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Some Aspects of Banks and Financial Markets in Emerging Economies

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Contents

List of Tables

Chapter 1

Introduction

Liquidity and Bank Runs

The policy of deposit insurance in the banking sector has succeeded in preventing bank runs but it has encouraged moral hazard (Kane, 1985 and 1989). This has increased the cost of capital. So the government and/or the central bank need to regulate (Flannery, 1982). In chapter 2, we ask the question - Is there an alternative to deposit insurance? What is the role of equity capital in this context? Is full insurance optimal?

The seminal paper on bank runs by Diamond and Dybvig (1983) argues that a lack of deposit insurance leads to multiple Nash equilibria, including a *panic run* as an equilibrium. In chapter 2, we use a general equilibrium model with both risk averse and risk neutral agents. Each group has some endowment. Within each group, there are two types of agents - type 1 need to consume in the short term and type 2 need to consume in the long term.

But agents do not know their type at the time they invest. We allow banks to sell equity as well as deposits.

We show that risk averse agents invest in deposits and the risk neutral agents invest in equity. Since the latter is irredeemable and depositors are senior claimants, there exists an amount of equity capital that is sufficient to ensure a run-free outcome as a Nash equilibrium. This allows risk averse depositors to be completely insured, even in the absence of deposit insurance. If the amount of risk neutral equity capital is smaller, then also runs can be avoided but with less than full insurance for depositors.

Diamond and Dybvig (1983) examined the role of a liquidity shock in the context of the problem of bank runs. In chapter 3, we look at the role of a liquidity shock in the context of the asset markets. In particular, we analyze liquidity shocks and 'the lemon problem'.

Liquidity and the 'Lemon' Problem

We construct a model in which an agent can invest either in her own project or in others' projects, through a mutual fund. We term the former *real asset* and the latter is called *financial asset.* A real asset has two disadvantages. First, an agent can invest in *one* real asset which has a stochastic return. On the other hand, the return on financial asset is non-stochastic since it can be fully diversified. Second, in the case of a real asset, the owner has private information on the quality of the asset. This creates a problem for owners of real assets. Should an agent try to sell her real asset, the buyer is not sure whether it is being sold because it is a *lemon*, or because the seller has liquidity needs. On the other hand, in the case of financial assets, we assume that there is strict separation of ownership and information. The prospective buyer knows that the owner has no special information. Thus while the market for real assets is characterized by asymmetric information, financial assets are traded under symmetric information. Why, then, do risk averse agents invest in real assets? Why not invest in financial assets only?

An efficient financial market will transfer a greater proportion of the firm value to its shareholders. In developing or emerging economies, the institutions governing capital markets and corporate governance are under-developed (La Porta et. al., 1998). So the net return to the shareholders is low. So our analysis suggests that weak regulation of financial markets could account for the investment in real assets. In particular, the regulation may be weak enough so that all investment goes into real assets.

Liquidity Crunch

In chapter 3, we consider *liquidity shock* on the demand side. To solve the liquidity problem, assets are sold in secondary markets. But the latter often witness a situation of inadequate liquidity on the supply side. In chapter 4, we generalize the model in chapter 3 to allow for *liquidity crunch*. There are two states of the world. One is 'no liquidity crunch' and the other is 'liquidity crunch'. In the latter state, we allow for parametric variation of the degree of liquidity crunch.

The text book treatment is that the secondary market price of an asset is equal to its discounted (expected) present value. But this is not always true. Liquidity in the secondary market plays a role in the pricing of assets (Lucas, 1990). What is the role of market integration in determining the relative prices of assets in the secondary markets under liquidity crunch? Under what condition(s) are real assets demanded, in the more general case in which we allow for liquidity crunch? How does a change in the degree of liquidity crunch affect the optimum portfolio? We examine these questions in chapter 4.

Partially Segmented Markets

In emerging economies, the asset markets are not well integrated with each other. There is 'limited participation' by the providers of liquidity in each market. This is lack of *integration of markets on the demand side.* Another aspect of emerging economies is that, liquidity is a more serious problem in the financial asset market than in the real asset market. For example, there is evidence that, in emerging economies, there is large amount of 'black money' (Johnson et. al., 1997). This can be invested more easily in real assets than in financial assets (Jha, 1999). So there is usually more than adequate liquidity in the real asset market at the same time that there is a liquidity crunch in the financial asset market. In chapter 5, we assume that markets are segmented on the demand side alone. The sellers of assets can operate in either market[1]. Under these circumstances, is there a trading

[1] In chapter 6, we study the case of completely segmented markets.

opportunity for those agents who possess neither a *lemon* nor do they face a liquidity shock? Can they profitably sell their real assets and buy financial assets in the secondary markets, even if they do not have a *lemon*? If yes, then is this always the case or are there multiple equilibria? We examine these questions in chapter 5.

Completely Segmented Markets

Integration of markets on the supply side is the case when the sellers of assets can operate in either market. But this may not always be possible. Think of real estate as an example of real asset. In India, there is substantial involvement of 'black money' in the real estate market (Jha, 1999). The sellers of real estate may have to accept the black money otherwise, they forego the opportunity to sell. There may now be difficulty for the sellers of real estate in using the black money in the financial asset market. So the money obtained in selling the real estate can be used to buy real estate only! This does not seem to make sense. But what if agents have asymmetric information? In our model, the quality of the real asset and the liquidity needs of agents are private information. So this gives those agents who do not face a liquidity shock, an opportunity to get rid of their bad real asset and buy another real asset which *may* be good. So in this scenario, it makes sense to sell a real asset and buy another real asset.

In chapter 6, we take the basic model as in chapter 3, and further
(a) assume that markets are completely segmented,

(b) use mean variance analysis, and

(c) assume that the liquidity crunch is more severe in the financial asset market than in the real asset market.

Under what conditions are real assets demanded when markets are completely segmented? We study this in chapter 6.

The thesis plan

In this thesis, throughout, we build theoretical models. The plan of the thesis is as follows. In chapter 2, we study liquidity and bank runs. In chapter 3, we construct a model to analyze liquidity and the 'lemon' problem and discuss the benchmark case of no liquidity crunch and integrated markets. In chapters 4, 5 and 6 we extend the basic model in chapter 3. In chapter 4, we allow for liquidity crunch in integrated markets. In chapter 5, we allow for liquidity crunch in the financial asset market, and partially segmented markets. In chapter 6, we study completely segmented markets. In chapter 7, we conclude with some policy implications.

Chapter 2

Liquidity, Bank Runs and Capital Adequacy

2.1 Introduction

Demand deposits can be vulnerable to bank runs. To prevent bank runs, typically government provides deposit insurance. This policy is successful in preventing bank runs but it encourages moral hazard (Kane, 1985 and 1989). So government has to supervise and regulate (Flannery, 1982). But this leads to other distortions. So it is important to look for a way out. One way is to re-examine the basic question viz. is it necessary for government to provide deposit insurance? Is there an alternative to deposit insurance? Can equity capital play a role in the context of liquidity and demand deposits? Is full insurance optimal? We address these questions in this chapter.

Diamond and Dybvig (1983) forms the theoretical foundation used by policy makers to argue for government sponsored deposit insurance schemes. According to the Diamond-Dybvig paper, a lack of deposit insurance can lead to a panic run [1]. In this chapter, we show that such panic runs can be avoided even in the absence of deposit insurance. We allow banks to sell equity as well as deposits. The presence of equity effectively solves the bank-run problem. In this chapter, we examine the role of equity in a bank in providing assurance and show that if there is 'adequate capital', the outcome is ex-ante efficient *and* run-proof. If capital is inadequate, then also panic runs can be avoided but the outcome is a constrained optimum, where the outcome depends on the equity in the bank.

Our model highlights the importance of adequate capital, as a market outcome, in preventing bank runs. Sharpe (1978) also develops a notion of 'adequate capital' but the motivation in defining adequate capital in that paper is to ensure that the value of the deposit insurer's liability is no larger than the insurance premium. Moreover, the model does not involve liquidity as a key factor; the emphasis is on stochastic return on bank investments. Similarly, in Flannery (1989), the notion of adequate capital is discussed in the context of a model with stochastic return on bank's investment. There is no discussion of capital's role in ensuring that depositors do not panic. Again, Buser, Chen and Kane (1981) have analyzed capital adequacy as a

[1] After the seminal paper by Diamond and Dybvig (1983) which analyzed *panic runs* only, the literature on bank runs became richer with analysis of *information-based* bank runs (e.g. Jacklin and Bhattacharya, 1988). This literature assumed a stochastic return on bank's investments. In this chapter, we focus on panic runs.

means to reduce the costs of subsidized deposit insurance schemes without arguing that with adequate capital, deposit insurance is unnecessary[2].

In section 2.2, we briefly review the literature on bank runs. In section 2.3, we set out the model. In section 2.4, we study the working of the model. We have two cases viz. the case of adequate capital and the case of inadequate capital. Section 2.5 deals with the first case. In section 2.6, we consider a situation where there is not enough risk neutral capital to guarantee complete insurance to risk averse agents. In section 2.7, we conclude.

2.2 A Critical Review

To begin with, let us look at the essence of the bank run problem as in the seminal paper in this area viz. Diamond and Dybvig (1983), hereafter referred to as DD model. There are three periods (0, 1 and 2). Consider a project which has a certain return R in period 2 per unit of investment in period 0, where $R > 1$. The return in period 1 is 1 unit for one unit investment in period 0. Agents do not know when they will need funds. So there is uncertainty in return on investment. Agents are risk averse. They would prefer a smaller spread in return. Only a fraction of agents (t) needs funds in the short term i.e. in period 1. They are called type 1. The remaining $1 - t$ proportion of agents need to consume in period 2 (type 2).

[2]One limitation of our analysis is that we take a certain return on bank investments. A more general model could, perhaps, incorporate adequate capital to take care of stochastic return on investment as well as a stochastic proportion of agents hit by a liquidity shock.

Insurance is, however, not available because information on liquidity needs is asymmetric and non-verifiable[3]. Suppose we have competitive banking. Typically, a representative bank will allow deposit rates such that the short term rate is lower than the long term rate. The insurance aspect is captured by the fact that the short term return is lower than the short term rate on deposits, lower than the long term return on deposits, which, in turn, is lower than the return from the long term technology. However, there are multiple Nash equilibria, with one of them that of a panic run. This leads to pre-mature liquidation and economic loss. By providing insurance to depositors, a bank makes itself vulnerable to a run.

Consider next the case of deposit insurance. If government insures deposits, then a panic can be prevented. How? Tax is imposed on early withdrawals and the collection is ploughed back into the bank. Those depositors who do not need to consume in the short term now have an incentive to wait and withdraw in the long term only. Hence, taxation and deposit insurance prevents a run on the bank.

[3]DD argues that since information on liquidity needs is private, market fails to provide insurance. But observe that a liquidity shock can take various forms. Examples are sudden accident, illness, a death in the family, a loss of job, etc. Observe that in practice, we do have insurance for many of these calamities. It is not a blanket insurance for any eventuality but there is separate insurance in many cases. Moreover, at least in the case of developed economies, there is little lag between the eventuality and the compensation from insurance company. The other institutional reality, at least in the developed countries, is the widespread use of *credit* cards. So the insurance market failure is perhaps exaggerated. In this thesis, however, we do not pursue this issue any further.

'As the government can impose a tax on an agent *after* he or she has withdrawn, the government can base its tax on f. the realized total value of T=1 withdrawals. This is in marked contrast to a bank, which must provide sequential service and cannot reduce the amount of a withdrawal after it has been made. This asymmetry allows a potential benefit from government intervention.' (Diamond and Dybvig, 1983; p. 414)

But let us look at the issue more closely.

Role of the government within the framework of DD model[4]

There are two interpretations to tha above passage:

(1) When type 1 depositors withdraw, in period 1, the full amount due to them, then the banks liquidate an amount that is equal to the gross amount that is due to type 1 depositors. After the total value of withdrawals is realized, then the government imposes a tax and collects the same from the type 1 depositors.

(2) All type 1 depositors give their bank a notice for withdrawal in period 1. After the total value of withdrawals is known, the government announces the tax scheme. Type 1 depositors withdraw the *net* amount. The difference

[4]This section was written by this author before he came across the papers by McCulloch and Yu (1998) and Wallace (1988) who have a similar criticism to the deposit insurance scheme envisaged by DD. It is included here for completion but no credit is claimed. The credit goes to McCulloch and Yu (1998) and Wallace (1998).

between the amount that was due and the amount that is withdrawn i.e. the tax is left with the bank. The tax amount is simply transferred from the accounts of type 1 depositors to those of type 2 depositors (who get a subsidy). Observe that banks liquidate only the net amount.

What is the difference between the two interpretations? In the first case, government is paid after investment has been liquidated. When government pays the collected taxes to the deposits of type 2 depositors, these additional amounts are *fresh* investments in period 1. Given the technology specification. in period 2, these additional investments do not yield the long-term rate of return R in period 2. Next consider the second interpretation. In this case, the tax amount is transferred to the accounts of type 2 depositors as a book entry, without the underlying project being liquidated to cover the tax amount. So this tax amount will yield a return of R in period 2.

Clearly, Diamond and Dybvig have the second case in mind since the aim is to realize the long-term rate of return. But note that in the second case, the sequential service constraint is not observed.

If the sequential service constraint is dispensed with, then do we really need to fall back on tax-subsidy scheme? Is there an alternative to the government intervention to ensure optimal outcome? In what follows. we consider a *contract* between depositors and the bank that works basically in the same way as the tax subsidy scheme.

Consider a contract between depositors and banks that states ex-ante that type 1 depositor will give a notice of withdrawal in period 1. Based on the notices, the bank can retain from the amount due to those who withdraw in period 1 and transfer the same as a book entry to the amount of those who do not withdraw in period 1. This is equivalent to a tax in Diamond and Dybvig model and achieves the same objective. It is true that banks do not have the power to enforce this but note that no matter what contract there is between any two parties, ex-post fulfillment of the conditions on the part of either party requires the threat of the coercive power of the government to enforce. So what is the role of the government? It is simply to enforce contracts - in this particular case, government needs to enforce the contract that stipulates that if the proportion of agents who wish to withdraw early is large, then the bank will retain from the amount payable to depositors who withdraw early and transfer it to the remaining depositors.

The unique feature of the government is that it has coercive powers, which are necessary to enforce contracts between agents. This is the traditional role of the government and this is all that is required even within the Diamond and Dybvig model[5].

Fixed versus Variable Returns on Demand Deposits

The essential disagreement between DD and the critics[6] relates to the types of contracts that investors and institutions can get into. Jacklin (1993) ar-

[5]In DD model, depositors invest their endowment with the bank which promises a return and actually pays it out (unless there are no funds left). Why? Because it is *assumed* that contracts are enforced. So the assumption of contract enforcement is already there in DD model. It just needs to be applied consistently.

[6]See Bhattacharya and Thakor (1994) for a survey of the banking literature.

gues that, the outcome of the deposit insurance scheme can be mimicked by a firm selling shares, when shares are tradable in the short term [7]. The theoretical literature has a number of papers analyzing the role of government regulation in the banking sector. In particular, they argue that allowing for contracting among the depositors and the bank, can solve most of the problems without any explicit need for the government to step in. Alonso (1996) and Cooper, Russel and Thomas (1998) have banks with depositors who accept, under some conditions, a positive probability of (information based) bank runs, as an equilibrium outcome. Nicolo (1996), much like McCulloch and Yu (1998) and Jacklin (1993), have state contingent deposit claims, where the banks infer about the state from the type of withdrawals made by the depositors in the short run. In our model, depositors are assured of withdrawal amounts independent of the actual states. The credibility of the assurance comes from the presence of bank equity, and does not need any government involvement.

The DD model tries to ensure for the depositors an outcome as close as possible to the insurance market equilibrium. In insurance schemes, as distinct from risk sharing, agents who are *more* risk averse transfer a part, or all, of their risk to those who are *less* risk averse. In the DD model, all agents have identical risk aversion, and it is not clear who insures whom. In our model, by explicitly introducing agents with two different attitudes to risk, we reformulate the analysis as a true insurance problem.

[7] In response to Jacklin (1987) paper, Villamil (1991) examines the demand deposit/demand equity indeterminacy problem.

There are two important features of bank deposits that allow us to treat them as an insurance mechanism. A bank offers deposit holders a promised return on their deposits and a guarantee that they will be able to withdraw on demand. In DD (and others like McCulloch and Yu (1998)), the bank, however, offers a contingent return to the depositors. Moreover, in all these exercises, the late withdrawers are residual earners, the actual amount that they get depending on what happens in the short run. In DD, as well as those of its critics, the method of preventing runs makes the return to depositors uncertain, in both the short and the long terms. However, being risk averse, it is in the interest of depositors to reduce the risk of future uncertain returns. In our bank this is avoided by the owners of the bank, its equity holders, being the residual earners. Bank equity plays two crucial roles. First, it makes the promise to late withdrawers credible, preventing them from running the bank. Second, it allows a part of the depositors' risk to be transferred to the risk neutral equity owners.

Disintermediation Possibility

Jacklin (1987) (and others like McCulloch and Yu (1998)) refer to a disintermediation possibility. This is a problem shared by the deposit insurance scheme as well as the contingent bonus scheme. Their solution is to assume that agents are forced to deposit their entire fund with the bank[8]. We con-

[8]In the next chapter, we construct a new model in which there is no restriction on investors. They can invest in real or financial assets. We examine, in the next chapter, the condition under which real assets are demanded.

tinue with this assumption in this chapter. However, we show that, given the credible promises on deposits, risk averse agents investing in deposits, and risk neutral agents investing in equity, is a Nash equilibrium outcome[9]. Going back to our observation about the enforcement of voluntary contracts, we will assume that contracts that are ex ante efficient, and voluntarily signed, will not be allowed by the government (or the legal institutions) to be breached.

2.3 The Model

Ours is a three period model, $0, 1, 2$. There is a continuum of agents in the interval $[0, 1]$. Agents are either risk averse, or risk neutral. θ proportion of people are risk averse, and $1 - \theta$ are risk neutral. Also, they are either of type 1, or type 2. Type 1 agents derive utility from consumption in period 1 only, and type 2 agents from consumption in period 2 only. In period 0, each agent faces a probability t of being type 1. An alternative interpretation is that t proportion of agents will be of type 1 and $1 - t$ proportion will be of type 2. We make the following assumption.

A.2.1: *$F(t)$ is uniform, on $[0, 1]$.*

The distribution of t is common knowledge in period 0. However, in period

[9]In Gorton and Pennacchi (1990) also, intermediaries issue equity and debt. But in their model, intermediaries attract *informed* agents to hold equity and *uninformed* agents to hold debt.

	Risk averse	Risk neutral	Total
Type 1	θt	$(1-\theta)t$	t
Type 2	$\theta(1-t)$	$(1-\theta)(1-t)$	$1-t$
Total	θ	1-θ	1

Table 2.1: Distribution of agents by risk aversion and by utility function

1, the type of an agent is known privately to the agent only. Table 2.1 describes the agent classification in period 1. Each risk averse agent has an endowment of 1 unit in period 0 and nothing in other periods. Each risk neutral agent has an endowment of K units in period 0 and nothing in any other period. The total endowment in the economy in period 0 is $\theta + (1-\theta)K$.

Let

$$\theta' \equiv \frac{1-\theta}{\theta} \tag{2.1}$$

For each unit of resource invested in period 0, the return is $R(>1)$ in period 2. Alternatively, the investment may be liquidated in period 1 in which case only 1 unit can be recovered. The technology is constant returns to scale and, the long term return is greater than the short term one. Also, pure storage is costless and does not yield any extra return. This technology is available to everyone. Also observe that, there is no uncertainty in the technology.

