus, an agent cannot eliminate aggregate risks by diversifying his portfolio. When an agent's wealth mainly consists of financial instruments which are marked to markets, the performance of markets significantly affects the value of his portfolio. In the bank-based financial system, bank deposits are the main format by which agents keep their savings. The intermediated deposits are able to provide insurance against nondiversifiable shocks by averaging gains and losses over time. Depositors have fixed claims against intermediaries, no matter how the aggregate activity fluctuates.

Allen and Gale (1997) suggest that a long-lived financial intermediary (FI) could alleviate suffering from aggregate fluctuations by intergenerational transfer and asset accumulation. The FI in their setup allocates the whole resources and offers an optimal deposit contract to each generation in a *centralized* manner. In the steady state, this intermediated deposit contract asks agents to deposit their endowments and promise to pay them an amount of consumption goods in return such that at each date total consumption equals total expected production plus endowment. Moreover, the consumption is invariable regardless of the realized shock at each date and the intergenerational transfer through intermediation completely smooth out the adverse effect of aggregate shocks. In their analysis monopoly power is vital for an intermediary to perform the function of intertemporal risk-sharing. If agents have free access to the services of both financial market and intermediation, an intermediary is unable to compete with market when its accumulated buffers are too small to provide the same allocations as market trade could provide. Then, the intertemporal smoothing mechanism collapses.

In this paper we ask if the function of intertemporal smoothing can be *decentralized*? Could profit-driven intermediaries perform as well as the centralized intermediation *a lá* Allen and Gale? More specifically, exactly how large the monopoly power the FI should be conferred upon in order to fully insure agents against aggregate shocks? How does the interaction between financial markets and intermediaries affect the function of intertemporal risk-sharing? How do regulatory policies of the banking industry affect the provision of risk sharing? We proceed our analysis through a dynamic overlapping generation economy with aggregate shocks to the problems.

We show that [1] financial intermediation and the financial market are complementary to, not competitive with, each other; [2] monopoly power is necessary for intermediaries to provide intertemporal consumption smoothing; [3] the decentralized consumption smoothing is less efficient than the centralized consumption smoothing scheme *a lá* Allen-Gale; [4] the centralized consumption smoothing scheme is not implementable in our decentralized economy due to the need to provide incentives for agents to participate in intermediated contracts; [5] a proper regulatory policy of financial intermediation is needed to motivate financial intermediaries to provide Pareto superior deposit contracts.

In the literature of risk-sharing provision, many papers assume that the returns of investment are constant. Diamond and Dybvig (1983) show that agents could smooth out idiosyncratic risks through deposit contracts in a one-generation economy with individual preference shocks and illiquid two-period investment technology.

Qi (1994) models an infinitely repeated version of Diamond and Dybvig (1983) to show that an intergenerational bank could achieve interest rate smoothing and provide liquidity insurance by intergenerational transfers. Also, it improves on an intragenerational bank and an autarky economy. Bhattacharya and Padilla (1996) conclude that government interventions with full information solve the problems of underinvestment and the lack of consumption smoothing in an intergenerational market equilibrium. Thus, the economy reaches a level of welfare as high as what an intergenerational bank can offer. Qian et al. (2004) argue that the performance of intergenerational bank with initial capital is superior to that of the intergenerational market with full participation, which dominates the intragenerational market. An intergenerational bank with or without initial capital allocates resources more efficiently than the market if there exists limited participation with uncertainty about trading types. Allen and Gale (1997) analyze intertemporal risk-sharing for a dynamic economy with nondiversifiable aggregate shocks. Allen and Gale (1998), integrating preference shocks with aggregate shocks in a single generation model, suggest that bank runs can be first-best efficient and government intervention improves welfare only in the case of costly runs or when the market of risky assets is introduced. Allen and Gale (2004) propose Arrow securities markets for intermediaries in a one-generation model. They conclude that "efficiency depends on the completeness of markets but does not depend on whether contracts are complete or incomplete," so a role for government intervention is provided.

The rest of the paper proceeds as follows. In section 2, we describe an overlapping generation model with aggregate shocks. In section 3, review the financial market equilibrium described in Allen and Gale (1997). Then, the role of financial intermediaries is explored in section 4. Section 5 concludes the paper.

2 The Model

We study an infinite-horizon economy with overlapping generation agents. Each new generation is born at date $t \in \{0, 1, 2, \dots, \infty\}$ and lives for two periods; $i = 1, 2$ denotes young and old age respectively. At date $t = 0$, there is an initial old generation who lives for one period. Each generation has a continuum of agents with measure one.

There are two types of assets, a safe asset and a risky asset, and a consumption good. The safe asset is represented by a storage technology transforming one unit of consumption good at date t into one unit of consumption good at $t + 1$. The durable risky asset lasts eternally and yields a random return of y_t units of the consumption good at each date t. Each risky asset is initially owned by one initial old and we normalize the number of risky assets and the population of the initial old to one. Since the risky asset generates returns eternally, it has a positive market value and the initial old would inelastically supply his risky asset in the market. The aggregate shock y_t is drawn from the space of $\{y_H, y_L\}$ with equal probability .5. Both y_H and y_L are non-negative and the expected value of y_t is positive. The distribution of y_t is publicly known.