Let c_{ik} denote the consumption of a type i agent ($i = 1, 2$) in period k, $k = 1, 2$. Given our assumption on the consumption requirements of agents,

c_{12} or c_{21} are irrelevant. The superscript a will denote the risk averse agents, while n will denote the risk neutral ones in this chapter. The expected utility of a risk averse agent in period 0 is

$$EU^a = \int_0^1 [tu(c_{11}^a) + (1-t)\rho u(c_{22}^a)]dt \tag{2.2}$$

This follows from A.2.1. Given our assumption on the preferences of agents, it follows that we only need to consider c_{11}^a and c_{22}^a. ρ is the discount rate, $0 < \rho < 1$.

Similarly, for the risk neutral agent, under A.2.1, we have

$$EU^n = \int_0^1 [tc_{11}^n + (1-t)\rho c_{22}^n]dt \tag{2.3}$$

A.2.2: $\rho R > 1$.

A.2.2 guarantees that agents prefer to be type 2 or, the long term returns are sufficiently high. For risk averse agents, the issue is similar to the problem of insurance. Being type 2 is a "win" situation, while being type 1 is a "loss". However, since the information regarding types is private, an insurance market with risk averse agents only, will fail (Diamond and Dybvig, 1983). In our model, we will investigate how far this insurance market can be mimicked by the presence of risk neutral agents. The amount of risk neutral capital, measured by $(1-\theta)K$, will play a crucial role. It will also help us in defining what one means by the notion of capital adequacy in banks.

For getting explicit solutions we will use another assumption in this chapter.

A.2.3: $u^a = \gamma x^\gamma$, $\gamma < 0$.

If each agent invests on her own, then

$$EU^a = t^e u(1) + (1 - t^e)\rho u(R) \equiv \underline{U}^a \tag{2.4}$$

$$EU^n = [t^e.1 + (1 - t^e)\rho R]K \equiv \underline{U}^n \tag{2.5}$$

where t^e is the expectation of t. With A.2.1, $t^e = (1/2)$.

2.4 The Bank

A bank in our model is an institution that can sell shares and (demand) deposits. These are issued in period 0. Deposit claims in any period are senior to claims by the shareholders in that period. For each unit invested in deposits, an agent receives either r_1 in period 1 and zero in period 2, or zero in period 1 and r_2 in period 2. So $c^a_{11} = r_1$, and $c^a_{22} = r_2$. Shares are long term assets (irredeemable in period 1), while deposits can be liquidated in period 1 if the depositor so wishes. Banks, however, can offer dividends $v_1 \geq 0$ and $v_2 \geq 0$ to shareholders, in periods 1 and 2, respectively. We will carry out the analysis with one (aggregate, or representative) bank, which will make zero profits because of competitive pressures.

Suppose every agent buys the issue of the bank. Then the bank's proceeds from selling shares and deposits is the total endowment of the economy, $\theta + (1-\theta)K$. This the bank invests in the available technology. Since the technology offers a positive net return in period 2 only, in period 1, the liquid value of its investment is the same as what it received in period 0. This is also the value it can disburse in period 1. The bank's liabilities in period 1 are the demands made by the depositors in period 1 and, the amount of dividends committed to by the bank, for period 1 (v_1 per share).

While depositors can liquidate their holdings in period 1 if they so want (depending on their type), shareholders cannot. Thus type 1 shareholders will be left with an asset which will be redeemable only in period 2. The utility value to them from the ensuing consumption in period 2 is zero. Ideally, they would like to trade this asset with type 2 agents.

For the moment, assume that all risk averse agents buy deposits and all risk neutral agents buy equity. A bank run will occur in period 1 if type 2 depositors withdraw their deposits in period 1. They will do so if they are better off withdrawing in period 1, rather than wait for period 2. To prevent this from happening, first r_1 must be less than r_2. Second, type 2 depositors must be convinced that they will be paid their r_2 in period 2.

Suppose that, $r_1 < r_2$, and the type 2 depositors wait till period 2. The bank's resources at the end of period 1 are the amount left over after paying type 1 depositors and the committed dividend payments of period 1. If E is the total endowment of the economy, then this is equal to

$$E - r_1\theta t - v_1(1-\theta)K = \theta + (1-\theta)K - r_1\theta t - v_1(1-\theta)K$$

In period 2, given the technology, this will become

$$[E - r_1\theta t - v_1(1-\theta)K]R$$

For type 2 depositors to wait, it must be the case that,

$$r_2\theta(1-t) \leq [E - r_1\theta t - v_1(1-\theta)K]R$$

Thus, for all realizations of t, for which the following holds, type 2 depositors will not run the bank in period 1.

$$t \leq \frac{R(1+\theta' K) - v_1\theta' KR - r_2}{Rr_1 - r_2}, \quad Rr_1 - r_2 > 0. \tag{2.6}$$

In this model, the parameters are, K, R, θ', while the endogenous variables are r_1, r_2, v_1. Define $\underline{t}$ to be the value of t such that (2.6) holds with equality. Then, if we can ensure that the parametric configurations, coupled with the solution to the endogenous variables, are such that $\underline{t} \geq 1$, then for all realizations of t, it will pay the type 2 depositors not to run the bank in period 1.

2.5 Capital Adequacy

Suppose that type 2 depositors are confident that they will be paid in period 2 and, hence, do not run the bank in period 1. In other words, they believe that banks have full (unlimited) liability to the depositors. We continue to assume that risk neutral agents buy equity only, while the risk averse agents are depositors. Then, the shareholders of the bank become residual income earners of period 2. Define $\pi(t)$ to be the amount of residual income earned per unit of capital. In period 2, a shareholder earns $v_2 + \pi(t)$ per unit of capital. Being residual income earners, π could be positive, or negative.

Total return to shareholders in period 2, is

$$(1-\theta)K(v_2+\pi(t)) = [\theta + (1-\theta)K - r_1\theta t - v_1(1-\theta)K]R - r_2\theta(1-t)$$

Then, for each t, given r_1, r_2, v_1 and v_2,

$$v_2 + \pi(t) = \frac{R(1-r_1 t) - r_2(1-t)}{\theta' K} + (1-v_1)R \qquad (2.7)$$

This expression allows us to make a couple of interesting observations. First, observe that, in period 1, type 1 risk neutral agents will have v_1K in cash, and will own period 2 redeemable assets of book value $E[v_2K + \pi(t)K]$. They do not have any use for period 2 value and, hence, will want to sell their assets to those who want to consume in period 2. This will allow a market for ex-dividend shares to function in period 1 where, type 1 risk neutral agents will sell their period 2 claims to type 2 risk neutral agents. Suppose, type 2 depositors protected by unlimited liability, do not withdraw cash in period 1. Type 1 depositors, on the other hand, will not buy assets redeemable in period 2. Thus, only the type 2 risk neutral agents, each holding v_1K of cash, will demand these shares. The supply of such shares, x^s, is given by[10]

$$x^s = t(1-\theta)K$$

and the demand, x^d, by

$$x^d = \frac{(1-t)(1-\theta)Kv_1}{p}$$

[10] Jacklin (1993)

where p is the price of ex-dividend shares in period 1. The money value of the total demand for shares from type 2 risk neutral agents is worth $(1-t)(1-\theta)Kv_1$. Solving for p, by equating demand and supply, one gets,

$$p = \frac{1-t}{t} v_1$$

Thus, for each t,

$$c_{11}^n(t) = (v_1 + p)K$$

and

$$c_{22}^n(t) = (1 + \frac{v_1}{p})K(v_2 + \pi(t))$$

Substituting the value of p and for $v_2 + \pi(t)$ from (2.7), we get,

$$c_{11}^n = \frac{v_1}{t} K$$

and

$$c_{22}^n = \frac{1}{\theta'(1-t)}[R(1-r_1 t) - r_2(1-t)] + \frac{(1-v_1)RK}{(1-t)}$$

With unlimited liability, the expected utility of risk neutral shareholders, from (2.3) and the values of c_{11}^n and c_{22}^n, is

$$EU^n = \rho RK + v_1(1-\rho R)K + \frac{\rho}{\theta'}[R(1-r_1 t^e) - r_2(1-t^e)] \qquad (2.8)$$

where t^e is the expected value of t (equal to 1/2 with our assumption on the distribution of t). There are two important things about (2.8). First, observe that EU^n is decreasing in v_1 as $\rho R > 1$, by assumption. Second, if the bank were to issue no deposits, and behave like the firm in Jacklin (1993), then the third expression on the right-hand-side of (2.8) will vanish. In other words, risk neutral shareholders, by choosing $v_1 = 0$ and not issuing deposits, can achieve an expected utility of ρRK. Thus any solution, where the bank has unlimited liability, must ensure that (risk neutral) shareholders get at least ρRK. *ρRK is then the reservation utility level of the shareholders.*

It is important to understand what is happening here. Risk neutral agents are residual income earners in period 2. There are $(1-\theta)(1-t)$ of them (type 2) around in period 2. Being residual income earners, they not only get their own $v_2K + \pi(t)K$, they also get what was due to the type 1 risk neutral agents — who are not interested in consumption in period 2. This is possible because the latter sell off their shares to type 2 risk neutral agents. This is not difficult to see when $v_1 > 0$. But, we have just argued that $v_1 = 0$. This essentially means that shareholders are signing a contract that says the following: in period 2 they will get $v_2K + \pi$, and in period 1 they get nothing. Ex ante, such a contract gives them the maximum utility. Ex post, however, if they turn out to be type 1 in period 1, they will want to break the contract by selling their shares and getting a price in period 1.

Since $v_1 = 0$, no risk neutral equity owner will be able to buy their shares. However, depositors can withdraw money from the bank in period 1 and buy these shares. Only type 2 depositors will have this incentive. This too will lead to a bank run, as type 2 depositors will withdraw in period 1. Alternatively, it will lead to disintermediation in the short run. To prevent this, we need a restriction on the possible trades in period 1 (Jacklin, 1987). Simply put, shares should be non-transferable in period 1 (or, more like long term bonds with no market for them in period 1). With $v_1 = 0$, type 2 shareholders are already precluded from trade. The trading restriction prevents type 2 depositors from buying shares in period 1 and, hence, they have no incentive to withdraw deposits in period 1. Such an assumption is implicit in our algebra; we now make it explicit.

A.2.4: *Bank shares are non-transferable in period* 1.

One question still remains. Even though ex ante, all shareholders will prefer to sign a contract which allows A.2.4, ex post, they will want to breach it if they are type 1. This is where contract enforcement becomes important, something that requires institutional (legal) backing. The risk neutral shareholders play a role similar to Selgin's (1996, Chapter 11) corn merchants. In Selgin, the bank issues IOUs to period 1 depositors, who trade them against corn from the merchants, who later (period 2) redeem them at the bank. These merchants are outside the banking system, and the rationality of their actions is not modeled. In our general equilibrium setup, on the other hand, they are an integral part of the banking mechanism.

Competition among banks will ensure that $EU^n = \rho RK$. This can be achieved with $v_1 = 0$, and most importantly, $R(1-r_1t^e)-r_2(1-t^e) \equiv Z = 0$. To see this, write the bank's problem as follows:

(P) *maximize* $EU^a = \int_0^1 [tu(c_{11}^a) + (1-t)\rho u(c_{22}^a)]dF(t)$, subject to $EU^n \geq \rho RK$ *and* unlimited liability, i.e., $\underline{t} \geq 1$.[11]

Recall that $c^a_{11} = r_1$, and $c^a_{22} = r_2$.

Suppose a solution to (P) exists. Competitive banking with unlimited liability will guarantee that EU^n is no greater than ρRK. This will be achieved with $Z = R(1 - r_1 t^e) - r_2(1 - t^e) = 0$, and $v_1 = 0$. Using the relationship between r_1 and r_2 thus obtained, maximization of EU^a gives the following first order condition:

$$u'(r_1) = \rho R u'(r_2) \tag{2.9}$$

We now need to ensure that unlimited liability is credible, and type 2 depositors do not run the bank. For this, two things need to be satisfied — $1 < r_1 < r_2 < R$ (it pays type 2 depositors to wait for period 2) and $\underline{t} \geq 1$ (type 2 depositors will wait). From (2.9), $\rho R > 1$, and $Z = 0$, the first requirement follows. For the second requirement, observe that plugging in the value of r_2 in terms of r_1 from $Z = 0$, and putting it into the value of $\underline{t}$ in (2.6), one gets.

$$K \geq \frac{1}{\theta'} \frac{(t^e - \underline{t}) + r_1(\underline{t} - t^e)}{1 - t^e} \tag{2.10}$$

In equation (2.10) everything is a parameter, excepting $\underline{t}$. To see how the mechanism works, and to get explicit solutions, we use A.2.3.

[11] See equation(2.6) and the explanation that follows.

Proposition 2.1: *Suppose A.2.1 - A.2.4 hold. Let* $Q \equiv (\rho R)^{1/(1-\gamma)}$. *If* $K \geq K_0 \equiv [R-Q]/[(R+Q)\theta']$, *then a Nash equilibrium exists where risk averse agents buy deposits, risk neutral agents buy equity and, there is no bank run. The equilibrium deposit rate pair* (r_1^*, r_2^*) *is given by* $r_1^* = [2R]/[Q+R]$ *and* $r_2^* = Qr_1^*$, *and period* 1 *dividends are given by* $v_1^* = 0$.

<u>Proof:</u> Choose $r_1 = r_1^*$, $r_2 = r_2^*$ and $v_1 = 0$. We first show that it does not pay a risk neutral agent, J, to buy deposits if all other risk neutral agents are buying equity and, all risk averse agents are buying deposits. If J buys deposits, her period 1 consumption will be $r_1^* K$ if she turns out to be type 1, and $r_2^* K$ in period 2 if she is of type 2. This gives her an expected utility in period 0, of

$$\begin{aligned} & \frac{1}{2}[r_1^* + \rho r_2^*]K \\ = & \frac{RK(1+\rho Q)}{Q+R} \\ < & \rho RK \end{aligned}$$

given A.2.2. If J buys equity instead, she gets ρRK. This follows from (2.8) where $v_1 = 0$, and $Z = 0$. The fact that $Z = 0$ follows from using $t^e = (1/2)$ and using the values of r_1^* and r_2^*. It also follows from (2.8) that J gets at least her reservation utility.

We now show that no risk averse agent will deviate. Given $v_1 = 0$ and A.2.3, a risk averse agent will not buy equity. The other alternative is to invest directly in technology, and getting a consumption of 1 if type 1, and R if type 2. This will give a lower utility than buying deposits, as is evident from the fact that $1 < r_1^* < r_2^* < R$, since $1 < Q < R$. Intuitively, the risk averse agent by buying deposits, gets a narrower spread than by investing in the technology.

To show there is no run, we have to show that $\underline{t} \geq 1$. With $v_1 = 0$, from (2.6),

$$\underline{t} = \frac{R(1 + \theta' K) - r_2^*}{R r_1^* - r_2^*}.$$

Plugging in the values of r_1^* and r_2^*, and using $K \geq [R - Q]/[(R + Q)\theta']$, one gets $\underline{t} \geq 1$. *This completes the proof.*

Thus, if banks have unlimited liability, depositors can be fully insured. For unlimited liability to be credible, there must be enough risk neutral capital. The latter depends on two things — the proportion of risk neutral to risk averse agents, θ', and the proportion of risk neutral to risk averse capital in the economy, K, per representative agent. This suggests that, if the risk neutral capital is not sufficient, then the depositors cannot be fully insured.

However, note that, if $K < K_0$, it does not follow that there has to be a positive probability of a run on the bank. Recall that there is a positive probability of a run if $\underline{t} < 1$. For this, it must be the case that $(1+\theta' K) < r_1$. This follows from (2.6), after putting $v_1 = 0$. Thus, a run can always be avoided if one chooses $r_1 = (1 + \theta' K)$. In Diamond and Dybvig, $\theta' = 0$, and hence, zero probability of a run implied that $r_1 = 1$. However, this meant that the outcome was inefficient (no insurance). Thus, the question that remains is the following: Suppose that $K < K_0$. Does it mean that $r_1 = (1 + \theta' K)$, which allows for partial insurance, is the only solution when $K < K_0$? We study this question in the next section.

2.6 Less than Adequate Capital

For this section we will continue to assume that A.2.1-A.2.4 hold; in addition, $K < K_0 \equiv [R - Q]/[(R + Q)\theta']$. This ensures that capital is not adequate, i.e., $\underline{t} < 1$, if we choose $r_1 = r_1^*$ and $r_2 = r_2^*$. What is the way out, if equity capital is inadequate?

Many policy suggestions like unitary banking or narrow banking focus on the asset side of the balance sheet of commercial banks. In many countries, the central bank requires commercial banks to maintain *statutory liquidity ratio* (SLR) and/or *cash reserve ratio* (CRR) in their balance sheets. The issue considered is typically the assets portfolio *given* that commercial banks have demand deposits. It is taken for granted that deposits can be withdrawn on demand without any restrictions. It is this feature that raises the question of the appropriate asset mix for the banks whether it is narrow banking or unitary banking. However, if demand deposits are subject to the so-called *option clause* that was used in Scottish banking before 1765 (White, 1984), then there is correspondingly less need for liquid assets or facilities like Deposit Insurance or Lender of Last Resort. The Bank of Scotland (a commercial bank) in 1730 used the option clause that gave them an option to delay the redemption of notes up to six months, with the condition that the bank pays interest. However, the bank did not exercise the option regularly (White, 1984; p. 26).

Option clause is similar to the so-called suspension of convertibility. The option clause is agreed to, ex-ante, in the contract between a bank and a depositor (White, 1984). Suspension of convertibility, usually, refers to a restriction *imposed* by the central bank or the clearing house association on commercial banks (Friedman and Schwartz, 1963)? In what follows, we will reserve the term 'option clause' for a clause in a contract, voluntarily agreed to, between the bank and the depositors. The term 'suspension of convertibility' is used hereafter for restrictions imposed on banks and depositors.

Constrained demand deposit

Diamond and Dybvig (1983) argued that suspension of convertibility is an inefficient solution. They finally suggest a tax scheme that prevents bank runs - tax those who withdraw early and use the money to add to the balances of those who do not withdraw early. Observe that if t is stochastic, then the tax is contingent on the realization of t in period 1. So the period 1 return to the depositor is uncertain. The period 2 return in DD is in any case uncertain. This is in sharp contrast to banking in practice. In practice, an agent can, subject to adequate balance in her account, withdraw her principal amount with a certain interest from her bank on demand. Let us call this instrument *unconstrained* demand deposit. Observe that in the literature on bank runs, the optimum solution is not an unconstrained demand deposit. The instrument is subject to a restriction. The constraint takes various forms in the literature such as:

1. Option clause - this is part of a contract between depositor and the bank whereby, in the event of many or large pre-mature withdrawals, the bank reserves the right to postpone the redemption (with interest).

2. Suspension of convertibility - this is a restriction usually imposed by the central bank or the banks' association on banks and depositors in the event of a crisis.

3. Tax schemes - tax those who withdraw early and use the money to add to the balances of those who do not withdraw early.

4. Equity-like instrument as in Jacklin (1993) - let the market price of ex-dividend shares of a 'firm' reflect the proportion of agents who wish to withdraw early.

5. The state contingent pay-out - for example, in McCulloch and Yu (1998), the depositors are promised a (small) amount that can be paid under all circumstances and, depending on the realization of the state of nature, pay out the balance (if any) as a bonus.

6. Positive probability of bank runs, as an equilibrium outcome - for example, in Alonso (1996), banks have depositors who accept a positive probability of (information based) bank runs, as an equilibrium outcome.

In all six cases, either the redemption timing is uncertain or the redemption amount is uncertain. The restriction may be agreed to voluntarily by depositors and banks, or it is imposed by the regulatory authority or some association. Alternatively, it may take the form of a tax policy. It could be reflected in a 'low' market price (when the need for funds is high) or there could be a bonus. In the last case, it is accepted that bank runs can occur. Deposits have ceased to be *unconstrained demand deposits* - they are subject to an option clause or suspension of convertibility or taxation. In the fourth case, as the very name suggests, the instrument has ceased to be a deposit! In the fifth case, the bank resembles a mutual fund giving dividends. In the last case, a bank run is optimal.

In the first two cases, the bank makes a distinction between the type 1 agents who come to withdraw early and those who come to withdraw late. If a type 1 agent is early, she gets the full amount but if she is late, then the redemption is delayed. So one is not sure to get the promised amount on time. In the third, fourth and fifth cases, one is sure to get the redemption on time but the amount is not fixed. In the last case, there is even a possibility of a bank run. So, in any case, either the redemption amount is not fixed or the time of redemption is not fixed.

In what follows, we extend the model of the precious section in this chapter, to include a variant of "option clause" . The latter term is, hereafter, used in a broad sense to mean any condition on demand deposits provided it is agreed to voluntarily between the bank[12] and the depositors and the

[12]One issue that has bothered many thinkers is that of monitoring bank managers. In the context of our model, the specific issue in this context is that managers may misuse the option clause - more so when the latter is invoked at an individual banker's level. One

contract is enforced by the government. More specifically, the option clause in our model will allow banks to reduce the redemption amount if the realization of t is greater than t_s. Observe that in the previous section, this t_s was implicitly fixed at values greater than 1 and, hence, irrelevant.

We will pose the problem generally, and allow any t_s. For all realizations $t \leq t_s$, the depositors will be able to withdraw r_1. If $t > t_s$, proportion $t - t_s$ will receive $b \leq r_1$ and the proportion t_s will receive r_1. Given A.2.3, $b > 0$.[13] Since the bank does not know the type of each depositor, it will implement this policy by giving the first t_s depositors r_1 and the remaining depositors who want to withdraw in period 1 will receive b. Again, to prevent type 2 depositors from withdrawing in period 1, the following must be true: $r_1 < r_2$, and for $t > t_s$,

$$[1 + \theta' K - r_1 \min(t, t_s) - b \max(t - t_s, 0) - v_1 \theta' K] R \geq r_2(1 - t)$$

which can be written as

$$[1 + \theta' K - r_1 t + (r_1 - b) \max(t - t_s, 0) - v_1 \theta' K] R - r_2(1 - t) \geq 0 \quad (2.11)$$

way to solve the problem is as suggested by Gorton and Mullineaux (1987). They wrote,

'The CBCH (Commercial-bank clearinghouse), originally formed as a simple collective to reduce the costs of collecting checks, became involved in monitoring activities and established mechanism of managerial control. In fact, the CBCH "regulated bank behaviour".'

[13]With A.2.3, $u(0)$ is negative infinity. With any $t_s < 1$, this implies a positive probability of $t > t_s$, and depositors will get a negative infinity utility with positive probability. In other utility functions, where $u(0)$ is bounded below, b could be equal to zero — a complete suspension of convertibility rather than a partial one as is necessary here. As will become clear, our utility function actually makes the point we are trying to state in this chapter more difficult. The final result is, therefore, stronger!

Observe that this expression is similar to the one leading up to equation (2.6), with a modification for the option clause. Also, if the expression above is satisfied for some $t > t_s$, then, given $r_1 \geq b$, it is satisfied for all t.

The condition $r_1 \geq b$ is important. If $r_1 > b$, we have a non-trivial solution to the (voluntarily contracted) suspension of convertibility, in the sense that some type 1 depositors get paid less than others. If, on the other hand, $r_1 = b$, then every type 1 depositor (or any body who wants to withdraw in period 1) gets the same amount, implying that the option clause solution is a trivial one, i.e., $t_s = 1$.

We proceed as before. Observe that (2.11) guarantees that shareholders in the bank obtain non-zero returns in period 2. Once again, for the moment assume that all risk neutral agents buy equity and trade in ex-dividend shares in period 1. For any v_1 and t, like before, the consumption of type 1 risk neutral agents will be v_1/t. Now, from (2.3) and (2.11),

$$\begin{aligned} EU^n &= v_1 K(1-\rho R) + \rho RK + \rho \frac{2R - Rr_1 - r_2}{2\theta'} \\ &+ \frac{\rho R(r_1 - b)}{2\theta'}(1 - 2t_s + t_s^2) \end{aligned} \tag{2.12}$$

Given A.2.2, like in the previous section, $v_1 = 0$, and the risk neutral agents, by themselves (i.e., without issuing deposits) can obtain ρRK. Hence, we must have $EU^n \geq \rho RK$. From (2.12), therefore,

$$2R - Rr_1 - r_2 + R(r_1 - b)(1 - 2t_s + t_s^2) \geq 0 \tag{2.13}$$

If $t_s = 1$, the left-hand side of (2.13) collapses to what we had described as Z in the previous section.

Again, suppose that all risk averse agents buy deposits. If $t \leq t_s$, then with probability t they will be type 1 and obtain a utility equal to $u(r_1)$ and with probability $1 - t$ they will be type 2 and obtain a utility $\rho u(r_2)$. If $t > t_s$, and they are of type 1, they will get $u(r_1)$ if they come to the bank soon enough. If reaching the bank is a random event, this probability will be t_s/t. [14] With probability $(t - t_s)/t$, they will be late and get $u(b)$. If they are of type 2, they are assured of r_2. Thus,

$$\begin{aligned} EU^a &= \int_0^{t_s} tu(r_1)dF(t) \\ &+ \int_{t_s}^1 \left\{ t\left[\frac{t_s}{t}u(r_1) + \frac{t - t_s}{t}u(b)\right]\right\} dF(t) \\ &+ \int_0^1 (1-t)\rho u(r_2)dF(t) \end{aligned} \tag{2.14}$$

Using A.2.1, (2.14) can be written as

$$EU^a = \left(t_s - \frac{t_s^2}{2}\right)u(r_1) + (1/2)(1 - t_s)^2 u(b) + (1/2)\rho u(r_2) \tag{2.15}$$

Also, for type 2 depositors not to indulge in a panic run to the bank, they must be convinced that (2.11) holds for all t. In particular, if it holds for $t = 1$, it holds for all t. Putting $t = 1$ in (2.11), we get

$$(1 + \theta' K)R - Rr_1 + R(r_1 - b)(1 - t_s) \geq 0 \tag{2.16}$$

The competitive bank's problem is then a simple one — maximize EU^a given by (2.15), subject to (2.13) and (2.16). However, now we need an additional constraint, regarding the maximum value of t_s. The definition of t_s implies that it be restricted to values that are no greater than 1, i.e., $(1 - t_s) \geq 0$. If

[14] Diamond and Dybvig (1983)

λ is the Lagrange multiplier for (2.13), η for (2.16), and α for the restriction that $(1 - t_s) \geq 0$ in this chapter, the following must hold:

$$\left(t_s - \frac{t_s^2}{2}\right)u'(r_1) - \lambda R(2t_s - t_s^2) - \eta R t_s = 0 \tag{2.17}$$

$$\frac{1}{2}\rho u'(r_2) - \lambda = 0. \tag{2.18}$$

$$\frac{1}{2}(1 - t_s)^2[u'(b) - 2\lambda R] - \eta R(1 - t_s) = 0 \tag{2.19}$$

$$(1 - t_s)[u(r_1) - u(b) - 2\lambda R(r_1 - b)] - \eta R(r_1 - b) - \alpha = 0 \tag{2.20}$$

As in Proposition 2.1, we can easily show that if $v_1 = 0$, and we maximize (2.15) subject to (2.13) and (2.16), then we can support a Nash equilibrium where all risk neutral agents buy equity and risk averse agents buy deposits. The proof is exactly as in Proposition 2.1. The only thing to check is that $r_2 > r_1$. This follows directly from combining (2.17) and (2.18), since $\rho R > 1$, $\eta \geq 0$, and $t_s > 0$.[15] However, we are here more interested in the value of t_s. Specifically, is the option clause an equilibrium outcome?

Proposition 2.2 *Let $K < K_0 \equiv [R - Q]/[(R + Q)\theta']$, and A.2.1-A.2.4 hold. Then, the optimal t_s equal to 1 is always a solution. However, the depositors do not obtain full insurance, i.e., $u'(r_1) \neq \rho R u'(r_2)$.*

Proof: First, observe that equations (2.17) to (2.20) are always satisfied at $t_s = 1$, provided $\alpha = 0$. Indeed, we will now argue that α is always equal to zero. Suppose instead that $\alpha > 0$. Then $t_s = 1$. But then, either one of

[15] If $t_s = 0$, the option clause is irrelevant since then b becomes like r_1!

these two must hold for (2.20) to be satisfied: $\{\eta < 0$ and $r_1 > b\}$ or, $\{\eta > 0$ and $r_1 < b\}$. Both are invalid since $\eta \geq 0$, by virtue of being the Lagrange multiplier, and $r_1 \geq b$, by definition. The fact that α is never positive, does not rule out $t_s = 1$. It does, however, suggest that there could be instances where $t_s < 1$ is a solution.

We now show that $\eta > 0$. Suppose, instead, that $\eta = 0$. Then, from combining (2.17) and (2.18), and (2.18) and (2.19) given $\alpha = 0$, $u'(r_1) = \rho R u'(r_2)$ and $u'(b) = \rho R u'(r_2)$, implying $b = r_1$. Using A.2.3,

$$r_2 = Q r_1$$

where Q was defined as $(\rho R)^{(1/(1-\gamma))}$. Also, from (2.13), using $b = r_1$, and the fact that $\lambda > 0$ (from A.2.3), we get

$$r_2 = 2R - R r_1$$

This implies that

$$r_1 = \frac{2R}{R+Q}$$

From (2.16), and $r_1 = b$, we get

$$1 + \theta' K \geq r_1 = \frac{2R}{R+Q}$$

which, in turn, implies that $K \geq K_0$. This leads to a contradiction. So, $\eta > 0$. Given A.2.3, we know that r_1, r_2 (and b) will all be positive [16]. Recall that, given A.2.3, $\lambda > 0$. *This completes the proof.*

[16]Of course, with $t_s = 1$, value of b is irrelevant.

With $t_s = 1$, and equation (2.16) holding with equality ($\eta > 0$), it follows that $r_1 = 1+\theta' K$. In the last section, where $K \geq K_0$, K, and hence $\theta' K$, was large enough to allow r_1 and r_2 to satisfy the (full) insurance condition of $u'(r_1) = \rho R u'(r_2)$. In equation (2.17), the full insurance condition can never be satisfied if $\eta > 0$. Our two propositions argue that η will be equal to zero if and only if $K \geq K_0$, i.e., there is enough equity in the bank. The problem with the DD model was that they were trying to achieve a full insurance outcome, without there being any risk neutral capital. Not surprisingly, such a setup was prone to (market) failure.

Why is $t_s = 1$? Suppose that $t_s < 1$. This necessarily means that $r_1 > b$. But this implies that in period 1, the agents, if they are type 1, get either a high return of r_1 or a low return of b. Consider another bank that reduces r_1 slightly (to $r_1 - \epsilon$) and increases b (to $b + \delta$) such that conditions (2.13) and (2.16) continue to hold.[17] Depositors being risk averse, one can show that this will improve their period 0 expected utility of period 1. Moreover, the second bank will be able to further increase t_s in this situation. Hence t_s moves towards 1.

2.7 Conclusion

The bank in DD model does not have equity capital and it does not promise fixed return in the long term (period 2). We changed this assumption in our model. We modeled a bank as a firm that has both equity capital

[17]This can be done by choosing $\epsilon t_s = \delta(1 - t_s)$.

and deposits and it promises a certain return to depositors in both periods. Equity holders get an uncertain return.

Another change (related to equity) is that we have allowed for risk neutral agents as well. DD (and Jacklin (1993)) consider risk averse agents only. Risk neutral agents perform two functions in our model. First, they absorb the risk due to the variation in the proportion of type 1 agents. Second, they keep equity capital in the bank. Since equity is irredeemable, it acts as an assurance for type 2 agents who may otherwise panic. In our model, we show how a run can be prevented without impairing (ex-ante) efficiency if equity capital is adequate. Even if equity capital is inadequate, the market outcome is run-proof banking (though the outcome is a constrained optimum).

It is true that DD discuss *suspension of convertibility* but for them it is a matter of direct intervention - something that needs to be *imposed* by the central bank or the government in the event of a crisis. For them, it is a substitute for deposit insurance/lender of last resort facility extended by the central bank. On the other hand, in Scottish banking (White, 1984), there used to be an 'option clause' in the contract, as a market outcome, between a commercial bank and the depositors. The depositors give the bank the right to opt for postponement of redemption (with interest), if there are too many agents who wish to withdraw. In our model, we have used a variant of the option clause and examined the optimal contract that is voluntarily agreed to by the depositors and their bank.

In our model, there is no direct government intervention. The only role of the government in our model is that it enforces contracts. Risk neutral agents perform two functions in our model. First, they absorb the risk due to the variation in the proportion of agents who need funds. Second, they keep equity capital in the bank. Since equity is irredeemable, this acts as an assurance for depositors who may otherwise panic. So there is no need for the government to insure deposits. Equity acts as a substitute for deposit insurance because either can be used to prevent panic bank runs [18]. But that is where similarity ends. Whereas deposit insurance leads to moral hazard, equity capital prevents it.

If equity is large enough, depositors can be fully insured, i.e., they obtain full insurance coverage against liquidity shocks and have perfect consumption smoothing. If the amount of equity is less, then also runs are prevented but depositors are only partially insured. The solution we obtain is also efficient, as we maximize the depositors' utility by keeping the (bank's) shareholders at their opportunity cost.

Should capital adequacy norms be imposed? In our model, if there is adequate endowment with risk neutral agents, there will be sufficient equity forthcoming anyway. If the endowment with risk neutral agents is inadequate, then there is a scarce resource and it must show up in a constrained

[18] In our model, the return on bank investments is certain and we have not allowed for moral hazard by bank managers. Once we allow for a more general case, then the argument of Calomiris and Kahn (1991) has relevance. They argue that demand deposits are a desirable form of bank liability as they, along with sequential service, provide an incentive for monitoring by the depositors.

optimum. Moreover, the sufficient amount of (risk neutral) capital, to provide full insurance to depositors, is dependent on the risk aversion of the depositors, the amount of resources with them, the distribution governing liquidity shocks, etc. It is not likely that the government has information on these parameters. This makes the job of defining a capital adequacy norm extremely difficult. On the other hand, banks left to themselves, but facing the threat of competition, will develop the types of contract necessary to tackle the problem of (inadequate) capital [19], if any.

It is not really necessary to have capital as assurance. One substitute is reputation of the bank. Another is unlimited liability of partners (who are known to be rich). It is true that there are other problems with unlimited liability but all we need is an enabling provision in law that permits this. If the difficulties with unlimited liability are serious, it will be avoided anyway and in case they are not, then there is scope for its use.

At present one reason for imposing capital adequacy norms is that deposit insurance has led to moral hazard. So capital adequacy norm is used to correct the side effect of a medicine (deposit insurance). What we are arguing is that capital adequacy can be used to prevent the disease (bank runs) itself.

[19]There are other issues in this context like should capital requirements depend on the business cycle? Should we consider market value or historical accounting in working out capital adequacy? We are abstracting from these issues in this thesis. So the conclusion that there is no need to impose capital adequacy norms has to be viewed in the light of the specific model in this chapter.

An alternative to capital adequacy that has an old history in the literature is unitary/narrow banking. This literature tends to focus on the asset side of the balance sheet. In the recent literature and in our model, the emphasis is on the liabilities side of the balance sheet. In our model, the balance sheet is enlarged to include equity which is irredeemable.

While it is important to have an appropriate legal framework, the case for direct intervention by government is doubtful.

Chapter 3

Liquidity Shock and the 'Lemon' Problem

3.1 Non-financial assets in developing economies

It is often observed that, in developing/emerging economies, managers own shares in the companies they manage. Alternatively, people invest in self-managed projects, greater proportions of their assets than do those in developed markets. They will more readily open a retail outlet with their savings than buy financial assets, or a portfolio of shares in projects operated by others.[1] In this chapter, we study possible explanations for this

[1] It is difficult to get estimates of the proportion of investment in non-financial assets in emerging economies. But there are indicators that suggest that the investment in non-financial assets in emerging economies is substantial. One indicator is the importance of the so-called unorganized sector in the emerging economies. There are various names used for the unorganized sector in developing economies: informal sector, small industries,

phenomenon.

Our major contention is that such behavior is a rational outcome given the properties, or the institutional environments, in which the asset markets operate in emerging economies. A more efficient financial market will transfer a greater proportion of the firm value to its shareholders. In developing economies, on the other hand, given the relatively under-developed institutions governing capital markets and corporate governance. shareholders get a lower proportion of the firm value compared to that in developed financial markets. This is often the result of the observed characteristics of emerging markets, variously described as being 'thin' or with a few large players, having larger volatility and lesser degrees of integration among the various types of asset markets. We argue that it is these properties that encourage people to invest less in pure financial assets.

In this chapter, we set out a three period model. Agents invest in period 0, (possibly) face a consumption liquidity shock (LS) in period 1 and sell assets, or consume in period 2. Assets can be sold in the secondary market in period 1. In this chapter, we study the case where there are enough liquid funds in period 1 with the potential buyers, so that assets are priced at

household economic activities and unincorporated enterprises. 'According to the Central Statistical organization's (CSO) estimates, the contribution of Unorganised sector to the total net value added (NVA) stood at about 64% in the recent years. Of this, nearly 75% was accounted for by the non-agricultural unorganized sector...' (Jacob, 1997). Most of the investment in the unorganized sector is not channeled through the financial markets. These are typically owner managed firms.

their "present value". This, we term NLC, or no liquidity crunch (NLC). We consider two kinds of assets - real assets and financial assets. Since there are two possible assets, there are two asset markets to consider. We will allow these markets to be incompletely integrated, implying thereby, the shocks in one market need not be fully transmitted to the other market. In particular, it is possible that in one market there is a liquidity crunch while the other faces no such problem; or, agents may not be able to operate in both markets, etc. When there are no such segmentations between the asset markets, we will term them fully integrated markets, or FIM.

The plan of this chapter is as follows. In section 3.2, we set out the basic model. In section 3.3, we study the benchmark case of NLC and FIM. In section 3.4, we examine the question - do asset markets need to be integrated? In section 3.5, we discuss the issue of separation of ownership and management in the light of our model in this chapter. In section 3.6, we conclude with remarks on owner-managed firms and the cost of delegation.

3.2 The Basic Model

Consider a three period model, periods labeled $0, 1, 2$. There is a continuum of risk averse (potential) entrepreneurs, E, in $[0, 1]$, each of whom has an endowment of one unit of investible funds. They have no endowment in periods 1 and 2. Each of them also has an identical project, that yields a risky return in period 2. Each unit of period 0 investment in a particular project gives a period 2 return of $\overline{R}$ with probability β, if the outcome is good, and

$\underline{R}$ with probability $(1-\beta)$, if the outcome is bad. Also, $\infty > \overline{R} > \underline{R} > 0$, and $0 < \beta < 1$. We define

$$R^e \equiv \beta\overline{R} + (1-\beta)\underline{R}. \tag{3.1}$$

Since each project has the same probabilities of success and failure, and are independent, one interpretation is that in period 2, β proportion of the projects will give a return $\overline{R}$, and $(1-\beta)$ proportion will give a return $\underline{R}$. In period 1, both good and bad projects give a return of zero. In other words, if an investment is liquidated in the short run (period 1), the entire value of the investment is lost.

In period 0, the entrepreneur, E, decides on a, the proportion of the endowment invested in her own project. The remaining $(1-a)$ is invested in others' projects. Agents do not invest directly in others' projects, but through a mutual fund. Thus, when an entrepreneur invests a in one's own project, the rest, $(1-a)$, is invested in the mutual fund, a financial asset. The mutual fund invests in (independent) risky projects, some of which may succeed and others may fail. However, given its ability to diversify risk, the mutual fund is able to guarantee a return to its clients equal to the mean return of all the projects that it funds. The mutual fund is, therefore, a fully diversified portfolio, with return R_f in period 2. There are two important points to note here. First, R_f is non-stochastic. Second, owing to delegation cost, R_f is different from R^e.