Each agent is endowed with e units of the consumption good when young and nothing when old. The young agent uses his endowment for consumption and investment in both safe and risky assets. The preferences of an agent are characterized by

$$U(c_1, c_2) = u(c_{t,1}) + v(c_{t,2}), \tag{1}$$

where $c_{t,i}$ denotes generation t agent's consumption at age i. Both $u(\cdot)$ and $v(\cdot)$ are twice continuously differentiable, strictly increasing, and strictly concave.

To simplify the analysis, we focus on the following form of the model:

$$U(c_1, c_2) = \ln(c_{t,1}) + \ln(c_{t,2}), \tag{2}$$
$$e = 1,$$
$$y_t = \begin{cases} y_H & = 1 \quad \text{with probability .5}, \\ y_L & = 0 \quad \text{with probability .5}. \end{cases}$$

3 The financial market

In this dynamic economy with aggregate shocks, each newborn agent allocates his endowment to consumption ($c_{t,1}$) and investment in both the safe asset (s_t) and the risky asset (x_t). The price of the risky asset at date t is p_t. When old, he realizes the returns of investment and sells his holdings of the risky asset with price p_{t+1} to young generation agents at date $t+1$ in order to finance the consumption when old ($c_{t,2}$). Since both young and old generations benefit from *intergenerational* trade of the ownership of the risky asset, an agent participates in the market and has an expected return higher than just holding the safe asset for his investment.

A market equilibrium is a sequence of portfolio choices $\{(s_t, x_t)\}$ and prices of the risky asset $\{p_t\}$ such that [1] given p_t, $\{(s_t, x_t)\}$ solve the generation t's maximization problem:

$$\begin{aligned} \max \quad & E \ \ln(c_{t,1}) + \ln(c_{t,2}) \\ \text{s.t.} \quad & c_{t,1} = 1 - s_t - p_t x_t, \\ & c_{t,2} = s_t + (p_{t+1} + y_{t+1}) x_t, \end{aligned} \tag{3}$$

where the consumption when young and investment must be less than or equal to his endowment and the consumption when old should be equal to the total returns of portfolio; [2] the feasibility constraint holds:

$$c_{t,1} + c_{t-1,2} = 1 + y_t, \text{ and} \tag{4}$$

$$x_t = 1. \tag{5}$$

The equilibrium price and allocations, $\{(p_t, s_t, x_t)\}$, are functions of y_t. An equilibrium is a stationary Markov equilibrium if the above functional relations are time-invariant for all t.

According to the Proposition 1 of Allen and Gale (1997), there exists a stationary Markov equilibrium $\{(p_t, s_t, x_t)\}$ in which the price of the risky asset is a constant $p_t = p$ and the demand for the safe asset is $s_t = 0$ at every date t if $\sup u'(\cdot) > \inf v'(\cdot)$. The stationary Markov equilibrium is characterized by $p = .5$, $c_1^M = .5$, $c_2^M = 1.5$ if $y = 1$ and .5 if $y = 0$; the level of expected utility is -0.836988. Let c_{2H}^M denote the old-age consumption when the shock is good ($y = 1$) and c_{2L}^M when the shock is bad ($y = 0$). Then $c_{2H}^M = 1.5$ and $c_{2L}^M = .5$.

In a stationary Markov equilibrium, the risky asset dominates the safe asset; thus, the agent holds only the risky asset. When young, each agent allocates his endowment to consume and to purchase the risky asset. When old, the agent uses the returns of his investment in the risky asset to consume. Thus the old's consumption in this economy fluctuates due to aggregate shocks. The adverse impact of aggregate shocks, y_t, is not completely eliminated by the trade in the financial market.

4 A financial system with market and intermediaries

Next we introduce financial intermediation into this environment and examine how it coordinates with the market in dealing with aggregate shocks. More specifically, we explore the extent to which financial intermediaries could smooth out consumption fluctuation caused by aggregate shocks and how financial intermediaries *cooperate*, *not compete*, with financial market. We show that *profit-driven* deposit contracts of several types are Pareto improving on the above Markov market equilibrium. However the full smoothing-out of consumption *a lá* Allen and Gale (1997) is not attainable through profit-driven intermediation due to incentive problems.

The deposit contracts in question have functions of risk-sharing among generations and consumption-smoothing across a long time horizon, and therefore are attractive to agents. Moreover, they are profitable and allow financial intermediaries to accumulate profits. It is the accumulation of profits that makes intermediated consumption-smoothing work. In order to clarify how intermediaries perform these functions, we decompose intermediated contracts into two parts: *stand-alone* risk-sharing between two consecutive generations and *profit-nurtured* consumption-smoothing. There are two kinds of consumption-smoothing contracts. One provides smoothing of young-age consumption and old-age consumption. The other one provides a complete insurance against old-age consumption.