In the absence of any difficulty in period 1, for a given choice of a, agent E expects a period 2 return of aR^e from the investment made in her own project, and $(1-a)R_f$ from the mutual fund. *Henceforth, we will term the investment in E's own project as an investment in real asset (RA), to distinguish it from the investment in the financial asset (FA).* Let

$$m \equiv R^e - R_f \tag{3.2}$$

In period 0 everyone operates under symmetric information. In period 1, however, E knows the quality of her own RA, but not those of others. In particular, if there is a market for RAs in period 1, an owner of a bad RA will try to sell her asset to an uninformed buyer. With $a > 0$, we, therefore, have the possibilities of period 1 trades in RAs under asymmetric information.

For trade of RAs under asymmetric information, we must have buyers who do not know the exact type of the RA being offered in the market. This is possible only when both good and bad projects are offered for sale. To effect this, we will assume that the entrepreneurs are of two types. A type 1 entrepreneur gets utility from period 1 consumption only. Type 2 entrepreneurs, on the other hand, obtain utility from consumption in period 2, and no utility from consumption in period 1 (Diamond and Dybvig, 1983). In period 0, agent E does not know what type she will be, but knows that the probability of being type 1 is t, where $0 < t < 1$. In period 1 all E get to know their types. Since the distribution of types is *i.i.d.* for all E, in period 1, t proportion of agents E will be type 1, and $(1-t)$ will be of type 2. t is known in period 0[2]. Let c_{ik} be the consumption of an agent E of type i,

[2]This means that there is no aggregate uncertainty, as far as liquidity shock (on the demand side) is concerned, in period 1. In the next chapter, uncertainty is introduced by

$i = 1, 2$, in period k, $k = 1, 2$. Let U_i be the utility of a type i agent. Then,

$$U_1 = u(c_{11})$$

and

$$U_2 = u(c_{22})$$

Given the utility function, $c_{12} = c_{21} = 0$. We assume that $u'(.) > 0$ and $u''(.) < 0$. We assume that all markets are competitive. *Throughout we will make the simplifying assumption that the discount rate is* 0 *for all agents.*

The possibility of being a type 1 agent is equivalent to facing a consumption liquidity shock in the short term, when assets will have to be sold. Observe that a typical entrepreneur will own two types of assets in period 1, the RA and the shares in the mutual fund. Assets cannot be liquidated in the short run as, by assumption, the short term liquidation value is zero. However, these can be sold in asset markets, one each for the RAs and the other for FAs. Each of the asset markets has two types of buyers. The first is a group of risk neutral buyers, N. These period 1 risk neutral buyers are different from the entrepreneurs and have (independent) liquid resources to buy the assets[3] being traded in that period (similar to the "investors" in Holmstrom and Tirole, 1998). These buyers come to the markets with

allowing for the *possibility* of liquidity crunch (on the supply side).

[3]Diamond and Dybvig (1983) had assumed that agents can invest in a project which gives a 2 period return of $R > 1$. If funds are required before period 2, then the project has to be liquidated in period 1, when the return is 1 per unit of investment. This is the only source of liquidity in period 1 in their model. There is no outside liquidity available in their model. We have relaxed this assumption in this chapter.

a total amount of goods, or supply of liquidity, which they are willing to exchange for existing projects, or assets, if the expected return on the asset is no lower than the price they will have to pay. The second group of buyers are the entrepreneurs themselves, who do not have any endowment of liquidity in period 1, but can obtain it by selling some of their assets.

Assume that the utility function of risk neutral agents N in period 1 is

$$U^N = c_1^N + c_2^N. \tag{3.3}$$

Given that the short run liquidation value of the projects is zero, the price of the assets depends on the supply of liquidity, with the buyers, in each of these markets. In this chapter, we assume that there is adequate liquidity and that the markets are integrated.[4]

The only role of the risk neutral agents N in our model is that they buy assets in the secondary market in period 1. Hence, our focus is on the behavior of agents E only.

Let B denote a bad project and G denote a good project. In period 1, then, four types of entrepreneurs can be classified, depending on their (utility) types and the quality of the RAs they own. This is given in Table 3.1. Since we are allowing for period 1 trade in assets, the first thing to note is that we can define two types of sales in period 1. First are the *forced* sales by type 1 entrepreneurs, who need liquidity in period 1 and will sell at any (non-negative) price. Second, are the *strategic* sales by type 2 entrepreneurs,

[4] In chapter 4, we will move to the case of inadequate liquidity and thereafter, in chapters 5 and 6, we will take up segmented markets.

	Type 1	Type 2	Total
Type G	β t	$\beta(1-t)$	β
Type B	$(1-\beta)t$	(1-β)(1-t)	1-β
Total	t	1-t	1

Table 3.1: Distribution of agents by the quality of real asset owned and by the utility function

	Type 1	Type 2
Type G	$1G$	$2G$
Type B	$1B$	$2B$

Table 3.2: Nomenclature

who are not selling for consumption (or liquidity) reasons in period 1, but because they can sell in a market where their assets are overvalued.

In what follows, we will use the nomenclature, as given in Table 3.2, to describe the agents.

Before we state any result, it is important to consider one particular aspect of what we have called a real asset. By definition, a measurable amount a is owned by an entrepreneur and the remainder $1 - a$ by the mutual fund. When the entrepreneur sells her stake in the asset, she sells a measurable portion of it. Buyers may diversify across all such real assets on sale in period 1. On the other hand, the real asset market may be organized such that buyers will have to buy all a proportion of an RA. We allow for both possibilities in our analysis. However, we show that it does not matter whether or not agents can diversify across RAs in period 1 so long as the asset markets are integrated. *Throughout we assume that markets are competitive. Thus all buyers and sellers take prices as given and, the buying price of an asset is the same as its selling price.*

Lemma 3.1 *All type* 1 *agents will sell all their assets in period* 1.

Proof: This follows directly from the utility function of type 1 agents.

Lemma 3.2 *All* $2B$ *agents will undertake strategic sale of their RAs in period* 1.

Proof: Consider a $2B$ agent in period 1. Recall that a is invested in RA and $(1-a)$ is invested in FA in period 0. As a $2B$ agent she knows, by period 1, that the quality of her RA is bad. If she hangs on to it, she will get an amount $a\underline{R}$ in period 2, and her total utility will be

$$u(a\underline{R} + (1-a)R_f).$$

Consider now the outcome if she sells her own RA. Suppose the price of an RA in period 1 is P_r. If the $2B$ agent sells her RA, she will obtain aP_r amount of liquidity. Since the buying and selling prices of RAs are the same, she can buy $(aP_r)/P_r = a$ units of RA(s) with this amount. Observe that when she can diversify across RAs in period 1 she can also choose not to do so. So, suppose she buys the entire amount of an RA being sold by another entrepreneur. Let the probability of this new RA being good be β'. Her expected utility in period 2 will be

$$\beta' u(a\overline{R} + (1-a)R_f) + (1-\beta')u(a\underline{R} + (1-a)R_f)$$

which is greater than what she gets by not trading in her bad RA so long as $\beta' > 0$. From Lemma 3.1, there will be some good RAs in the market and, hence, $\beta' > 0$. The result follows.

Observe that Lemma 3.2 is a direct result of asymmetric information. Only the owner of the real asset knows the true value of her project, and thus, a $2B$ agent can always exchange her bad real asset for another asset that gives her greater expected utility.

Let us now derive the distribution of the quality of RAs traded in the market in period 1 when $2B$ agents sell their RAs and, solve for the value of β'. The suppliers of RAs in period 1 will be all type 1 agents who have to sell (total amount at), and all type 2 agents who sell strategically (total amount $a(1-\beta)(1-t)$). The supply of good RAs will come from type 1 agents only — the measure of this being $a\beta t$. Thus, the period 1 probability of a real asset (offered for sale in the market) being good, β', is given by

$$\beta' = \frac{\beta t}{t + (1-\beta)(1-t)} = \frac{\beta t}{1 - \beta + \beta t} \tag{3.4}$$

Define

$$R' \equiv \beta' \overline{R} + (1-\beta')\underline{R} \tag{3.5}$$

Then the period 2 expected return from RAs on sale by all type 1 agents and type $2B$ agents with bad projects in period 1 is R'.

Claim 3.1 *$0 < \beta' < \beta$ and $\underline{R} < R' < R^e < \overline{R}$.*

Proof: Since $0 < \beta < 1$ and $0 < t < 1$, it follows that $0 < \beta' < \beta$ and that $\underline{R} < R' < R^e < \overline{R}$.

As far as R^e and R_f are concerned, we assume the following.

A.3.1: $0 < R_f = R^e - m < R^e$; **i.e.** $0 < m < R^e$.

Further, we have

A.3.2 *In period 1, when indifferent between RA and FA, agent E buys FA.*

We will use the following utility function for the risk averse agents:

A.3.3: *If $u(.)$ is the per period utility, then,*

$$u(.) = \gamma(.)^{\gamma}, \quad \gamma < 1, \quad \gamma \neq 0$$

In the next section, we consider the benchmark case in which the RA and the FA markets are fully integrated (FIM) and there is adequate liquidity (no liquidity crunch, NLC) with the buyers in the secondary markets.

3.3 The Benchmark Case

As a benchmark case, we first consider the situation where all markets are fully integrated (FIM) and there is no liquidity crunch (NLC). We will define a liquidity crunch as a lack of sufficient liquidity in period 1, to support prices that equate the cost of an asset to its expected return. Observe that the presence of risk neutral buyers in period 1 ensure that, the price of the asset cannot be greater than the expected return on them. On the other hand, if there is sufficient liquidity with these buyers, competitive pressures will ensure that the price of the asset must be no less than the expected return on them. Thus, with sufficient liquidity, the period 1 price P_j of asset j, $j = r$ denoting RA and $j = f$ denoting FA, will be equal to the expected return of the corresponding asset. If Z_j is the period 2 return as expected in period 1, then NLC implies $P_j = Z_j$. If, on the other hand, there is a liquidity crunch, we will have $P_j = \lambda_j Z_j$, $0 \leq \lambda_j < 1$. Let α denote, henceforth, the probability that there is enough liquidity among the buyers (NLC), i.e., $\lambda_j = 1$, and $(1 - \alpha)$ be the probability that there is a liquidity crunch (LC), or $0 \leq \lambda_j < 1$. Notice that the net demand for liquidity in period 1 comes from the agents who must consume in period 1. Type 2 agents with bad real assets are *not* net demanders of liquidity as they sell bad assets in period 1 and then use the proceeds to buy assets that will give them returns in period 2.

We model asset market integration as a situation where players can operate in either markets. As we will see later, one way the segmentation of markets will show up is the fact that λ_r may not be equal to λ_f when markets are not integrated.

As a starting point, we assume that with probability 1 there is enough liquidity in the asset markets in period 1, or $\alpha = 1$. In other words, the period 1 price of each asset in equilibrium will be equal to the expected returns on these assets.

In period 1, each E knows her type, and the quality of her RA but not the type or the asset quality of other entrepreneurs. Recall that P_f is the price of a mutual fund share in period 1, and P_r is the corresponding price of a unit of the RA. Since the presence of a liquidity crunch determines the asset prices in period 1, we now introduce the following notation. Under NLC, $P_f = \overline{P}_f$ and $P_r = \overline{P}_r$; under LC, we will have $P_f = \underline{P}_f$ and $P_r = \underline{P}_r$.

Since all entrepreneurs are identical in period 0, we can assume that they take the same decision on the amount to be invested in RA i.e. a in period 0. We analyze the problem in two stages:

(1) period 1 trades and prices, for a given portfolio choice in period 0, and

(2) portfolio choice in period 0.

3.3.1 Period 1 Trades

We will assume that trading requires no margin money. Agents submit their sale and purchase orders and the net position is calculated, and settlements made. In this scenario, the demanders of net liquidity are the type 1 agents who have to consume in period 1. The bad type 2 agents have a zero net demand for liquidity — they sell their bad projects and use the proceeds to buy other assets. At the end of the settlement, they are left with zero net liquidity. The risk neutral agents N are the ones who give up liquidity to type 1 agents and get assets instead.

In period 1, markets are fully integrated. So an agent E can sell her RA and buy FA. Recall that return on FA is non-stochastic since it is fully diversified. So an agent can diversify in period 1 after selling her RA. On the other hand, diversifying across RAs in period 1 may be difficult. For the purpose of our analysis, however, we will show that it does not matter whether or not agents can diversify across RAs in period 1. In what follows, we will consider both possibilities viz., agents can diversify across RAs in period 1, and agents cannot diversify across RAs in period 1.

Lemma 3.3 *Let $P_r = R'$, $P_f = R_f$ and markets be fully integrated. Then, it always pays a $2B$ agent to sell her RA and buy an FA.*

<u>Proof:</u> First, suppose that $2B$ can buy into only *one* RA; i.e., she cannot diversify across RAs. Let V denote her expected period 2 utility, in period 1. She sells her RA and gets aP_r amounts of liquidity, with which she buys $(aP_r)/P_r$ of a real asset on sale. This exchanged asset has a probability β' of giving a return $\underline{R}$ and a probability $(1-\beta')$ of giving a return $\underline{R}$. Thus,

$$\begin{aligned} V &= \beta' u\Big(\frac{aP_r}{P_r}\overline{R} + (1-a)R_f\Big) + (1-\beta')u\Big(\frac{aP_r}{P_r}\underline{R} + (1-a)R_f\Big) \\ &= \beta' u(a\overline{R} + (1-a)R_f) + (1-\beta')u(a\underline{R} + (1-a)R_f) \end{aligned}$$

Given concavity of $u(.)$, it follows that

$$\begin{aligned} V &< u(\beta'[a\overline{R} + (1-a)R_f] + (1-\beta')[a\underline{R} + (1-a)R_f]) \\ \Rightarrow V &< u\Big(a(\beta'\overline{R} + (1-\beta')\underline{R}) + (1-a)R_f\Big) \end{aligned}$$

Using (3.5), we get

$$V < u(aR' + (1-a)R_f)$$

Substituting P_r for R' and P_f for R_f, we get

$$V < u\left(\left[\frac{aP_r}{P_f} + (1-a)\right]R_f\right)$$

But the latter is the utility from selling RA and buying FA. So it pays to sell an RA and buy an FA when she cannot diversify across real assets in period 1.

Now suppose she can fully diversify across RAs in period 1. Then her period 2 expected utility will be

$$u(aR' + (1-a)R_f) = u\left(\left[\frac{aP_r}{P_f} + (1-a)\right]R_f\right)$$

since $P_r = R'$ and $P_f = R_f$. Observe that $u\left(\left[\frac{aP_r}{P_f} + (1-a)\right]R_f\right)$ is the utility from selling her RA and buying FA. So for anything less than complete diversification, she is better off buying the FA, while with full diversification, she is no worse off buying the FA only. Using A.3.2, the result follows.

Proposition 3.1 *Under NLC and FIM, given A.3.1 and A.3.2, there is a unique Nash equilibrium in period* 1 *in which type* 1 *agents sell all their assets, type* 2 *agents retain their FAs, type* 2*G agents retain their RAs and type* 2*B agents sell their RAs and buy FAs, and* $P_r = \overline{P}_r = R'$ *and* $P_f = \overline{P}_f = R_f$.

<u>Proof:</u> First, we show that the prices of RA and FA are R' and R_f respectively. Thereafter, we consider the behavior of type 1 and type 2 agents vis-a-vis RAs and FAs in period 1.

The period 2 return on the FA is R_f. So, its price P_f cannot be more than R_f; it cannot be less than R_f, since then there will be excess demand for FAs given that risk neutral buyers have enough liquidity and are indifferent between consuming in period 1 or period 2. Let Z_r be the expected return on the RAs offered for sale in period 1. Then, NLC implies, in the same way, $P_r = Z_r$.

We now show that it never pays a $2G$ agent to sell her RA under NLC. If all type 2 agents sell their RAs, the expected value of an RA in the market is R^e since type 1 agents always sell all their RAs in period 1 and, by Lemma 3.2, so do all $2B$ agents. So then, $P_r = Z_r = R^e$. But then, it pays a $2G$ agent not to sell her RA. By holding on to it she is guaranteed an expected utility $u(a\overline{R} + (1-a)R_f)$. Instead, if she sells her RA and,

buys a diversified portfolio of RAs, she gets $u(aR^e + (1-a)R_f)$;

or buys another RA, she gets $\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u(a\underline{R} + (1-a)R_f$;

or buys FA, she gets $u([(aP_r)/P_f + (1-a)]R_f)$.

Given that $u(.)$ is concave, $R^e < \overline{R}$ and $P_f = R_f$, it follows that a $2G$ agent should not sell her RA even when other $2G$ agents are doing so. Indeed, Z_r falls as the proportion of $2G$ agents selling their RAs falls. So, under NLC, no $2G$ agent will sell her RA in period 1.

Thus, given Lemma 3.2, the expected return on all RAs offered for sale in period 1 will be R'. The FA has a certain return of R_f in period 2. Thus, $P_r = \overline{P}_r = R'$ and $P_f = \overline{P}_f = R_f$.

Next, we consider the behavior of agents vis-a-vis RAs and FAs. From Lemma 3.1, type 1 agents sell their assets in period 1. From the above discussion, $2G$ agents retain their real assets. We now show that each type 2 agent retains her FAs in period 1. Suppose not. Then she sells her FA and buys RA. First assume that it is possible to diversify across RAs in period 1. Then she gets $\frac{(1-a)\overline{P}_f}{\overline{P}_r}$ units of RA and her return is $\frac{(1-a)\overline{P}_f}{\overline{P}_r}R'$. After substituting for the prices, we get $(1-a)R_f$ but this is equal to the return on FA. So she does not gain by deviating. Second, consider the case where it is not possible to diversify across RAs in period 1. Then her expected return per unit of RAs (purchased after using the sale proceeds of selling FAs) is $\beta'\overline{R} + (1-\beta')\underline{R}$ which is R'. So her expected return is $\frac{(1-a)\overline{P}_f}{\overline{P}_r}R'$. Again after substituting for the prices, it is clear that she gets an *expected* return of $(1-a)R_f$ but this is equal to the *certain* return on FAs. Since agent E is risk averse, she strictly prefers to retain her FAs.

Finally, from Lemma 3.3, $2B$ agents sell their RAs and buy FAs and the proposition is proved as the uniqueness of the equilibrium follows directly from the fact that $P_r = R'$ and $P_f = R_f$. *This completes the proof.*

3.3.2 Period 0 Choice

We now come to the choice of a in period 0. We will assume that all agents in period 0 know that period 1 is characterized by NLC and FIM and that the equilibrium prices in period 1 will be as given in Proposition 3.1. This allows them to form period 0 expectations about their utility and its dependence on their period 0 choice of a. But, first, a couple of obvious results that will help in the intuition of the later results.

Lemma 3.4 $tR' + (1-t)[\beta\overline{R} + (1-\beta)(\beta'\overline{R} + (1-\beta')\underline{R})] = R^e$

Proof: It is easy to check that after substituting for R' and β' in the left hand side of the expression in Lemma 3.4, using (3.4) and (3.5), we get the result.

Lemma 3.5 *Under NLC and FIM, given A.3.1 and A.3.2, the period* 0 *expected return on an RA is* R^e.