4.1 Stand-alone risk-sharing between two consecutive generations

At the beginning of each date and before the aggregate shock is realized, the young trades parts of his endowments for the risky asset. An intermediated transfer scheme is offered after the trade of the risky asset and before the shock is realized. The transfer scheme asks the young agent to deposit their remaining endowment after the trade of the risky asset (*i.e.,* $1 - p_t x_t$) and the old agent to deposit their claims against today's consumption good (including claims against dividends and the revenue from selling the risky assets). The transfer scheme promises payments to depositors contingent on the realized shock in the following way:

- when the realized shock is y_H , the payment to the young depositor is $c_1^M + T$ and the old depositor $c_{2H}^M - T$, and
- when the realized shock is y_L , the payment to the young depositor is $c_1^M - T$ and the old depositor $c_{2L}^M + T$.

Both young and old agents have incentives to participate in such a transfer scheme with an appropriate level of transfer T. The transfer T smoothes out consumption and the agent becomes better off. It is also feasible for an intermediary to provide such a transfer scheme. An appropriate level of transfer T satisfies the participation conditions for both initial old and subsequent generations:

$$.5\ln(c_{2L}^M + T) + .5\ln(c_{2H}^M - T) \geq .5\ln c_{2L}^M + .5\ln c_{2H}^M \tag{6}$$

$$\begin{aligned}\{.5\ln(c_1^M + T) + .5\ln(c_1^M - T)\} + \{.5\ln(c_{2L}^M + T) + .5\ln(c_{2H}^M - T)\} \\ \geq c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M\end{aligned} \tag{7}$$

The left-hand side of (6) and (7) are the expected utility of being a participant of the transfer scheme for the initial old and the subsequent generation respectively. The right-hand side is the expected utility of not participating in the transfer scheme.

The range of T satisfying both (6) and (7) is between 0 and 0.214. Notice the agent's expected utility of subsequent generations is maximized at $T^* = 0.109612$. Since the intergenerational transfer scheme does not require any resources, the long-lived risk-neutral financial intermediaries set transfer $T^* = 0.109612$ without loss generality.

Although the transfer scheme makes the young agent worse-off by moving them from certain consumption c_1^M to uncertain consumptions between $c_1^M + T^*$ and $c_1^M - T^*$, the gains from the transfer scheme when old is more than compensating the loss when young. The subsequent generations have incentives to participate in the transfer scheme. Those who have participated in the transfer scheme would rationally go back to intermediaries after trading in the market when old.

4.2 Some qualifications for the intertemporal smoothing

The subsequent generations gain from the transfer scheme. A FI with monopoly power could make profits by retaining some resources when implementing the transfer scheme. In this subsection we show that those contracts designed to smooth consumption such that consumption when young at both states (denoted by c_{1H}^F and c_{1L}^F respectively) and consumption when old at both states (c_{2H}^F and c_{2L}^F) fail to satisfy the FI's participation condition. From this finding we further develop in the next section a deposit contract which improves upon the stand-alone risk-sharing transfer and partially smoothes the depositor's intertemporal consumption.

Consider that a FI proposes a deposit contract and tries to smooth consumption such that $c_{1H}^F = c_{1L}^F = c_{2L}^F$. At date t, after market trades of risky assets and before the production shock being realized, the FI offers a deposit contract which asks

- the young agent deposits his remaining endowment $(1 - p_t x_t)$, and
- the old agent deposits his claim against today's consumption good (including claims against dividends and the revenue from selling the risky assets).

The deposit contract promises depositors the following state-contingent payment:

- the initial old receives $c_{2H}^F = c_{2H}^M - T^* - \beta$ when $y = y_H = 1$, and $c_{2L}^F = c_{2L}^M + T^*$ when $y = y_L = 0$,
- when $y = y_H = 1$, the young agent of subsequent generations receives $c_{1H}^F = c_1^M + T^* + \alpha_{1H}$ and the old agent receives $c_{2H}^F = c_{2H}^M - T^* - \beta$, and

- when $y = y_L = 0$, the young agent of subsequent generations receives $c^F_{1L} = c^M_1 - T^* + \alpha_{1L}$ and the old agent receives $c^F_{2L} = c^M_{2L} + T^* + \alpha_{2L}$,

where

$$\alpha_{1H} = \min\{\phi - (c^M_1 + T^*), \pi^{young,t}_{t-1}\} \geq 0, \quad (8)$$
$$\alpha_{1L} = \min\{\phi - (c^M_1 - T^*), \pi^{young,t}_{t-1}\} \geq 0,$$
$$\alpha_{2L} = \min\{\phi - (c^M_{2L} + T^*), \pi^{old,t}_{t-1}\} \geq 0.$$

β is the price the FI charges an agent for the deposit contract and it is the source of FI's profits; ϕ is a fixed level of consumption independent of realized shocks and will be specified later; $\pi^{young,t}_{t-1}$ and $\pi^{old,t}_{t-1}$ are the accumulated profits assigned for the payment to the young and old agents respectively at date t. When the accumulated profits (π_{t-1}) are sufficiently large to provide a buffer for consumption smoothing, depositors will always obtain ϕ units of the consumption good in their youth regardless of realized outcomes and old age when bad outcome is realized; that is $c^F_{1H} = c^F_{1L} = c^F_{2L} = \phi$.

Recall that the stand-alone risk-sharing transfer scheme is welfare improving on the stationary Markov equilibrium allocation and, thus, is appealing to agents. Whoever provides such a scheme could grasp some profits if competition is not so stiff. Furthermore, as a FI accumulates profits over time, it nurtures the capability of smoothing consumption over time and improves the agent's well-being one step further. In order to clarify this aspect of FI, instead of working on the total amounts of payments to depositors, we decompose the payments into two parts, T^* and α. In the following we demonstrate how to compute the deposit contract. First the contingent payments is required to provide enough incentives for both young and old agents to accept the deposit contract. These participation conditions are specified as

$$.5\ln(c^M_{2H} - T^* - \beta) + .5\ln(c^M_{2L} + T^*) \geq .5\ln c^M_{2L} + .5\ln c^M_{2H}, \quad (9)$$

$$\{.5\ln c^F_{1H} + .5\ln c^F_{1L}\} + \{.5\ln c^F_{2H} + .5\ln c^F_{2L}\} \quad (10)$$
$$\geq c^M_1 + .5\ln c^M_{2H} + .5\ln c^M_{2L},$$

$$.5\ln c^F_{2H} + .5\ln c^F_{2L} \geq .5\ln c^M_{2H} + .5\ln c^M_{2L}, \quad (11)$$

(9) is for the initial old, (10) is for the young agent of subsequent generations, and (11) is for the old agent of subsequent generations. The explanation of both sides of these inequalities are similar to those of (6) and (7). The participation condition for FI is[1]

$$\beta \geq \alpha_{1L} + \alpha_{1H} + \alpha_{2L}. \tag{12}$$

It takes a few steps to compute ϕ. We first specify the bank profit and how it relates to the determination of ϕ. How much a FI could obtain from an agent of subsequent generations (*i.e.,* how large β could be)? Two factors determine the bank's profits β: the agent's gains from the stand-alone risk-sharing scheme and the monopoly power a FI has in the deposit market. Define B^* such that the following equation holds.

$$.5\ln(c_{2L}^M + T^*) + .5\ln(c_{2H}^M - T^* - B^*) = .5\ln c_{2H}^M + .5\ln c_{2L}^M. \tag{13}$$

Then B^* indicates the benefit an old agent could obtain through the deposit contract. Note that the benefit B^* is measured in terms of quantities of the consumption good. A FI could retain some of resources when the shock is high ($y = y_H = 1$) as its profits. Once the bank takes away more than B^*, the old agent has no incentive to go back to the bank after the trade of risky asset. Let δ denote the portion of B^* a FI could retain and be used as an indicator of the monopoly power of a FI. The profit a FI obtains is $\beta = \delta B^*$. Notice that δ is exogenous in this model. It could be exogenously determined by financial regulation.

Given δ, a FI chooses ϕ to maximize the representative agent's expected utility subject to participation conditions for agents and banks. More specifically, the bank solves the following optimization problem:

$$\max_{\phi} \quad 1.5\ln\phi + .5\ln(c_{2H}^M - T^* - \delta B^*)$$

$$\text{s.t.} \quad 1.5\ln\phi + .5\ln(c_{2H}^M - T^* - \delta B^*) \geq \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M \tag{14}$$

$$.5\ln(c_{2L}^M + T^*) + .5\ln(c_{2H}^M - T^* - \delta B^*) \geq .5\ln c_{2H}^M + .5\ln c_{2L}^M \tag{15}$$

$$\delta B^* \geq \alpha_{1L} + \alpha_{1H} + \alpha_{2L}. \tag{16}$$

Recall that the goal of FI is to smooth consumption such that $c_{1H}^F = c_{1L}^F = c_{2L}^F = \phi$. The FI chooses ϕ to maximize the expected utility when such a consumption-smoothing

[1] When the realized shock is high ($y_H = 1$), the FI's profit is $\beta - \alpha_{1H}$. When the realized shock is low ($y_L = 0$), the FI's profit is $-\alpha_{1L} - \alpha_{2L}$. With equal probabilities, the expected profit is $0.5(\beta - \alpha_{1H} - \alpha_{1L} - \alpha_{2L})$. Thus the participation condition for FI is $\beta \geq \alpha_{1L} + \alpha_{1H} + \alpha_{2L}$.

contract works. Thus the expected utility has 1.5 as the coefficient of $\ln\phi$. Constraints of (14), (15), and (16) are participation conditions for the young, the old, and the bank. Notice that $(c_1^M, c_{2H}^M, c_{2L}^M)$ and T^* are known from section 3 and subsection 4.1 respectively. From (13) we calculate $B^* = 0.16$.

The constraints of non-negative α in (8) which impose some conditions on ϕ need to be considered as well. When the accumulated profits is sufficiently large, $c_{1H}^F = c_{1L}^F = c_{2L}^F = \phi$, the non-negativity of α in (8) requires

$$\begin{aligned}\alpha_{1H} &= \max\{0, \phi - (c_1^M + T^*)\}, \\ \alpha_{1L} &= \max\{0, \phi - (c_1^M - T^*)\}, \\ \alpha_{2L} &= \max\{0, \phi - (c_{2L}^M + T^*)\}.\end{aligned} \tag{17}$$