Proof: Let $\mathcal{R}$ be the return (expected in period 0) on investing in an RA under NLC in the secondary market for RAs in period 1. Since markets are fully integrated, an agent E can sell her RA and buy FAs in period 1. The sale proceeds from selling her RA under NLC in period 1 are $a\overline{P}_r$. The number of units of FA that can be bought is $\frac{a\overline{P}_r}{\overline{P}_f}$. Then the period 2 return from selling RA and buying FA is $\frac{a\overline{P}_r}{\overline{P}_f}R_f$. Hence,

$$\mathcal{R} = t\overline{P}_r + (1-t)\left[\beta\overline{R} + (1-\beta)\frac{\overline{P}_r}{\overline{P}_f}R_f\right], \quad \overline{P}_f \neq 0$$

Recall that $\overline{P}_f = R_f$ (Proposition 3.1) and $R_f > 0$ (A.3.1). Hence, $\overline{P}_f > 0$. Substituting for the prices using Proposition 3.1, we get

$$\mathcal{R} = tR' + (1-t)[\beta\overline{R} + (1-\beta)R']$$

Using (3.5), we get

$$\mathcal{R} = tR' + (1-t)[\beta\overline{R} + (1-\beta)(\beta'\overline{R} + (1-\beta')\underline{R})]$$

Using Lemma 3.4, we get $\mathcal{R} = R^e$ and hence, the result.

Given the equilibrium trades and prices in period 1 for a given a, we next examine the optimal a (denoted by a^*) in period 0.

Proposition 3.2 *Let A.3.1 and A.3.2 hold. Given NLC and FIM, investment in RA in period* 0 *is positive* ($a^* > 0$).[5]

Proof: First, note that, assuming NLC, is the same as setting $\alpha = 1$. This means that in period 1 the asset prices will be R' for the RA and R_f for the FA (Proposition 3.1).

[5] In chapter 6, we show the same result under NLC when markets are completely segmented. See Proposition 6.2.

With probability t, the risk averse agents E will be type 1 and sell their RAs at a price $\overline{P}_r$ and the FA at $\overline{P}_f$ in period 1. With $(1-t)\beta$ they will be type 2 with a good RA and not participate in the period 1 asset market. Otherwise, they will be type 2 with a bad RA and operate in the period 1 asset market as dictated by Proposition 3.1 i.e. retain $(1-a)$ units of FA and sell a units of RA for $a\overline{P}_r$ and buy $\frac{a\overline{P}_r}{\overline{P}_f}$ units of FA. So we can write the period 0 expected utility as,

$$\begin{aligned} EU^E &= tu(a\overline{P}_r + (1-a)\overline{P}_f) \\ &+ (1-t)\Big\{\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u\Big(\Big[\frac{a\overline{P}_r}{\overline{P}_f} + (1-a)\Big]R_f\Big)\Big\} \end{aligned}$$

If, in period 0, the entrepreneurs know that the conditions in Proposition 3.1 will hold in period 1, then they know the equilibrium prices that will prevail in period 1. They will use these period 1 prices to compute their expected utility in period 0, $EU^E(.)$, for each level of a they choose. Substituting for the prices from Proposition 3.1, we get

$$\begin{aligned} EU^E &= tu(aR' + (1-a)R_f) + (1-t)\Big\{\beta u(a\overline{R} + (1-a)R_f) \\ &+ (1-\beta)u(aR' + (1-a)R_f)\Big\} \end{aligned} \tag{3.6}$$

This may be rewritten as

$$\begin{aligned} EU^E &= \Big[t + (1-t)(1-\beta)\Big]u(aR' + (1-a)R_f) \\ &+ (1-t)\beta u(a\overline{R} + (1-a)R_f) \\ \Rightarrow \frac{\partial EU^E}{\partial a} &= \Big[t + (1-t)(1-\beta)\Big]u'(aR' + (1-a)R_f)[R' - R_f] \\ &+ (1-t)\beta\, u'(a\overline{R} + (1-a)R_f)[\overline{R} - R_f] \end{aligned}$$

$$\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = \Big[t + (1-t)(1-\beta)\Big] u'(R_f)[R' - R_f] + (1-t)\beta\, u'(R_f)[\overline{R} - R_f]$$
$$= u'(R_f)\Big[tR' + (1-t)[\beta\overline{R} + (1-\beta)R'] - R_f\Big]$$

Using (3.5), we get

$$\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)\Big[tR' + (1-t)[\beta\overline{R} + (1-\beta)(\beta'\overline{R} + (1-\beta')\underline{R})] - R_f\Big]$$

After using Lemma 3.4, we get

$$\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)[R^e - R_f] > 0$$

after using A.3.1. This implies that $a^* > 0$. *This completes the proof.*

The intuition for the result is straightforward. From Lemma 3.5, we know that the *expected* return (as in period 0) on an RA under NLC is R^e. On the other hand, there is a *certain* return of R_f in the case of an FA. So a risk averse agent chooses to invest in RA since $R^e > R_f$.

3.4 Do Asset Markets Need to be Integrated?

We will now consider what happens if the period 1 asset markets are not integrated. For that, we first need to define what we mean by the lack of integration or, segmentation. We will refer to the risk averse entrepreneurs who sell their assets in period 1 as suppliers. Observe that some such suppliers (viz., those $2B$ agents who sell their RAs and buy RAs or FAs), are also demanders of assets. But observe that they sell *and* buy i.e. their net demand for assets in period 1 is zero. It is only the risk neutral agents N who are the net buyers of assets in period 1. The risk neutral buyers will be termed demanders. We define market segmentation from the point of view of what each type of agent on each side of the market can do. Thus, when the suppliers can operate in both markets *but the demanders cannot*, we have the markets integrated on the supply side and term it as SIM (supply integrated market). When only the risk neutral agents can operate in both markets, we will term it as a DIM (demand integrated market). Thus, the asset markets are fully integrated only when both SIM and DIM hold — FIM = SIM + DIM. Now we turn to the question that we asked in this section - do asset markets need to be integrated?

Under NLC, the asset prices in period 1 are given as R' for the RA and R_f for the FA, from Proposition 3.1. Suppose markets are *not* SIM. This will, by definition, disallow a $2B$ agent from buying an FA after selling her bad RA. So, she will be limited to exchanging her RA for one (or many) RA(s). From the proof in Lemma 3.3, this has an effect on the period 0 choice of a only if she cannot diversify across RAs in period 1. Recall that the period 1 expected utility of period 2 is the same if she buys a FA or holds a diversified portfolio of RAs instead. Also observe that, as long as there is NLC, the integration on the demand side is not an issue as the period 1 prices are given once NLC is given. Thus:

Corollary 3.1 *Let A.3.1 and A.3.2 hold. Period* 0 *investment choices are independent of SIM and DIM, if there is NLC in period* 1 *and one can diversify across RAs in period* 1.

3.5 Separation of Ownership and Management

Chandler (1959, 1977) emphasized the positive role played by the separation of ownership and management. But the theoretical underpinnings for this were not very clear. In fact, one part of the literature (e.g. Jensen and Meckling, 1976) suggests the opposite i.e. separation of ownership and management is costly. How does one reconcile the two views? What is the positive side of the separation of ownership and management? Acemoglu (1999) has shown that when ownership and management are combined, then the equilibrium is inefficient because the zero profit condition imposed by competing financial intermediaries gives very high powered incentives to entrepreneurs. This can be avoided by the separation of ownership and management 'because the manager is not the residual claimant of the returns, and hence has low powered incentives. Therefore, the divergence of interests between owners and managers may have beneficial effects...' (Acemoglu, 1999; p. 355).

Our model also suggests that the separation of ownership and management could be useful. In our model, the reason is that when ownership and management are combined, then we have an asymmetric information problem. In the case of a real asset, the owner has prior information on the quality of the asset which others do not have. This creates an obvious moral hazard for owners of RAs. Should an agent try to sell her RA, the buyer is not sure whether it is being sold because it is a bad asset, or because the seller has liquidity needs independent of the quality of the asset. This makes it difficult for them to sell their real asset when they have liquidity needs. So consumption smoothing becomes difficult if one invests in real assets. On the other hand, in the case of financial assets, the prospective buyers are more willing to believe that the *only* reason for the owners to be selling their financial asset is to finance consumption, and not necessarily to derive gains from any informational advantage. Thus while the market for real assets is characterized by asymmetric information between buyers and sellers, financial assets are traded under symmetric information. Observe that when an agent invests in financial assets, she is delegating the management to the firm's managers. So our model suggests that delegation i.e. separation of ownership and management helps. This is in contrast to the view that the separation of ownership and management brings in distortions.

3.6 Owner Managed Firms and the Cost of Delegation

Before the long-term projects mature, agents can face a consumption liquidity shock or, given that others are facing this shock, she could get an opportunity to trade in her bad real asset for another (portfolio of) assets with higher returns. In the absence of these short term events, agents invest in a portfolio that maximizes the long term expected return adjusted for risk. But in the presence of these short term shocks, agents need to take into account the interim period before the projects mature.

We have made a distinction between *real assets* and *financial assets.* An agent can invest in *one* real asset which has a stochastic return. On the other hand, the return on (a diversified portfolio of) financial assets is non-stochastic in the long run.[6] Moreover, while the market for real assets is characterized by asymmetric information between buyers and sellers, financial assets are traded under symmetric information. This is another advantage in favor of financial assets.

The disadvantage with financial assets in a developing economy is that there is a high cost. A more efficient financial market will transfer a greater proportion of the firm value to its shareholders. In developing economies, on the other hand, given the relatively under-developed state of the institutions governing capital markets and corporate governance, shareholders get a lower proportion of the firm value compared to that in developed financial markets. So our analysis suggests that weak regulation of financial markets could account for the investment in real assets.

In emerging economies, asset markets are not well integrated. But we have shown in our model that so long as there is adequate liquidity in each of the secondary markets, it does not matter whether markets are integrated. We will show through the remaining chapters that, market segmentation plays a crucial role when the asset markets do not have sufficient liquidity.

[6] In the next chapter, we introduce the risk element in the case of financial assets.

Chapter 4

Liquidity Crunch and Integrated Markets

4.1 The Constrained Supply of Liquidity

In this chapter, as in the previous one, some agents need to consume in the short term only and before their projects mature. In the last chapter, we saw how the agents invested in a portfolio of assets that could be sold in a secondary market with adequate liquidity. However, the secondary asset markets often face a situation of inadequate liquidity on the supply side. We term this inadequate liquidity as a *liquidity crunch*, or LC. If markets are integrated, then the problem can be solved to some extent since funds can flow from one market (with enough liquidity) to another market (with inadequate liquidity). This may not fully solve the problem if there is an overall liquidity scarcity.

The plan of this chapter is as follows. In section 4.2, we set out the model. In section 4.3, we do some comparative statics. In section 4.4, we conclude.

4.2 The Model

In the last chapter we considered the case of NLC. Given our definition of α (chapter 3), this was the case when $\alpha = 1$. In this chapter we allow for the possibility of α being less than one. We can then interpret $(1 - \alpha)$ as the probability of a liquidity crunch (LC) in period 1. Chapter 3 was a special case of $\alpha = 1$.

There are three things that now become uncertain in period 0; no agent E knows her type, or the quality of her RA, or the state of liquidity in period 1. In period 1, each agent E knows her type and the quality of her project and whether there is a liquidity crunch. The first two are private information, while the third becomes common knowledge in period 1. So there is asymmetric information on the type of agents and the quality of projects in period 1.

Recall from chapter 3 that, under NLC in each market, the period 1 asset prices are $P_r = R'$ and $P_f = R_f$. The result followed in two steps. First, we showed that it never pays a $2G$ agent to sell her RA. Then we used the fact that, with NLC, the price will be equal to the expected return on the real assets offered for sale, Z_r. Since the $2G$ agents stayed away from the asset market, Z_r was equal to R'. Under LC, these prices are no longer supportable in equilibrium. However, since both asset markets continue to be fully integrated, and there are risk neutral buyers, it must be the case that

$$\frac{P_r}{Z_r} = \frac{P_f}{R_f} \equiv \lambda, \quad 0 < \lambda < 1. \tag{4.1}$$

If the first part of the equation was not satisfied, then the return per unit dollar will be different in the two markets. Given that buyers can operate in both markets, all the demand will be for the asset which has the higher return per unit cost. Thus, for both asset markets to be operative, the first equality must hold. The second equality follows from our definition of a liquidity crunch in an asset market j, $j = r, f$, in chapter 3. Asset market integration, given the first equality in (4.1), implies $\lambda_r = \lambda_f = \lambda$.

If $\lambda = 1$, we have the familiar case of NLC. As λ decreases from the benchmark value of 1, the LC becomes more severe and the ratio of price to the expected return on an asset decreases. So the extent, or the degree, of a liquidity crunch can be measured by the value of λ.

Recall that, in general, we denote the price under NLC by $\overline{P}_j$ and under LC by $\underline{P}_j$, $j = r, f$. Under integrated markets, one cannot distinguish between the extent of the LC in the two asset markets. Also, when markets are fully integrated, it cannot be the case that there is an LC in one market but not in the other. Thus, under integrated markets, $(1 - \alpha)$ is the same for both markets. When markets are not integrated, the probability of LC can be different in one market from the other but, for algebraic simplicity, we will consider the same probabilities in both markets. However, we still allow the extent of the liquidity crunch to differ across markets when they are not integrated because then, λ_r need not be equal to λ_f. We do that in the later chapters.

Period 1 Trades

Lemma 4.1 *Under FIM, it always pays a 2B agent to sell her RA and buy FA.*

Proof: Observe that, as long as $(P_r/P_f) = (Z_r/R_f)$ the proof of Lemma 3.3 holds, where Z_r is the return on RAs offered for sale in period 1. Given (4.1), the result follows.

Proposition 4.1 *Under LC and FIM, given A.3.1 and A.3.2, there is a unique Nash equilibrium in period 1, with $\underline{P}_r = \lambda R'$ and $\underline{P}_f = \lambda R_f$. In this equilibrium, type 1 agents sell all their assets. All type 2 agents retain their FAs. Type 2G agents retain their RAs, while type 2B sell their RAs and buy FAs.*

Proof: Following through in the same manner as we did for Proposition 3.1, it is immediate that type $2G$ agents will not sell their RAs as long as (4.1) is true and this is guaranteed by FIM. A type 1 agent will sell all her assets in period 1 regardless of their prices. Hence, along with Lemma 4.1, it follows that $Z_r = R'$. From (4.1), we now have $\underline{P}_r = \lambda R'$ and $\underline{P}_f = \lambda R_f$.

Consider a type 2 agent. She can never gain by buying and selling the

FA, since the buying and selling prices are the same and the period 2 return is R_f on the FA regardless of the period in which they are bought.

Now suppose that, given the prices, a type 2 agent sells her FA to buy RA. Here, the agent can acquire a new RA portfolio which is fully diversified across all the RAs that have been offered for sale. This exchange of FA for a diversified RA gives her $\frac{(1-a)P_f}{P_r}$ units of RA and her return is $\frac{(1-a)P_f}{P_r}R'$. After using (4.1), the return is $(1-a)R_f$ but this is equal to the return on FA. So she does not deviate (A.3.2). Second, consider the case where it is not possible to diversify across RAs in period 1. Then her expected return per unit of RAs (purchased after using the sale proceeds of selling FAs) is $\beta'\overline{R} + (1-\beta')\underline{R}$ which is R'. So her expected return is $\frac{(1-a)P_f}{P_r}R'$. Again after substituting for the prices, it is clear that she gets an *expected* return of $(1-a)R_f$ but this is equal to the *certain* return on FAs. Since agent E is risk averse, she strictly prefers to retain her FAs. So a type 2 agent will not gain by exchanging her FA for RA (diversified, or not).

The uniqueness of the equilibrium follows from the fact that at any other price pair for the two assets, given the risk neutrality of the liquidity suppliers, there will either be excess demand or excess supply of either one or both assets. *This completes the proof.*

As long as there is full integration across markets, the degree of liquidity crunch does not affect the nature of the equilibrium of the period 1 asset markets. It, of course, by definition can support lower absolute prices compared to the case when there is no liquidity crunch. Thus the LC in period 1 makes type 1 agents worse off than they would be under NLC.

Period 0 Choice

Recall that in chapter 3, an agent knew the equilibrium prices in period 1. Now, since there are two states of the world, we have the vectors $(\overline{P}_r, \underline{P}_r)$ and $(\overline{P}_f, \underline{P}_f)$ for the RA and the FA respectively. The agent in period 0 knows the probability with which an LC can occur and, hence, knows the probability with which a particular period 1 payoff will happen if she is of type 1. Thus, with probability α her payoffs will be as dictated by Proposition 3.1 and, with probability $(1-\alpha)$ it will be as given by Proposition 4.1. The period 0 expected utility can be written as follows:

$$\begin{aligned}
EU^E &= \alpha\Big\{tu(a\overline{P}_r + (1-a)\overline{P}_f) \\
&+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) \\
&+ (1-\beta)u\Big(\Big[\frac{a\overline{P}_r}{\overline{P}_f} + (1-a)\Big]R_f\Big)\Big]\Big\} \\
&+ (1-\alpha)\Big\{tu(a\underline{P}_r + (1-a)\underline{P}_f) \\
&+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) \\
&+ (1-\beta)u\Big(\Big[\frac{a\underline{P}_r}{\underline{P}_f} + (1-a)\Big]R_f\Big)\Big]\Big\}
\end{aligned}$$

Substituting for the prices from Propositions 3.1 and 4.1, we get

$$\begin{aligned}
EU^E &= \alpha\Big\{tu(aR' + (1-a)R_f) \\
&+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f)
\end{aligned}$$

$$
\begin{aligned}
&+ \quad (1-\beta)u(aR' + (1-a)R_f)\Big]\Big\} \\
&+ \quad (1-\alpha)\Big\{tu(a\lambda R' + (1-a)\lambda R_f) \\
&+ \quad (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) \\
&+ \quad (1-\beta)u(aR' + (1-a)R_f)\Big]\Big\} \qquad (4.2)
\end{aligned}
$$

This is the expected utility in the general case i.e. allowing for liquidity crunch in period 1. Observe that if $\alpha = 1$, in (4.2), i.e. we have NLC for certain, then, we get back the expression for the expected utility under NLC as in (3.6).

Given the equilibrium trades and prices in period 1 for a given choice of a in period 0, we now examine the optimal choice of a (denoted by a^*) in period 0.

Proposition 4.2 *Let A.3.1 - A.3.3 hold. Assume that the period* 1 *asset markets are fully integrated. We have NLC with probability* α *and LC with probability* $(1-\alpha)$. *Then the optimum portfolio is as follows:*

(1) <u>Relative risk aversion less than 1</u> $a^* > 0$.