There are two interesting cases: (a) $\phi > c_1^M + T^*$ and (b) $c_1^M - T^* \le \phi < c_1^M + T^*$. Case (a) contradicts to the bank's participation condition. Recall that $c_1^M = c_{2L}^M$, the bank participation condition requires $\beta > \alpha_{1H} + \alpha_{1L} + \alpha_{2L} = 3\phi - 2c_1^M - c_{2L}^M - T^*$, which implies $\phi < (\beta + 3c_1^M + T^*)/3$. However the value of $(\beta + 3c_1^M + T^*)/3$ is less than $c_1^M + T^*$, contradicting $\phi > c_1^M + T^*$. Case (b) is consistent with the bank participation condition. Hence we only consider case (b), and from (17) we know that the state contingent payment of the deposit contract takes the form of

Contract I (18)

$$\begin{aligned}c_{1H}^F &= c_1^M + T^*, \\ c_{1L}^F &= c_1^M - T^* + \alpha_{1L}, \quad \alpha_{1L} = \min\{\phi - (c_1^M - T^*),\ \pi_{t-1}^{young,t}\}, \\ c_{2H}^F &= c_{2H}^M - T^* - \beta, \\ c_{2L}^F &= c_{2L}^M + T^*,\end{aligned}$$

where $\pi_{t-1}^{young,t}$ equals the total accumulated profits π_{t-1}. The function of intertemporal smoothing (*i.e.,* $c_{1H}^F = c_{1L}^F = c_{2L}^F = \phi$) is restricted, and the fully smoothing policy *a lá* Allen and Gale (1997) is not implementable due to the failure of the participation conditions of agents and FI.

4.3 An intertemporal smoothing scheme

According to the payment scheme considered in (18), now similar to the procedure in the subsection 4.2, the bank chooses ϕ to solve the following maximization problem:

$$\max_{\phi} \quad .5\ln\phi + .5\ln(c_1^M + T^*) + .5\ln(c_{2H}^M - T^* - \delta B^*) + .5\ln(c_{2L}^M + T^*)$$

$$\text{s.t.} \quad .5\ln\phi + .5\ln(c_1^M + T^*) + .5\ln(c_{2H}^M - T^* - \delta B^*) + .5\ln(c_{2L}^M + T^*) \tag{19}$$
$$\geq \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M$$

$$.5\ln(c_{2L}^M + T^*) + .5\ln(c_{2H}^M - T^* - \delta B^*) \geq .5\ln c_{2H}^M + .5\ln c_{2L}^M \tag{20}$$

$$\delta B^* \geq \alpha_{1L}. \tag{21}$$

In order to satisfy the incentive constraints for agents, a lower bound ($\underline{\phi}(\delta)$) and an upper bound ($\overline{\phi}(\delta)$) of ϕ can be found from (19) and (20) respectively. Both depend on the value of δ. It is easy to check that "$\underline{\phi}(\delta) \leq \overline{\phi}(\delta)$" holds for any value of δ in the parameters of (2) . Given δ and $\beta = \delta B^*$, the solution of the optimization is the upper bound of ϕ since the objective function is increasing in ϕ. Hence, the optimal ϕ equals $\phi(\delta) = \delta B^* + (c_1^M - T^*)$ which is obtained by the equality of (21).

For a given δ, define the lower bound of α_{1L}, $\underline{\alpha}_1$, when the bank's profit is δB^*. That is $\underline{\alpha}_1$ is such that the participation condition for the young agent is binding, *i.e.,*

$$.5\ln(c_1^M + T^*) + .5\ln(c_1^M - T^* + \underline{\alpha}_1) + .5\ln(c_{2H}^M - T^* - \delta B^*) + .5\ln(c_{2L}^M + T^*)$$
$$= \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M,$$

As one can easily find, δ is positively related to $\underline{\alpha}_1$.

When $\pi_{t-1} < \underline{\alpha}_1$, the accumulated profit is not enough to induce the young agent to come to the intermediation when the bank extracts δB^* as its profits, the deposit contract would not commit any payment additional to T^* to the young depositor when the realized shock $y_L = 0$. In this situation, the bank could not grasp δB^* as its profits. Otherwise the participation condition for the young agent is violated, and

$$.5\ln(c_1^M + T^*) + .5\ln(c_1^M - T^*) + .5\ln(c_{2H}^M - T^* - \delta B^*) + .5\ln(c_{2L}^M + T^*)$$
$$< \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M,$$

by the definition of B^* (see (13)). The most a FI could attain as its profit (denoted by

B_{sars}) is determined by the following equation: B_{sars} is defined by

$$.5\ln(c_1^M + T^*) + .5\ln(c_1^M - T^*) + .5\ln(c_{2H}^M - T^* - \delta B_{\text{sars}}) + .5\ln(c_{2L}^M + T^*) \\ = \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M.$$

The bank would provide the stand-alone risk-sharing contract to two consecutive generations and charge $\beta\text{sars} = \delta B_{\text{sars}}$ if banks accumulated profits is not enough ro provide this profit-nurtured consumption-smoothing *i.e.,* $\pi_{t-1} < \underline{\alpha}_1$.

Then the profit-nurtured consumption scheme can be described as

Contract II (22)

When $\pi_{t-1} > \underline{\alpha}_1$:

$$\begin{aligned} c_{1H}^F &= c_1^M + T^*, \\ c_{1L}^F &= c_1^M - T^* + \alpha_{1L}, \quad \alpha_{1L} = \min\{\phi - (c_1^M - T^*),\ \pi_{t-1}^{young,t}\}, \\ c_{2H}^F &= c_{2H}^M - T^* - \delta B^*, \text{ when } \pi_{t-2} > \underline{\alpha}_1 \\ c_{2H}^F &= c_{2H}^M - T^* - \beta\text{sars}, \text{ when } \pi_{t-2} < \underline{\alpha}_1 \\ c_{2L}^F &= c_{2L}^M + T^*; \end{aligned}$$

When $\pi_{t-1} < \underline{\alpha}_1$:

$$\begin{aligned} c_{1H}^F &= c_1^M + T^*, \\ c_{1L}^F &= c_1^M - T^*, \\ c_{2H}^F &= c_{2H}^M - T^* - \delta B^*, \text{ when } \pi_{t-2} > \underline{\alpha}_1 \\ c_{2H}^F &= c_{2H}^M - T^* - \beta\text{sars}, \text{ when } \pi_{t-2} < \underline{\alpha}_1 \\ c_{2L}^F &= c_{2L}^M + T^*. \end{aligned}$$

The FI can provide the stand-alone risk-sharing and charge βsars if the realized shock is y_L when agents are old. In the process of profits accumulation, the FI would, moreover, provide the intertemporal smoothing (*i.e.,* $\alpha_{1L} > 0$) if the buffer is large enough (*i.e.,* $\pi_{t-1} > \underline{\alpha}_1$). The agents obtain $\alpha_{1L} > 0$ if $y_t = y_L$ and would be charged δB^* if $y_{t+1} = y_H$. Both stand-alone risk-sharing and intertemporal smoothing schemes are Pareto superior to the market equilibrium.

4.4 A complete insurance against old-age consumption

In the previous subsection we discuss the FI could nurture a function of intertemporal risk-sharing through its profit-driven motivation. In this subsection, we illustrate another form of risk-sharing – a complete insurance against old-age consumption.

Consider that a FI proposes a deposit contract which provides a complete insurance against old-age consumption, *i.e.,* $c^F_{2H} = c^F_{2L}$. At date t, after market trades of risky assets and before the production shock being realized, the FI offers the deposit contract which asks

- the young agent deposits his remaining endowment $(1 - p_t x_t)$, and
- the old agent deposits his claim against today's consumption good (including claims against dividends and the revenue from selling the risky assets).

The deposit contract promises depositors the following state-contingent payment:

- the initial old receives $c^F_{2H} = c^M_{2H} - T^* - \beta^{\text{III}}$ when $y = y_H = 1$, and $c^F_{2L} = c^M_{2L} + T^* - \beta^{\text{III}}$ when $y = y_L = 0$,
- when $y = y_H = 1$, the young agent of subsequent generations receives $c^F_{1H} = c^M_1 + T^*$ and the old agent receives $c^F_{2H} = c^M_{2H} - T^* - \beta^{\text{III}}$, and
- when $y = y_L = 0$, the young agent of subsequent generation receives $c^F_{1L} = c^M_1 - T^*$ and the old agent receives $c^F_{2L} = c^M_{2L} + T^* + \alpha^{\text{III}}_{2L} - \beta^{\text{III}}$, and $\alpha^{\text{III}}_{2L} = \min\{\phi^{\text{III}}, \pi_{t-1}\} \geq 0$,

where ϕ^{III} is equal to $c^M_{2H} - c^M_{2L} - 2T^*$ such that a complete insurance (*i.e.,* $c^F_{2H} = c^F_{2L}$) is provided when the accumulated profits (π_{t-1}) is sufficiently great. The bank's profit β^{III} is determined by the exogenous monopoly power δ and the potential profits B^{III} which is determined by

$$\begin{aligned}\{.5\ln(c^M_1 + T^*) + .5\ln(c^M_1 - T^*)\} + \{.5\ln(c^M_{2H} - T^* - B^{\text{III}})& \\ + .5\ln(c^M_{2L} + T^* + \phi^{\text{III}} - B^{\text{III}})\} = \ln c^M_1 + .5\ln c^M_{2L} + .5\ln c^M_{2H},&\end{aligned} \tag{23}$$

and $\beta^{\text{III}} = \delta B^{\text{III}}$. The payment scheme of the deposit contract must satisfy the following participation conditions:

$$\begin{aligned}\{.5\ln(c^M_1 + T^*) + .5\ln(c^M_1 - T^*)\} + \{.5\ln(c^M_{2H} - T^* - \beta^{\text{III}})& \\ + .5\ln(c^M_{2L} + T^* + \alpha^{\text{III}}_{2L} - \beta^{\text{III}})\} \geq \ln c^M_1 + .5\ln c^M_{2H} + .5\ln c^M_{2L},&\end{aligned} \tag{24}$$

$$\beta^{\text{III}} \geq .5\alpha_{2L}^{\text{III}}. \tag{25}$$

(24) and (25) are participation conditions for the agents and the FI respectively. Similar to the analysis in subsection 4.3, $\underline{\alpha}_2$ is defined such that the following condition holds.