(2) <u>Relative risk aversion greater than 1</u> $a^* > 0$ *if and only if* $m > m_1 > 0$ *where*

$$
m_1 \equiv \frac{(1-\alpha)t(\lambda^\gamma - 1)(R^e - R')}{1 - (1-\alpha)t(1-\lambda^\gamma)} \qquad (4.3)
$$

Proof: From (4.2),

$$\begin{aligned}
\frac{\partial EU^E}{\partial a} &= \alpha t u'(aR' + (1-a)R_f)[R' - R_f] \\
&+ \alpha(1-t)\beta\, u'(a\overline{R} + (1-a)R_f)[\overline{R} - R_f] \\
&+ \alpha(1-t)(1-\beta)\, u'(aR' + (1-a)R_f)[R' - R_f] \\
&+ (1-\alpha)t\, u'(a\lambda R' + (1-a)\lambda R_f)[\lambda R' - \lambda R_f] \\
&+ (1-\alpha)(1-t)\beta\, u'(a\overline{R} + (1-a)R_f)[\overline{R} - R_f] \\
&+ (1-\alpha)(1-t)(1-\beta)\, u'(aR' + (1-a)R_f)[R' - R_f] \quad (4.4)
\end{aligned}$$

Evaluating the derivative at $a = 0$, we get

$$\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \alpha t u'(R_f)[R' - R_f] \\
&+ \alpha(1-t)\beta\, u'(R_f)[\overline{R} - R_f] \\
&+ \alpha(1-t)(1-\beta)\, u'(R_f)[R' - R_f] \\
&+ (1-\alpha)t\, u'(\lambda R_f)[\lambda R' - \lambda R_f] \\
&+ (1-\alpha)(1-t)\beta\, u'(R_f)[\overline{R} - R_f] \\
&+ (1-\alpha)(1-t)(1-\beta)\, u'(R_f)[R' - R_f] \\
&= \Big[\alpha t + (1-t)(1-\beta)\Big] u'(R_f)[R' - R_f] \\
&+ (1-t)\beta\, u'(R_f)[\overline{R} - R_f] \\
&+ (1-\alpha)t\, u'(\lambda R_f)[\lambda R' - \lambda R_f]
\end{aligned}$$

Adding and subtracting $(1-\alpha)tu'(R_f)[R' - R_f]$, we get

$$\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= u'(R_f)\Big\{ \Big[t + (1-t)(1-\beta)\Big][R' - R_f] \\
&+ (1-t)\beta[\overline{R} - R_f]\Big\}
\end{aligned}$$

$$
\begin{aligned}
&+ \quad (1-\alpha)t\Big\{u'(\lambda R_f)[\lambda R' - \lambda R_f] - u'(R_f)[R' - R_f]\Big\} \\
&= \quad u'(R_f)\Big\{tR' + (1-t)\Big[\beta\overline{R} + (1-\beta)R'\Big] - R_f\Big\} \\
&+ \quad (1-\alpha)t\Big\{u'(\lambda R_f)[\lambda R' - \lambda R_f] - u'(R_f)[R' - R_f]\Big\}
\end{aligned}
$$

After using (3.5), we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= u'(R_f)\Big\{tR' + (1-t)\Big[\beta\overline{R} + (1-\beta)(\beta'\overline{R} + (1-\beta')\underline{R})\Big] - R_f\Big\} \\
&+ \quad (1-\alpha)t\Big\{u'(\lambda R_f)[\lambda R' - \lambda R_f] - u'(R_f)[R' - R_f]\Big\}
\end{aligned}
$$

Using Lemma 3.4, we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= u'(R_f)[R^e - R_f] \\
&+ \quad (1-\alpha)t\Big\{u'(\lambda R_f)[\lambda R' - \lambda R_f] - u'(R_f)[R' - R_f]\Big\}
\end{aligned}
$$

(Observe that if $\alpha = 1$, then $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)[R^e - R_f] > 0$ under A.3.1. Hence, $a^* > 0$ if $\alpha = 1$. See Proposition 3.2.) Using A.3.3, we get

$$
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = \gamma^2 R_f^{\gamma-1}\Big[R^e - R_f + (1-\alpha)t[R' - R_f](\lambda^\gamma - 1)\Big]
$$

Substituting for R_f using (3.2), we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2(R^e - m)^{\gamma-1}\Big[m + (1-\alpha)t[R' - (R^e - m)](\lambda^\gamma - 1)\Big] \\
&= \gamma^2(R^e - m)^{\gamma-1}\Big[m[1 + (1-\alpha)t(\lambda^\gamma - 1)] \\
&+ \quad (1-\alpha)t[R' - R^e](\lambda^\gamma - 1)\Big] \\
&= \gamma^2(R^e - m)^{\gamma-1}\Big[mD - (1-\alpha)t[R^e - R'](\lambda^\gamma - 1)\Big]
\end{aligned}
$$

where

$$D \equiv 1 - (1-\alpha)t(1-\lambda^\gamma) > 0 \text{ under A.3.3}^1 \tag{4.5}$$

$$\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = \gamma^2(R^e - m)^{\gamma-1}[m - m_1]D$$

where m_1 is defined as

$$m_1 \equiv \frac{(1-\alpha)t(\lambda^\gamma - 1)(R^e - R')}{1 - t(1-\alpha)(1-\lambda^\gamma)}$$

Observe that the denominator in the above expression is D (see (4.5)). Since $D > 0$ (see (4.5)), it follows that m_1 has the same sign as $(\lambda^\gamma - 1)$.

If $0 < \gamma < 1$, then $(\lambda^\gamma - 1) < 0$. On the other hand, if $\gamma < 0$, $(\lambda^\gamma - 1) > 0$. Hence, m_1 has the same sign as $(-\gamma)$. Therefore, if $0 < \gamma < 1$, then $m_1 < 0$. This implies that $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$ if $0 < \gamma < 1$. On the other hand, if $\gamma < 0$, then $m_1 > 0$. This implies that $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$ if and only if $m > m_1 > 0$ when $\gamma < 0$. Observe that under A.3.3, relative risk aversion is equal to $1-\gamma$. Hence, under LC in integrated markets, in case relative risk aversion is greater than one, then $a^* > 0$ if and only if $m > m_1 > 0$. If relative risk aversion is less than one, then $a^* > 0 \ \forall\, m \geq 0$. *This completes the proof.*

Recall that in chapter 3, we had shown that $a^* > 0$ under NLC and FIM. Now we have shown that under LC and FIM, $a^* > 0$ if relative risk aversion is less than 1. If relative risk aversion is greater than one, then m needs to

[1] Recall that under A.3.3, $\gamma < 1$, $\gamma \neq 0$. If $0 < \gamma < 1$, then, clearly we have $0 < \lambda^\gamma < 1$ which implies that $D > 0$. On the other hand, if $\gamma < 0$, then $\lambda^\gamma > 1$ which implies that $(1 - \lambda^\gamma) < 0$. This implies that $D > 0$.

be greater than $m_1 \gg 0$ before agents invest in real assets. In other words, given relative risk aversion greater than one, the possibility of a liquidity crunch actually reduces the range of values of m when the agents hold on to real assets. Alternatively, for low values of m, $m \leq m_1$, the liquidity crunch actually discourages holding on to real assets. This suggests that the more important reason for holding on to real assets in emerging economies could be the high value of m reflecting the erosion of value to owners of financial assets due to transaction costs, agency costs, etc. We will analyze this issue further in later chapters when we discuss segmented markets, and in the concluding chapter.

4.3 Comparative Statics

Before we consider comparative statics, observe that in (4.4), $a^* \gg 1$ if $R' \geq R_f$. So we for an interior solution, we need to assume

A.4.1 $R' < R_f$

Now we examine the question - what is the effect of varying the degree of liquidity crunch on the optimal portfolio?

Proposition 4.3 *Let A.3.1 - A.3.3 and A.4.1 hold. Suppose that markets are fully integrated. We have NLC with probability α and LC with probability $1-\alpha$. Suppose that $0 < a^* < 1$. Then*

$$\begin{aligned}\frac{\partial a^*}{\partial \lambda} &> 0 \, if \, S > 1 \\ &< 0 \, if \, S < 1\end{aligned}$$

where S is the relative risk aversion.

<u>Proof:</u> From the first order condition i.e. $\frac{\partial EU^E(a^*)}{\partial a} = 0$, we have

$$\frac{\partial a^*}{\partial \lambda} = -\frac{\frac{\partial^2 EU^E}{\partial a \partial \lambda}}{\frac{\partial^2 EU^E}{\partial a^2}}$$

By concavity, $\frac{\partial^2 EU^E}{\partial a^2} < 0$. Hence, the sign of $\frac{\partial a^*}{\partial \lambda}$ is the same as the sign of $\frac{\partial^2 EU^E}{\partial a \partial \lambda}$. So let us check the sign of $\frac{\partial^2 EU^E}{\partial a \partial \lambda}$. From (4.4), we get

$$\frac{\partial^2 EU^E}{\partial a \partial \lambda} = (1-\alpha)t[u''(\lambda B)\lambda B + u'(\lambda B)][R' - R_f]$$

where

$$B \equiv aR' + (1-a)R_f \tag{4.6}$$

Substituting for the relative risk aversion (S), we have

$$\frac{\partial^2 EU^E}{\partial a \partial \lambda} = (1-\alpha)t[S-1][R_f - R']u'(\lambda B)$$

Since $R_f > R'$, under A.4.1, $\frac{\partial^2 EU^E}{\partial a \partial \lambda}$ has the same sign as $[S-1]$. So

$$\begin{aligned}\frac{\partial a^*}{\partial \lambda} &> 0 \, if \, S > 1 \\ &< 0 \, if \, S < 1.\end{aligned}$$

This completes the proof.

4.4 Conclusion

In this chapter, we allowed for the possibility of a liquidity crunch in the secondary markets. That is, the amount of liquidity that will be brought in by the risk neutral buyers in period 1 is stochastic. We have considered the case of integrated markets which means that if there is a liquidity crunch, it hits both the markets to the same extent. Recall that under no liquidity crunch, the return on a financial asset was certain (chapter 3). But now under the possibility of a liquidity crunch in the secondary markets, the short term return on a financial asset is no longer certain. The return on a real asset is also uncertain. So we have two *lotteries*. What is the implication of this for the portfolio? Now, it is possible that $a^* > 0$ *even if* $m = 0$. We have shown that the 'less' risk averse choose to invest in RAs even if $m = 0$. On the other hand, for the 'more' risk averse, there is a threshold (m_1). They invest in real assets if and only if $m > m_1$.

So far, we have three differences between real assets and financial assets in our model:

(a) There is greater diversification with financial assets than with real assets.

(b) Real assets are sold in a market with asymmetric information where as financial assets are sold under symmetric information.

(c) There is an agency cost in the case of delegated investment i.e. in investing in financial assets.

We now move on to incorporating the fourth difference. The financial asset markets are very volatile. For example, "Argentina has a standard deviation of almost 30 percent and is one of eight countries for which the historical standard deviation exceeds 10 percent per month." (Rouwenhorst, 1999: p. 1443). We turn to this aspect in the next chapter.

Chapter 5

Partially Segmented Markets

5.1 Liquidity Crunch in the Financial Asset Markets Only

In the previous chapter, we have considered integrated markets. In this chapter, we take up the case of segmented markets. It may seem a bit artificial, but is conceptually important and needs to be emphasized in the context of emerging asset markets. In an economy with highly developed asset markets and with symmetric information, there is a fair degree of integration across these markets, with shocks in one market being highly correlated with shocks in another. However, in emerging economies, the asset markets are less integrated with each other and shocks in one may be negligibly correlated with shocks in some other asset market. The information asymmetry is also a serious problem in emerging economies.

Segmented markets could, in a large part, be due to the fact that the legal and policy framework in emerging economies are yet to be fully worked out. For example, in India, foreign financial institutions can invest in financial assets but foreigners are as yet unable to buy out a local entrepreneur managing her own retail business. On the other hand, a shareholder sitting outside India, can allocate funds to the foreign institutional investor but cannot directly buy the shares held by an individual in a particular company as only foreign *institutions* are allowed to operate in the stock markets. In other words, there is 'limited participation' by the providers of liquidity in each market. It is not just that an emerging economy is not well integrated with the outside world. Even within a country, the various markets tend to be somewhat segmented. For example, there is large amount of 'black money'[1] that can be invested more easily in real assets (RAs) than in financial assets (FAs). So there is usually more than adequate liquidity in the RA market at the same time that there is a liquidity crunch in the FA market.

There is a similar problem in Shleifer and Vishny (1997). This paper examines the limit of arbitrage in the stock markets. There is considerable volatility in the stock markets. This volatility can be a good arbitrage op-

[1]The share of the unofficial economy in Russia in 1995 is estimated at 41.6% (Johnson, Kaufmann and Shleifer, 1997; Table 1, p. 183). Similarly, for India, Jha (1999) writes "In the most comprehensive study to date, Acharya et.al. (1985) estimated India's black economy to be 18 – 21 percent of GDP in 1980." (Jha, 1999; p. 171). But other "Various 'guesstimates' of unaccounted income in India range from Rs. 350 – 700 thousand crore comprising more than 50 percent of GDP." (Jha, 1999; p. 173).

portunity. One can buy when the prices are low and sell when the prices are high. And, yet this arbitrage opportunity is not always fully exploited in practice. Shleifer and Vishny examine the limit of arbitrage. They explain this phenomenon in terms of the inadequate (access to) funds with the informed buyers. Observe that our assumption of the possibility of inadequate liquidity with risk neutral buyers in the financial asset market is in line with their reasoning. However, our focus is different. We are explaining why agents invest in real assets. Shleifer and Vishny, on the other hand, focus on why arbitrage becomes ineffective in extreme circumstances, when prices diverge far from fundamental values. The similarity between our model and their model is the inadequate availability of funds with the relevant traders.

There is a similar problem in Holmstrom and Tirole (1998). Firms may have liquidity problems in spite of the fact that there is no shortage of liquidity in the economy. The liquidity problems are due to the firms' inability to pledge returns to investors, as managers in firms extract private benefits which are non-verifiable. So liquidity is not sufficient. It is the access to liquidity which can be a difficulty.

In chapter 3, we discussed the role of no liquidity crunch (NLC) in an asset market in ensuring that the price of an asset is equal to the present value of the asset. In chapter 4, we discussed how under liquidity crunch (LC) in integrated markets, we have the weaker condition that the ratio of prices of two assets is equal to the ratio of their expected returns. In this chapter, we look at the case where the two asset markets are partially segmented. In particular, we assume that there is an LC in the FA market, but this is not transmitted to the RA market, which faces NLC.[2] Recall that there are two groups of risk neutral buyers N in period 1 - N_r risk neutral agents buy real assets in the RA market and N_f agents buy financial assets in the FA market. So LC in the FA market can occur despite no overall shortage of liquidity in the economy. N_f agents have limited access to funds in period 1.

In this chapter, sellers of assets can operate in both markets. In particular, they can sell in one market and use the proceeds to buy an asset in the other market. The risk neutral buyers in the two asset markets are, however, segmented. This essentially means that the rate of return on the two assets will, in general, not be the same. Given our terminology developed in earlier chapters, this is a situation of SIM (supply integrated market), where the suppliers of assets buy and sell in both markets, but the risk neutral buyers cannot operate simultaneously in both markets.[3]

So far in our analysis, the period 1 asset trading opportunity to type 2 agents arose due to asymmetric information. Recall that in chapters 3 and 4, where we had fully integrated markets, only those type 2 agents who had bad RAs exchange them for FAs and, this was regardless of whether, or not, there was an LC. In this chapter, we will show that, with segmented markets,

[2]So, even the ratio of prices of two assets is not equal to the ratio of their expected returns when asset markets are segmented.

[3]In the next chapter, we consider the opposite case where a seller in one market can buy an asset in that very market only.

even those with good RAs ($2G$ agents) can also exchange their RAs. This is because, they can now exploit, under LC, the difference between $\frac{P_r}{Z_r}$ and $\frac{P_f}{Z_f}$. Recall that Z_j is the period 2 return on asset j offered for sale in market j, as expected in period 1, $j = r$ denoting RA and $j = f$ denoting FA. The difference between the two ratios may be large enough to induce a type 2 agent to sell even her good RA. We will show that there exist multiple equilibria - one in which type $2G$ retain their RAs in period 1 and the other in which all type 2 agents sell their RAs in period 1.

The plan of this chapter is as follows. In section 5.2, we set out the model. In section 5.3, we characterize the equilibrium in which only $2B$ agents sell their RAs in period 1. In section 5.4, we characterize the equilibrium in which all type 2 agents sell their RAs in period 1. In section 5.5, we conclude.

5.2 Multiple Equilibria

The basic structure of the model is the same as has been described in chapter 3. There are two additional things. First, we assume that the buyers in period 1 are completely uncoordinated, i.e., a buyer operates only in one market, RA or FA. Second, the RA buyers have unlimited liquidity, while the FA buyers may, or may not, be constrained by liquidity.

We define an LC in the FA market by the situation that the amount of money with the buyers in the FA market is such that they cannot pay a price equal to the total value of the assets being sold. That is to say, the FA market cannot support a price $P_f = Z_f = R_f$ under LC. Therefore, an

LC occurs in the FA market when the maximum supportable FA price in period 1 is less than Z_f. For completeness, we restate the formal structure we had defined in earlier chapters. Let the period 1 asset price P_j for asset $j = r, f$, be given by

$$P_j = \lambda_j Z_j \quad j = r, f \tag{5.1}$$

In chapter 4, we had $\lambda_r = \lambda_f = \lambda$. In this chapter, the fact that the asset markets are segmented, implies that $\lambda_r \neq \lambda_f$. In this chapter, we assume that

A.5.1: $0 < \lambda_f < 1$, $\lambda_r = 1$.

As discussed earlier, since the RA market has no liquidity constraint, it follows that the period 1 RA price, P_r, will continue to reflect the true expected value of the RAs being offered in the market. The FA is now available in period 1 at a price less than its true worth, whenever λ_f is less than one. Indeed, λ_f could be low enough to encourage the $2G$ agents (those type 2 agents who have the better RAs) to exchange their RAs for low priced but high return FAs. If this were the case, then all type 2 agents, as well as all type 1 agents, will offer their RAs for sale in period 1 and the expected return on an RA on offer will be R^e rather than R'.[4] So, we have

[4]Recall that in chapters 3 and 4, since only type 1 and type $2B$ agents sold their RAs in period 1, the probability of a good RA for sale in the market is β' and hence the expected return on an RA is R'. Now, if all type 1 and all type 2 agents sell their RAs in period 1, then the probability of a good RA for sale in the market in period 1 is β. Hence the

$Z_r \in \{R', R^e\}$.

As in the previous chapter, the probability of NLC will be denoted α, and that of an LC by $(1-\alpha)$. Also, the period 1 price under NLC will be denoted by $\overline{P}_j$ and under LC by $\underline{P}_j$ $j = r, f$. Thus, $\overline{P}_r = R'$ and $\overline{P}_f = R^e$. Under A.5.1, $\underline{P}_r \in \{R', R^e\}$, $\underline{P}_f = \lambda_f Z_f$.

Observe that, if the event NLC occurs, i.e., $\lambda_f = 1$, the period 1 analysis is the same as that of chapter 3. Thus, with probability α the period 1 equilibrium will be similar to that of chapter 3. We will, therefore, concentrate on the event LC, which occurs with probability $(1-\alpha)$.

In the next section, we characterize the equilibrium in which $2G$ retain their RAs in period 1 and thereafter consider the equilibrium in which all type 2 agents sell their RAs in period 1.

5.3 Sale of Real Assets by Agents Who Have A *Lemon* or a Need for Liquidity

First, we study the period 1 trades, given the portfolio choice in period 0. Second, we study the optimal portfolio choice in period 0. Third, we study the effect of varying the degree of LC in the FA market (λ_f) on the optimum portfolio (a^*).

Period 1 Trades

Assume that there are two types of risk neutral agents - N_r agents who

expected return on an RA for sale in the market is R^e.

buy real assets, and N_f agents who buy financial assets. N_r agents operate in the RA market only. Similarly, N_f agents operate in the FA market only. Agents E can, however, operate in either market. We, therefore, have something similar to the *Unequal Access Assumption* in Errunza and Losq (1985).[5] In our terminology, we have SIM (supply integrated market) but *not* DIM (demand integrated market). In this sense, markets are not fully integrated, but are *partially integrated.*[6]

Lemma 5.1 *Suppose that markets are partially segmented (as discussed above). Let A.5.1 hold, along with A.3.1. Suppose that, in period* 1, *under LC,* $P_f = \lambda_f R_f$ *and* $P_r = R'$. *Then type* 2 *agents retain their FAs in period* 1, *and a* $2B$ *agent sells her RA and buys an FA.*

Proof: A type 2 agent can never gain by buying and selling the FA, since the buying and selling prices are the same and the period 2 return is R_f.

[5] In Errunza and Losq (1985),

> 'A subset of the investing population - the unrestricted investors - can invest in all the securities available; the others labelled the restricted investors, can trade only in a subset of the securities, those which are termed eligible; the noneligible or the ineligible securities can thus be held only by the unrestricted investors. ... we shall characterize such a market structure by the term "mild segmentation".' (Errunza and Losq, 1985;p. 107)

[6] In the next chapter, we will consider completely segmented markets as an opposite extreme of chapter 3.

Now suppose that, given the prices, a type 2 agent sells her FA to buy RA.

The exchange of FA for a diversified RA gives her $\frac{(1-a)P_f}{P_r}$ units of RA and her return is $\frac{(1-a)P_f}{P_r}R'$. This is less than $(1-a)R_f$. But $(1-a)R_f$ is equal to the return on FA. So she does not gain by such an exchange. Second, consider the case where it is not possible to diversify across RAs in period 1. Then her *expected* return is $\frac{(1-a)P_f}{P_r}R' < (1-a)R_f$ which is the *certain* return on FAs. So she prefers to retain her FAs. So a type 2 agent will not gain by exchanging her FA for RA (diversified, or not).

For the second part of the Lemma, recall that we have already shown in Lemma 3.2 that $2B$ agents always sell their RAs in period 1. So, we need only show that they will not sell their RA and buy other RA(s).

Suppose a $2B$ agent cannot fully diversify across RAs in period 1. Then her expected period 2 utility ($\mathcal{V}$) is given by

$$\mathcal{V} = \beta' u\Big(\frac{aP_r}{P_r}\overline{R} + (1-a)R_f\Big) + (1-\beta')u\Big(\frac{aP_r}{P_r}\underline{R} + (1-a)R_f\Big)$$
$$= \beta' u(a\overline{R} + (1-a)R_f) + (1-\beta')u(a\underline{R} + (1-a)R_f\Big)$$

Given concavity of $u(.)$, it follows that

$$\begin{aligned}\mathcal{V} &< u\Big(\beta'[a\overline{R} + (1-a)R_f] + (1-\beta')[a\underline{R} + (1-a)R_f]\Big) \\ &= u\Big(a(\beta'\overline{R} + (1-\beta')\underline{R}) + (1-a)R_f\Big)\end{aligned}$$

After using (3.5), we get

$$\begin{aligned}\mathcal{V} &< u(aR' + (1-a)R_f) \\ &< u\Big(\Big[\frac{aP_r}{P_f} + (1-a)\Big]R_f\Big)\end{aligned}$$

But the latter is the utility from selling RA and buying FA. [7] So it pays to sell an RA and buy an FA when she cannot diversify across RAs.

Now suppose she can fully diversify across RAs in period 1. Then her period 2 expected utility from selling an RA and buying RAs in period 1 will be

$$\begin{aligned} & u\left(\tfrac{aP_r}{P_r}R' + (1-a)R_f\right) \\ = \quad & u(aR' + (1-a)R_f) \\ < \quad & u\left(\left[\tfrac{aP_r}{P_f} + (1-a)\right]R_f\right) \end{aligned}$$

which is the utility from selling her RA and buying FA. So it pays to sell an RA and buy an FA even when she can diversify across RAs in period 1. *This completes the proof.*

Let us now put the pieces together and look at the equilibrium trades and prices in period 1 when markets are partially segmented.

Proposition 5.1 *Suppose that the real asset market and the financial asset market are partially segmented. Let A.3.1 and A.5.1 hold. Further assume that* $\lambda_f \geq \frac{R'}{R}$. *Then, under LC,* $P_f = \lambda_f R_f$ *and* $P_r = R'$ *can be supported as a Nash equilibrium in period* 1. *In this equilibrium, type* 1 *agents sell all their assets. Also all type* 2 *agents retain their FAs, type* 2*G agents retain their RAs and type* 2*B agents sell their RAs and buy FAs.*

[7] $P_f = \lambda_f R_f > 0$ since $R_f > 0$ under A.3.1.

State of the World	Probability	P_f	P_r
NLC in FA market	α	R_f	R'
LC in FA market	$1-\alpha$	$\lambda_f R_f$	R'

Table 5.1: Prices of assets under liquidity crunch in the financial asset market when real assets are sold by agents who have a *lemon* or a need for liquidity

Proof: Type 1 agents sell their assets by Lemma 3.1. Given Lemma 5.1, we only need to show that $2G$ agents will retain their RAs. From the proof of Proposition 3.1, we know that it never pays a $2G$ agent to buy RA(s). So, the only case to consider is the purchase of FA. If she sells RA and buys FA, she gets $\frac{aP_r}{P_f}R_f = \frac{aR'}{\lambda_f}$ under LC. [8] But the latter is less than or equal to $a\overline{R}$ since by assumption, $\lambda_f \geq \frac{R'}{\overline{R}}$. But this is what she gets if she retains her RA. So it does not pay a $2G$ agent to deviate. *This completes the proof.* [9]

Table 5.1 shows the equilibrium prices in period 1 when markets are partially segmented and $2G$ agents retain their RAs in period 1. This completes the discussion of period 1 trades in equilibrium.

Period 0 Choice

Next, we consider period 0 optimal portfolio choice, given the equilibrium trades and prices in period 1.

[8] $P_f = \lambda_f R_f > 0$ since $R_f > 0$ under A.3.1.

[9] We will show later that this may not be the only equilibrium.

Proposition 5.2 *Suppose that the real asset market and the financial asset market are partially segmented. Assume that we have NLC with probability α and LC with probability $1-\alpha$. Let A.3.1 - A.3.3, A.4.1 and A.5.1 hold, and, $\lambda_f \geq \frac{R'}{\overline{R}}$. Also suppose that the period 1 asset market equilibrium is as given in Proposition 5.1. Then, $a^* > 0$ if any one of the following two holds:*
(a) $\lambda_f \leq \frac{R'}{R_f}$, or
(b) $\lambda_f > \frac{R'}{R_f}$ and $\gamma > 0$.

Proof: In Proposition 3.1, we discussed equilibrium trades in period 1 under NLC. In Proposition 5.1, we discussed equilibrium trades in period 1 under LC when markets are partially segmented. So from Propositions 3.1 and 5.1, it follows that

$$\begin{aligned} EU^E &= \alpha\Big\{tu(a\overline{P}_r + (1-a)\overline{P}_f) \\ &+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u\Big(\Big[\frac{a\overline{P}_r}{\overline{P}_f} + (1-a)\Big]R_f\Big)\Big]\Big\} \\ &+ (1-\alpha)\Big\{tu(a\underline{P}_r + (1-a)\underline{P}_f) \\ &+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u\Big(\Big[\frac{a\underline{P}_r}{\underline{P}_f} + (1-a)\Big]R_f\Big)\Big]\Big\} \end{aligned}$$

Substituting for the prices from Propositions 3.1 and 5.1, we get

$$\begin{aligned} EU^E &= \alpha\Big\{tu(aR' + (1-a)R_f) \\ &+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u(aR' + (1-a)R_f)\Big]\Big\} \\ &+ (1-\alpha)\Big\{tu(aR' + (1-a)\lambda_f R_f) \\ &+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) \end{aligned}$$

$$
\begin{aligned}
&+ \quad (1-\beta)u\Big(\Big[\frac{aR'}{\lambda_f R_f}+(1-a)\Big]R_f\Big)\Big]\Big\} \\
\frac{\partial EU^E}{\partial a} &= \alpha t u'(aR'+(1-a)R_f)[R'-R_f] \\
&+ \alpha(1-t)\beta u'(a\overline{R}+(1-a)R_f)[\overline{R}-R_f] \\
&+ \alpha(1-t)(1-\beta)u'(aR'+(1-a)R_f)[R'-R_f] \\
&+ (1-\alpha)tu'(aR'+(1-a)\lambda_f R_f)[R'-\lambda_f R_f] \\
&+ (1-\alpha)(1-t)\beta u'(a\overline{R}+(1-a)R_f)[\overline{R}-R_f] \\
&+ (1-\alpha)(1-t)(1-\beta)u'\Big(\frac{aR'}{\lambda_f}+(1-a)R_f\Big)\Big[\frac{R'}{\lambda_f}-R_f\Big] \qquad (5.2)
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial EU^E}{\partial a}\Big|_{a=0} &= \alpha t u'(R_f)[R'-R_f] \\
&+ \alpha(1-t)\beta u'(R_f)[\overline{R}-R_f] \\
&+ \alpha(1-t)(1-\beta)u'(R_f)[R'-R_f] \\
&+ (1-\alpha)tu'(\lambda_f R_f)[R'-\lambda_f R_f] \\
&+ (1-\alpha)(1-t)\beta u'(R_f)[\overline{R}-R_f] \\
&+ (1-\alpha)(1-t)(1-\beta)u'(R_f)\Big[\frac{R'}{\lambda_f}-R_f\Big] \\
\Rightarrow \frac{\partial EU^E}{\partial a}\Big|_{a=0} &= u'(R_f)\Big\{\alpha t[R'-R_f]+\alpha(1-t)\beta[\overline{R}-R_f] \\
&+ \alpha(1-t)(1-\beta)[R'-R_f]+(1-\alpha)(1-t)\beta[\overline{R}-R_f]\Big\} \\
&+ (1-\alpha)tu'(\lambda_f R_f)[R'-\lambda_f R_f] \\
&+ (1-\alpha)(1-t)(1-\beta)u'(R_f)\Big[\frac{R'}{\lambda_f}-R_f\Big] \\
\Rightarrow \frac{\partial EU^E}{\partial a}\Big|_{a=0} &= u'(R_f)\Big\{[R'-R_f]\Big(\alpha t+\alpha(1-t)(1-\beta)\Big) \\
&+ [\overline{R}-R_f]\Big(\alpha(1-t)\beta+(1-\alpha)(1-t)\beta\Big)\Big\}
\end{aligned}
$$

$$
\begin{aligned}
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{[R' - R_f]\alpha\Big(t + (1-t)(1-\beta)\Big) \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)]
\end{aligned}
$$

Recall that $R' \equiv \beta'\overline{R} + (1-\beta')\underline{R}$ and that $\beta' = \frac{\beta t}{t+(1-t)(1-\beta)}$. Substituting for R' and β', we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \quad u'(R_f)\Big\{\Big[\frac{\beta t\overline{R}}{t+(1-t)(1-\beta)} \\
&+ \quad \frac{(1-\beta)\underline{R}}{t+(1-t)(1-\beta)} - R_f\Big]\alpha\Big(t+(1-t)(1-\beta)\Big) \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{\Big[\beta t\overline{R} + (1-\beta)\underline{R} - R_f\Big(t+(1-t)(1-\beta)\Big)\Big]\alpha \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)
\end{aligned}
$$

Recall that $R^e \equiv \beta\overline{R} + (1-\beta)\underline{R}$. Hence,

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \quad u'(R_f)\Big\{\Big[\beta t\overline{R} + R^e - \beta\overline{R} - R_f\Big(1-\beta(1-t)\Big)\Big]\alpha \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{\Big[R^e - \beta\overline{R}(1-t) - R_f + R_f\beta(1-t)\Big]\alpha \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\}
\end{aligned}
$$

$$
\begin{aligned}
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{\Big[(R^e - R_f) - \beta(1-t)[\overline{R} - R_f]\Big]\alpha \\
&+ \quad [\overline{R} - R_f](1-t)\beta\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{(R^e - R_f)\alpha + [\overline{R} - R_f]\beta(1-t)(1-\alpha)\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right][tu'(\lambda_f R_f)\lambda_f + (1-t)(1-\beta)u'(R_f)] \\
&= \quad u'(R_f)\Big\{(R^e - R_f)\alpha + [\overline{R} - R_f]\beta(1-t)(1-\alpha) \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right](1-\beta+\beta t)\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right]t[u'(\lambda_f R_f)\lambda_f - u'(R_f)] \\
&= \quad u'(R_f)\Big\{(R^e - R_f)\alpha \\
&+ \quad (1-\alpha)\Big[[\overline{R} - R_f]\beta(1-t) + \Big[R' + \frac{R'}{\lambda_f} - R' - R_f\Big](1-\beta+\beta t)\Big]\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right]t[u'(\lambda_f R_f)\lambda_f - u'(R_f)] \\
&= \quad u'(R_f)\Big\{(R^e - R_f)\alpha \\
&+ \quad (1-\alpha)\Big[[\overline{R} - R_f]\beta(1-t) + [R' - R_f](1-\beta+\beta t) \\
&+ \quad \frac{R'(1-\lambda_f)(1-\beta+\beta t)}{\lambda_f}\Big]\Big\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right]t[u'(\lambda_f R_f)\lambda_f - u'(R_f)] \\
&= \quad u'(R_f)\Big\{(R^e - R_f)\alpha \\
&+ \quad (1-\alpha)\Big[\overline{R}\beta(1-t) + R'(1-\beta+\beta t) - R_f
\end{aligned}
$$

$$
\begin{aligned}
&+ \quad \frac{R'(1-\lambda_f)(1-\beta+\beta t)}{\lambda_f}\Bigg]\Bigg\} \\
&+ \quad (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right] t[u'(\lambda_f R_f)\lambda_f - u'(R_f)]
\end{aligned}
$$

Using Lemma 3.4 and $R' \equiv \beta'\overline{R} + (1-\beta')\underline{R}$, we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= u'(R_f)\Bigg\{(R^e - R_f)\alpha \\
&+ (1-\alpha)\left[R^e - R_f + \frac{R'(1-\lambda_f)(1-\beta+\beta t)}{\lambda_f}\right]\Bigg\} \\
&+ (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right] t[u'(\lambda_f R_f)\lambda_f - u'(R_f)] \\
&= u'(R_f)\left\{(R^e - R_f) + (1-\alpha)\frac{R'(1-\lambda_f)(1-\beta+\beta t)}{\lambda_f}\right\} \\
&+ (1-\alpha)\left[\frac{R'}{\lambda_f} - R_f\right] t[u'(\lambda_f R_f)\lambda_f - u'(R_f)]
\end{aligned}
$$

Using A.3.3, we get

$$
\begin{aligned}
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Bigg\{(R^e - R_f) + (1-\alpha)t\frac{R'(1-\lambda_f)}{\lambda_f}\frac{(1-\beta+\beta t)}{t} \\
&+ (1-\alpha)t\left[\frac{R'}{\lambda_f} - R_f\right][\lambda_f^\gamma - 1]\Bigg\}
\end{aligned}
$$

$$
\begin{aligned}
\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Bigg\{(R^e - R_f) + (1-\alpha)t\Bigg[\frac{R'(1-\lambda_f)}{\lambda_f}\frac{(1-\beta+\beta t)}{t} \\
&+ \left[R_f - \frac{R'}{\lambda_f}\right][1-\lambda_f^\gamma]\Bigg]\Bigg\} \qquad (5.3)
\end{aligned}
$$

Note that if $\lambda_f > \frac{R'}{R_f}$, then $\left[R_f - \frac{R'}{\lambda_f}\right] > 0$. Also, if $\gamma > 0$, then $[1 - \lambda_f^\gamma] > 0$. Hence, $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$ if $\lambda_f > \frac{R'}{R_f}$ and $\gamma > 0$. This proves part (b) of the Proposition.

From (5.3),

$$
\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = \gamma^2 R_f^{\gamma-1}\Big\{(R^e - R_f)
$$

$$+ \quad (1-\alpha)t\Big[\frac{R'(1-\lambda_f)}{\lambda_f}\Big[1+\frac{(1-t)(1-\beta)}{t}\Big]$$

$$+ \quad \Big[R_f - \frac{R'}{\lambda_f}\Big][1-\lambda_f^\gamma]\Big]\Big\}$$

$$\frac{\partial EU^E}{\partial a}\Big|_{a=0} = \gamma^2 R_f^{\gamma-1}\Big\{(R^e - R_f)$$

$$+ \quad (1-\alpha)t\Big[\frac{R'(1-\lambda_f)}{\lambda_f} + \frac{R'(1-\lambda_f)}{\lambda_f}\frac{(1-t)(1-\beta)}{t}$$

$$+ \quad R_f - R_f\lambda_f^\gamma - \frac{R'}{\lambda_f} + R'\lambda_f^{\gamma-1}\Big]\Big\}$$

$$= \gamma^2 R_f^{\gamma-1}\Big\{(R^e - R_f) + (1-\alpha)t\Big[-R' + \frac{R'(1-\lambda_f)}{\lambda_f}\frac{(1-t)(1-\beta)}{t}$$

$$+ \quad R_f - R_f\lambda_f^\gamma + R'\lambda_f^{\gamma-1}\Big]\Big\}$$

$$= \gamma^2 R_f^{\gamma-1}\Big\{(R^e - R_f) + (1-\alpha)t\Big[(R_f - R') + \frac{R'(1-\lambda_f)}{\lambda_f}\frac{(1-t)(1-\beta)}{t}$$

$$+ \quad \lambda_f^{\gamma-1}[R' - \lambda_f R_f]\Big]\Big\}$$

Under A.4.1, $R_f > R'$. Hence, if $\lambda_f \leq \frac{R'}{R_f}$, then $\frac{\partial EU^E}{\partial a}\Big|_{a=0} > 0$. This proves part (a) of the Proposition. *This completes the proof.*

Both (a) and (b) are sufficient conditions, but not necessary for a^* to be greater than zero. In particular, it is evident that if λ_f is low enough, then people will hold real assets even when $m = 0$, i.e., there are no transaction, or agency costs of operating in financial assets.

Comparative Statics

How does the optimal portfolio of a risk averse agent change when the riskiness of the FA changes? As in the standard literature on comparative statics involving portfolio choice, riskiness of assets and risk aversion of agents (e.g. Hirshleifer, 1992, p. 101-2), we have ambiguous effects. The intuition is as follows. By substitution effect, the demand for an asset should fall if the asset becomes more risky. By income effect, the demand for consumption also falls in the state in which the asset can give a low return. "Nevertheless, it does not necessarily follow that there will be a reduction in purchases of the risky asset. Since each unit of [the riskier] asset ... now [can yield] fewer units of return ... than before, it *may* be the case that the individual would have to buy more units of [the riskier] asset ... even to generate the reduced quantity ... that he wants to consume." (Hirshleifer, 1992; p. 102)

The first order condition for the interior solution is $\frac{\partial EU^E(a^*)}{\partial a} = 0$. From this,

$$\frac{\partial a^*}{\partial \lambda_f} = -\frac{\frac{\partial^2 EU^E}{\partial a \partial \lambda_f}}{\frac{\partial^2 EU^E}{\partial a^2}}$$

By concavity, $\frac{\partial^2 EU^E}{\partial a^2} < 0$. Hence, the sign of $\frac{\partial a^*}{\partial \lambda_f}$ is the same as the sign of $\frac{\partial^2 EU^E}{\partial a \partial \lambda_f}$. So let us check the sign of $\frac{\partial^2 EU^E}{\partial a \partial \lambda_f}$. From (5.2), we have

$$\begin{aligned}\frac{\partial^2 EU^E}{\partial a \partial \lambda_f} &= (1-\alpha)\Big[t\Big\{u''(W)(1-a)R_f[R'-\lambda_f R_f] - u'(W)R_f\Big\} \\ &+ (1-t)(1-\beta)\Big\{-u''\Big(\frac{W}{\lambda_f}\Big)\frac{aR'}{\lambda_f^2}\frac{[R'-\lambda_f R_f]}{\lambda_f} - u'\Big(\frac{W}{\lambda_f}\Big)\frac{R'}{\lambda_f^2}\Big\}\Big]\end{aligned}$$

where

$$W \equiv aR' + (1-a)\lambda_f R_f \qquad (5.4)$$

$$\Rightarrow \frac{\partial^2 EU^E}{\partial a \partial \lambda_f} = (1-\alpha)\Big[t\Big\{-\frac{S(1-a)[R' - \lambda_f R_f]}{W} - 1\Big\}u'(W)R_f + (1-t)(1-\beta)\Big\{\frac{Sa[R' - \lambda_f R_f]}{W} - 1\Big\}u'\Big(\frac{W}{\lambda_f}\Big)\frac{R'}{\lambda_f^2}\Big]$$

where S is the relative risk aversion. The sign of $\frac{\partial^2 EU^E}{\partial a \partial \lambda_f}$ is not clear. Hence, the sign of sign of $\frac{\partial a^*}{\partial \lambda_f}$ is not clear. This completes our discussion on comparative statics.