$$.5\ln(c_1^M + T^*) + .5\ln(c_1^M - T^*) + .5\ln(c_{2H}^M - T^* - \beta^{\text{III}}) + .5\ln(c_{2L}^M + T^* + \underline{\alpha}_2 - \beta^{\text{III}})$$
$$= \ln c_1^M + .5\ln c_{2H}^M + .5\ln c_{2L}^M.$$

If the buffer is not large enough to provide the complete insurance (*i.e.*, $\pi_{t-1} < \alpha_{2L}$), the bank would propose the stand-alone risk-sharing and charge βsars. The state contingent payments of the complete insurance against old-age consumption is summarized as follows:

Contract III (26)

When $\pi_{t-1} > \underline{\alpha}_2$:

$$c_{1H}^F = c_1^M + T^*,$$
$$c_{1L}^F = c_1^M - T^*,$$
$$c_{2H}^F = c_{2H}^M - T^* - \beta^{\text{III}},$$
$$c_{2L}^F = c_{2L}^M + T^* + \alpha_{2L}^{\text{III}} - \beta^{\text{III}}, \quad \alpha_{2L} = \min\{\phi^{\text{III}}, \ \pi_{t-1}\};$$

When $\pi_{t-1} < \underline{\alpha}_2$:

$$c_{1H}^F = c_1^M + T^*,$$
$$c_{1L}^F = c_1^M - T^*,$$
$$c_{2H}^F = c_{2H}^M - T^* - \beta\text{sars},$$
$$c_{2L}^F = c_{2L}^M + T^*.$$

Notice that the rationale for the appearance of βsars is the same in Contract II. Since $\phi^{\text{III}} = c_{2H}^M - c_{2L}^M - 2T^*$ is known and irrelevant to δ, and $\beta^{\text{III}} = \delta B^{\text{III}}$ is determined by a given δ, from the constraint (25) we find out the lower bound of δ, denoted by $\underline{\delta}$, for the participation of FI. That is the monopoly power (δ) needs to exceed $\underline{\delta}$ for a bank to provide contract III.

4.5 Simulation results and policy implications

We generate a sequence of aggregate shocks, y_t, and simulate the dynamic economy with financial market and intermediaries for the parameter values in (2). Let the pseudo-

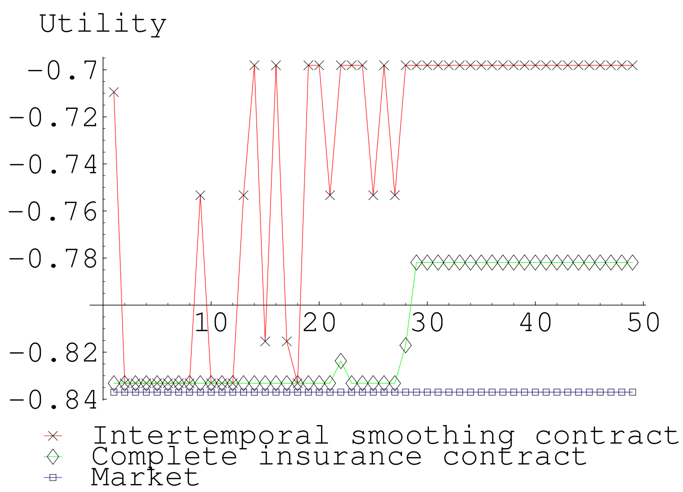

Figure 1. The expected utilities of participating in financial market and intermediaries.

random number (y_t) follow the discrete uniform distribution.[2] Figure 1 shows given $\delta = 0.9$ the levels of expected utility in three scenarios: participating the market only, entering into the intertemporal smoothing deposit contract, and entering into the complete-insurance deposit contract. The agent of subsequent generations is better off with the intertemporal smoothing contract than with the complete insurance contract.

Figure 2 shows the levels of actual utility. Given $\delta = 0.9$, the intermediaries in the steady state provide a fixed level of consumption ϕ by accumulating profits (*i.e.,* storing buffer); the mean and variance of agent's expected utility is $(-0.747228, 0.173331)$ and $(-0.832303, 0.131435)$. Figure 2 indicates the aggregate shocks are mitigated when the FI presents. Moreover, the intertemporal smoothing contract performs better than the complete insurance contract.

However, the accumulated profits of intermediaries till the last period is 0.952771 from the intertemporal smoothing contract and 3.64494 from the complete insurance contract. It is obvious that intermediaries would implement the the complete insurance contract for maximizing the long-run profits rather than the intertemporal smoothing contract. Therefor, the government should regulate proper monopoly power for different deposit contracts so that intermediaries voluntarily offer the Pareto superior de-

[2] 12905 is the seed chosen arbitrarily for the pseudo-random generator.

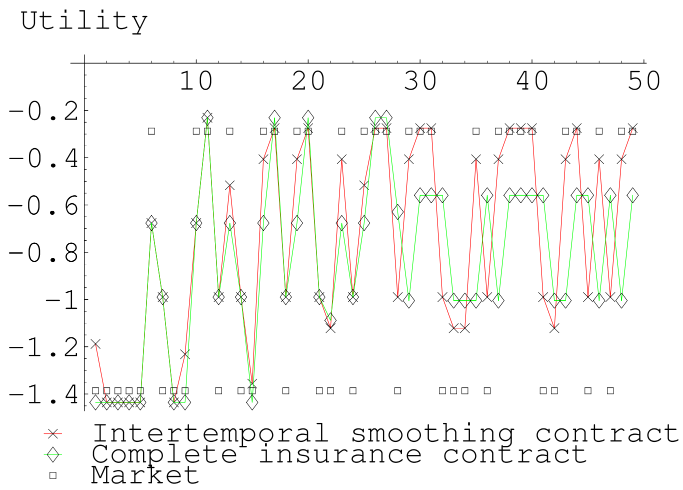

Figure 2. The actual utilities of participating in financial market and intermediaries.

posit contract. For the numerical results in our paper, intermediaries would propose the contract smoothing consumption for old age if the monopoly power is restricted to $\delta \geq 0.77647$ by the government.

In the following we compare our simulation results to Allen-Gale results. The expected utility from the centralized intertemporal smoothing scheme in Allen-Gale's paper is -0.575364. The expected utility from the centralize intermediation without intertemporal smoothing is -0.693147. In our model when $\delta > 0.958698$, the expected utility level from the intertemporal smoothing scheme exceeds -0.693147. That is when the monopoly power is sufficiently large, the decentralized smoothing scheme is Pareto superior to the centralized intermediation without smoothing.

When $\delta = 0.9$, the simulation results for 49 generations is reported in the three figures and the average expected utility levels and bank's profits are summarized as

$\delta = .9$	Expected utility	Accumulated Profits
Intertemporal Smoothing	-0.739072	0.952771
Complete Insurance	-0.810694	3.64494

From the expected utility levels and the profits gained by intermediaries under different decentralized schemes, we know that an appropriate monopoly power is required to in-

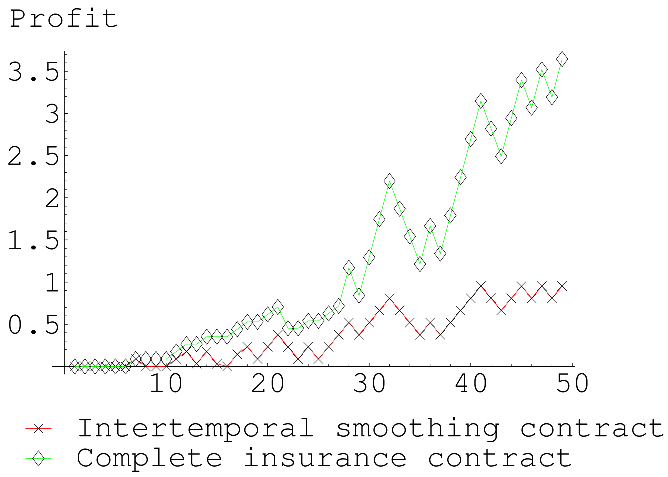

Figure 3. The accumulated profits of financial intermediaries.

duce the FI to choose the intertemporal smoothing scheme over the complete insurance scheme. Some facts about the expected utility and δ are summarized as follows:

	EU_{is}	EU_{ci}
	increasing in δ	decreasing in δ
$\delta = .77647$		-.71773
$\delta = .68466$	-.71773	

Profits from the intertemporal smoothing contract are always greater than from the complete insurance contract. A FI will not choose the complete insurance contract when $\delta < .77647$. Thus when $\delta \in (.68488, .77647)$, a FI chooses the intertemporal smoothing contract and the expected utility level is greater than the best level the complete insurance contract could generate (-.71773 when $\delta = .77674$).

5 Conclusion

In an overlapping generation framework, we examine how the profit-driven financial intermediary plays its role in consumption-smoothing. We suggest the financial intermediaries cooperate with financial market in consumption-smoothing and the government certainly has a role in regulating the banking industry.

In the decentralized economy, each bank maximizes the expected profits and each agent maximizes his lifetime expected utility. Hence, the price the FI charges an agent for the deposit contract is required to satisfy the self-interest objectives and participation conditions even if the buffer held by FI is very low. This price is a portion of depositor's benefits from the deposit contract and it is the origin of FI's profit accumulation which nurtures the consumption-smoothing scheme. By contrast, the saving policy of Allen and Gale (1997) is based on the long-lived agent's maximization of the expected long-run average utility, and it is not sufficient to ensure the maximization of the two-period lived agent's expected utility especially for the case of low buffer. The higher the degree of consumption smoothing, the higher the price required by FI. Also, the higher price would be much easier to induce the old agents not to deposit after market trade. Therefore, the function of consumption smoothing, which is provided by the profit-driven FI, is restricted and the fully smoothing policy *a lá* Allen and Gale (1997) is not attainable.

We further discuss the policy implication of our model. It is necessary to confer an appropriate level of monopoly power which both induce FI to provide consumption-smoothing deposit contract and encourage agents to deposit in FI. But if the monopoly power is large enough to induce FI to offer feasible deposit contracts arbitrarily, FI would provide the deposit contract for the purpose of profit-maximization instead of utility-maximization. Once the interest conflicts arise, the government should reexamine the policy objective and set an adequate monopoly power for FI. This paper provides a concrete view of the market power required to ensure consumption-smoothing scheme.

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