So far, in this chapter, we have considered the equilibrium in which 2G retain their RAs in period 1. Next, we study the equilibrium in which all type 2 agents sell their RAs in period 1.

5.4 Sale of Real Assets by Agents Who Have Neither A *Lemon* Nor Any Need for Liquidity

First, we study the period 1 trades, given the portfolio choice in period 0. Second, we study the optimal portfolio choice in period 0.

Period 1 Trades

We have already discussed the behavior of agents under NLC in chapter 3. So, we now focus on the trades in period 1 under LC.

Lemma 5.2 *Suppose that the real asset market and the financial asset market are partially segmented. Let A.5.1 hold, along with A.3.1. Suppose that, in period* 1, *under LC,* $P_f = \lambda_f R_f$ *and* $P_r = R^e$. *Then type* 2 *agents retain their FAs in period* 1 *and* 2B *agents sell their RAs to buy FAs.*

Proof: The proof is exactly the same as in the case of Lemma 5.1. For the first part of the proof, replace R' in the first part of the proof for Lemma 5.1 with R^e. For the second part, replace β' and R' with β and R^e respectively. *This completes the proof.*

Proposition 5.3 *Suppose the real asset market and the financial asset market are partially segmented. Let A.3.1 and A.5.1 hold, and* $\lambda_f \leq \frac{R^e}{\overline{R}}$. *Then, under LC,* $P_f = \lambda_f R_f$ *and* $P_r = R^e$ *can be supported as a Nash equilibrium in period* 1. *In this equilibrium, type* 1 *agents sell all their assets. All type* 2 *agents retain their FAs. All type* 2 *agents sell their RAs and buy FAs.*

Proof: Type 1 agents sell their assets in period 1 by Lemma 3.1. Given Lemma 5.2, we only need to show that $2G$ agents will sell their RAs and buy FAs. Given the prices, by selling her RA and buying an FA, a $2G$ agent gets $\frac{aP_r}{P_f}R_f$ which is equal to $\frac{aR^e}{\lambda_f}$. If she retains her RA, she gets $a\overline{R}$. Given the range of values of λ_f, it follows that $2G$ will sell her RA. *This completes the proof.*

Table 5.2 shows the prices of assets when markets are partially segmented and $2G$ agents sell their RAs in period 1. Recall that in Table 5.1, $P_r = R'$ for both states of the world. In contrast, in Table 5.2, under NLC in the FA market, $P_r = R'$ and under LC in the FA market, $P_r = R^e$. Why? Recall that we have assumed NLC in the RA market. So the reason the price of RA differs in the two equilibria is that in one case, the probability of an

State of the World	Probability	P_f	P_r
NLC in FA market	α	R_f	R'
LC in FA market	$1-\alpha$	$\lambda_f R_f$	R^e

Table 5.2: Prices of assets under liquidity crunch in the financial asset market when real assets are also sold by agents who have neither a *lemon* nor any need for liquidity

RA (offered for sale in the market in period 1) being good is β' while in the other case, the probability of of an RA (offered for sale in the market in period 1) being good is β.

Period 0 Choice

If λ_f is 'low', then do agents E invest in real assets?

Proposition 5.4 *Suppose that the real asset market and the financial asset market are partially segmented. Assume that we have NLC with probability α and LC with probability $1-\alpha$. Let A.3.1, A.3.2 and A.5.1 hold. Assume that $\lambda_f \leq \frac{R^e}{R}$ and 2G sell RAs. Then $a^* > 0$.*

Proof: In Proposition 3.1, we discussed equilibrium trades in period 1 under NLC. In Proposition 5.3, we discussed equilibrium trades in period 1 under LC when asset markets are partially segmented. So from Propositions 3.1

and 5.3. it follows that expected utility is given by

$$
\begin{aligned}
EU^E &= \alpha\Big\{ tu(a\overline{P}_r + (1-a)\overline{P}_f) \\
&+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u\Big(\Big[\frac{a\overline{P}_r}{\overline{P}_f} + (1-a)\Big]R_f\Big)\Big]\Big\} \\
&+ (1-\alpha)\Big\{ tu(a\underline{P}_r + (1-a)\underline{P}_f) + (1-t)u\Big(\Big[\frac{a\underline{P}_r}{\underline{P}_f} + (1-a)\Big]R_f\Big)\Big\}
\end{aligned}
$$

Substituting for the prices from Propositions 3.1 and 5.3, we get

$$
\begin{aligned}
EU^E &= \alpha\Big\{ tu(aR' + (1-a)R_f) \\
&+ (1-t)\Big[\beta u(a\overline{R} + (1-a)R_f) + (1-\beta)u(aR' + (1-a)R_f)\Big]\Big\} \\
&+ (1-\alpha)\Big\{ tu(aR^e + (1-a)\lambda_f R_f) + (1-t)u\Big(\frac{aR^e}{\lambda_f} + (1-a)R_f\Big)\Big\}
\end{aligned}
$$

Differentiating with respect to a, we get

$$
\begin{aligned}
\frac{\partial EU^E}{\partial a} &= \alpha t u'(aR' + (1-a)R_f)[R' - R_f] \\
&+ \alpha(1-t)\beta\, u'(a\overline{R} + (1-a)R_f)[\overline{R} - R_f] \\
&+ \alpha(1-t)(1-\beta)u'(aR' + (1-a)R_f)[R' - R_f] \\
&+ (1-\alpha)t\, u'(aR^e + (1-a)\lambda_f R_f)[R^e - \lambda_f R_f] \\
&+ (1-\alpha)(1-t)\, u'\Big(\frac{aR^e}{\lambda_f} + (1-a)R_f\Big)\Big[\frac{R^e}{\lambda_f} - R_f\Big] \qquad (5.5)
\end{aligned}
$$

Evaluating the derivative at $a = 0$, we get

$$
\begin{aligned}
\frac{\partial EU^E}{\partial a}\Big|_{a=0} &= \alpha t u'(R_f)[R' - R_f] \\
&+ \alpha(1-t)\beta\, u'(R_f)[\overline{R} - R_f] \\
&+ \alpha(1-t)(1-\beta)u'(R_f)[R' - R_f] \\
&+ (1-\alpha)t\, u'(\lambda_f R_f)[R^e - \lambda_f R_f] \\
&+ (1-\alpha)(1-t)\, u'(R_f)\Big[\frac{R^e}{\lambda_f} - R_f\Big]
\end{aligned}
$$

$$\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = [\alpha t + \alpha(1-t)(1-\beta)]u'(R_f)[R' - R_f]$$
$$+ \quad \alpha(1-t)\beta\, u'(R_f)[\overline{R} - R_f]$$
$$+ \quad (1-\alpha)t\, u'(\lambda_f R_f)[R^e - \lambda_f R_f]$$
$$+ \quad (1-\alpha)(1-t)\, u'(R_f)\left[\frac{R^e}{\lambda_f} - R_f\right]$$

Adding and subtracting $(1-\alpha)tu'(R_f)[R' - R_f]$, we get

$$\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = [t + \alpha(1-t)(1-\beta)]u'(R_f)[R' - R_f]$$
$$+ \quad \alpha(1-t)\beta\, u'(R_f)[\overline{R} - R_f]$$
$$+ \quad (1-\alpha)(1-t)\, u'(R_f)\left[\frac{R^e}{\lambda_f} - R_f\right]$$
$$+ \quad (1-\alpha)t\Big\{u'(\lambda_f R_f)[R^e - \lambda_f R_f] - u'(R_f)[R' - R_f]\Big\}$$

$$\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)\Big\{tR' - R_f + \alpha(1-t)[\beta\overline{R} + (1-\beta)R']$$
$$+ \quad (1-\alpha)(1-t)\frac{R^e}{\lambda_f}\Big\}$$
$$+ \quad (1-\alpha)t\Big\{u'(\lambda_f R_f)[R^e - \lambda_f R_f] - u'(R_f)[R' - R_f]\Big\}$$

$$\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)\Big\{tR' - R_f + (1-t)[\beta\overline{R} + (1-\beta)R']$$
$$- \quad (1-\alpha)(1-t)[\beta\overline{R} + (1-\beta)R'] + (1-\alpha)(1-t)\frac{R^e}{\lambda_f}\Big\}$$
$$+ \quad (1-\alpha)t\Big\{u'(\lambda_f R_f)[R^e - \lambda_f R_f] - u'(R_f)[R' - R_f]\Big\}$$

After using (3.5) and Lemma 3.4, we get

$$\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} = u'(R_f)\Big\{R^e - R_f$$

$$+\quad (1-\alpha)(1-t)\left(\frac{R^e}{\lambda_f}-[\beta\overline{R}+(1-\beta)R^t]\right)\Big\}$$

$$+\quad (1-\alpha)t\Big\{u'(\lambda_f R_f)[R^e-\lambda_f R_f]-u'(R_f)[R^t-R_f]\Big\}$$

Using the utility function as in A.3.3, we get

$$\begin{aligned}\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Big[R^e-R_f\\ &+\ (1-\alpha)(1-t)\left(\frac{R^e}{\lambda_f}-[\beta\overline{R}+(1-\beta)R^t]\right)\\ &+\ (1-\alpha)t\Big\{\lambda_f^{\gamma-1}[R^e-\lambda_f R_f]-[R^t-R_f]\Big\}\Big]\end{aligned}$$

$$\begin{aligned}\Rightarrow \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Big[m\\ &+\ (1-\alpha)(1-t)\left(\frac{R^e}{\lambda_f}-[\beta\overline{R}+(1-\beta)R^t]\right)\\ &+\ (1-\alpha)t\Big\{\lambda_f^{\gamma-1}R^e-\lambda_f^{\gamma}(R^e-m)-R^t+R^e-m\Big\}\Big]\end{aligned}$$

where $m\equiv R^e-R_f$ (see (3.2)).

$$\begin{aligned}\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Big[mD\\ &+\ (1-\alpha)(1-t)\left(\frac{R^e}{\lambda_f}-[\beta\overline{R}+(1-\beta)R^t]\right)\\ &+\ (1-\alpha)t\Big\{\lambda_f^{\gamma-1}R^e-\lambda_f^{\gamma}R^e-R^t+R^e\Big\}\Big]\end{aligned}$$

where $D\equiv 1-(1-\alpha)t(1-\lambda_f^{\gamma})$.

$$\begin{aligned}\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= \gamma^2 R_f^{\gamma-1}\Big[mD+(1-\alpha)(1-t)\left(\frac{R^e}{\lambda_f}-\overline{R}\right)\\ &+\ (1-\alpha)(1-t)(1-\beta)(\overline{R}-R^t)\\ &+\ (1-\alpha)t\Big\{\lambda_f^{\gamma-1}(1-\lambda_f)R^e-R^t+R^e\Big\}\Big]\end{aligned}$$

Note that $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$ since $\lambda_f \leq \frac{R^e}{R}$ by assumption and $R^e > R^l$ (Claim 3.1). Hence, $a^* > 0$. *This completes the proof.*

In Proposition 5.1, we showed that $2G$ agents retaining their RAs in period 1 can be an equilibrium outcome if $\frac{R^l}{R} \leq \lambda_f$. In Proposition 5.3, we showed that $2G$ selling their RAs in period 1 is an equilibrium if $\lambda_f \leq \frac{R^e}{R}$. So, we have multiple equilibria in period 1 if $\frac{R^l}{R} \leq \lambda_f \leq \frac{R^e}{R}$. Also observe that if the period 1 equilibrium is characterized by $2G$ agents selling their RAs, then it is more likely that $a^* > 0$.

5.5 Conclusion

In this chapter, we have studied the case of partially segmented markets. There are different buyers for different assets and buyers in one market do not operate in another market. So, due to liquidity crunch, there can be more under-pricing in one market than in another market in equilibrium. We assumed that the sellers of assets can operate in the real asset market as well as in the financial asset market.

In chapter 3, we had made a distinction between real and financial assets and assumed that the investors have to pay a cost of delegation m in the case of financial assets. In chapter 4 we allowed for the possibility of liquidity crunch in integrated asset markets. In this chapter, we have allowed for (partially) segmented markets and studied the case where the liquidity crunch is a more serious issue in the financial asset market than in the real asset market.

We had already seen the moral hazard problem in chapters 3 and 4. Recall that some agents who did not face a consumption shock still sold their real assets if these were of bad quality. In this chapter, we have shown that there exist multiple equilibria. In one equilibrium, amongst type 2 agents, only $2B$ agents sell their real assets in period 1 (as in chapters 3 and 4). But in the other equilibrium, all agents E sell their real assets irrespective of their assets' quality or their liquidity needs.

Chapter 6

Completely Segmented Markets

6.1 Black Money Cannot be Used Everywhere

So far we have assumed that markets are integrated on the supply side (SIM) i.e. the type 2 agents E who are the net sellers could operate in either market. In particular, they could sell their real assets (RAs) and buy financial assets (FAs). But SIM is not always the case. Think of real estate as an example of RA. In India, there is substantial involvement of 'black money' in the real estate market. The proportion of 'black money' with the buyers in the real estate market is high[1] and so the sellers of real estate have to accept the black money otherwise, they forego the opportunity to

[1] 'For example, more than 50 percent of the value of property transacted in the real estate market in Bombay is made in black money.' (Jha, 1999)

sell. There may now be difficulty for the sellers of real estate in using the black money. In particular, the financial asset market may be such that it is difficult to hide the value of the transaction. So the money obtained in selling the RA can be used to buy other RA(s) only! This may not serve any purpose in a world of symmetric information. Recall that in our model as outlined in chapter 3, the quality of the real asset and the liquidity needs of agents E are private information. So this gives the type $2B$ agents an opportunity to get rid of their bad real asset. So in this scenario, it makes sense to sell an RA and buy other RA(s).

In this chapter, we assume that markets are not integrated on the supply side (NSIM) i.e. an agent can sell her RA and buy other RA(s) only (she cannot buy financial assets by assumption). On the demand side, we continue to assume that, in general, asset market are not integrated (NDIM).

Recall that there were two trading opportunities in chapter 5 :

[1] due to asymmetric information ($2B$ agents sell their bad RAs), and

[2] due to difference in price (in the event that the FA market is hit by a 'very severe' liquidity crunch (LC), even $2G$ agents sell their RAs).

In this chapter, since an agent can buy and sell *within* each market only, this immediately rules out the possibility of $2G$ agents trading in period 1 to take advantage of a 'very severe' LC in the FA market. So there is only one trading opportunity - for the $2B$ agents. They know that they have a bad project and the buyers do not know that the project is bad since all type 1 agents sell all their assets (good or bad). So $2B$ agents could sell their bad RA and buy other RA(s) which may be good or bad. Type $2G$ agents retain their good real asset because it does not pay to trade within the RA market and there is no other trading opportunity for them by assumption.

Typically, in the FA market, there is very little problem of indivisibility i.e. an agent can buy, subject to some *market lot* restriction[2] any small number of units of the FAs. We talked about real estate as an example of an RA for the purpose of this chapter. In much of the real estate business, there is a serious indivisibility problem. Keeping this in mind, in this chapter, we assume that the RA market involves transactions of a full piece of an RA. In other words, if a type 2 agent sells her RA, she can buy *another* RA *only* (there is no risk diversification in period 1 for a $2B$ agent).

The plan of chapter 6 is as follows. In section 6.2, we set out the model and use the mean variance approach. In section 6.3, we conclude with policy implications of our analysis.

6.2 Mean Variance Analysis

The basic structure of the model is the same as in chapter 3 except for five changes. First, real estate is the real asset in this chapter. a is invested in real estate and $(1 - a)$ is invested in financial asset in period 0. Second, in period 1, an agent E can buy and sell in the same market only (i.e. NSIM). Third, we allow for liquidity crunch in the RA market as well, though we

[2] With electronic trading in FAs, even the restriction of market lot is, it seems, on its way out.

assume that the liquidity crunch is more severe in the FA market than in the RA market. So markets are segmented on the demand side (NDIM) as well. Fourth, an RA is an indivisible asset. Fifth, we use the mean variance approach.

As in chapter 5, define $\lambda_j \equiv \frac{P_j}{R_j}$, $j = r, f$. If $\lambda_j = 1$, we have no liquidity crunch (NLC) in market j. As λ_j decreases from the benchmark value of 1, the liquidity crunch becomes more severe. We now state more formally the assumption that the liquidity crunch is more severe in the FA market than in the RA market.

A.6.1 $0 < \lambda_f < \lambda_r \leq 1$.

As in the previous chapters, we will denote the price of asset j under NLC and under LC by $\overline{P}_j$ and $\underline{P}_j$ respectively.

Consider a portfolio of two assets viz. real asset (RA) and financial asset (FA). Let Y_j be the return per unit of investment in asset j ($j = r, f$) where r stands for real asset and f stands for financial asset. Let Y be the return on the portfolio of a total investment of 1 unit, where a is invested in RA and $(1 - a)$ is invested in FA. Hence,

$$Y = aY_r + (1 - a)Y_f \tag{6.1}$$

Clearly,

$$Y^e = aY_r^e + (1 - a)Y_f^e \tag{6.2}$$

where the superscipt e denotes the mathematical expectation of the relevant variable.

Period 1 Trades

We have assumed that the RA and the FA markets are completely segmented. But observe that due to asymmetric information, there are trading opportunities within the RA market.

Proposition 6.1: *Assume that markets are completely segmented (NSIM and NDIM). Assume that we have NLC with probability α and LC with probability $1-\alpha$. Then, $\overline{P}_r = R'$, $\underline{P}_r = \lambda_r R'$, $\overline{P}_f = R_f$ and $\underline{P}_f = \lambda_f R_f$ can be supported as a Nash equilibrium in period 0. In this equilibrium, type 1 agents sell all their assets. Type 2 agents retain their FAs. Type 2G agents retain their RAs. Each type 2B agent sells her RA and buys another RA.*

Proof $\overline{P}_r = R'$, $\underline{P}_r = \lambda_r R'$, $\overline{P}_f = R_f$ and $\underline{P}_f = \lambda_f R_f$ can be supported as a Nash equilibrium in period 0 by an argument similar to that in the proof to Proposition 3.1 and Proposition 4.1. Type 1 agents sell their assets by Lemma 3.1. Type 2 agents retain their FAs because under NSIM, the only option they have is to sell FA and buy another FA. But buying and selling prices are the same. Hence, it does not pay to sell FA. Next, we show that $2G$ agents retain their RAs. Consider a deviation by a $2G$ agent. By assumption, RA and FA markets are not integrated. Hence, a $2G$ agent can sell RA to buy another RA only. If she does that, her expected utility (EU) is given by

$$\mathcal{W} = \beta' u(a\overline{R} + (1-a)R_f) + (1-\beta')u(a\underline{R} + (1-a)R_f)$$

since β' is the probability that an RA offered for sale in period 1 is good (given that type 1 and type $2B$ sell their RAs in period 1). Given concavity, it follows that

$$\begin{aligned} \mathcal{W} &< u(\beta'[a\overline{R} + (1-a)R_f] + (1-\beta')[a\underline{R} + (1-a)R_f]) \\ &= u(a[\beta'\overline{R} + (1-\beta')\underline{R}] + (1-a)R_f) \end{aligned}$$

Recall that $R' \equiv \beta'\overline{R} + (1-\beta')\underline{R}$. Hence, we have

$$\begin{aligned} \mathcal{W} &< u(aR' + (1-a)R_f) \\ &< u(a\overline{R} + (1-a)R_f) \end{aligned}$$

The latter is what she gets if she retains her RA i.e. if she does not deviate. So it does not pay a $2G$ agent to deviate.

Next, we show that each $2B$ agent sells her RA to buy another RA. Consider a deviation by a $2B$ agent. If she does not sell her RA, then her expected utility is $u(a\underline{R}+(1-a)R_f)$ which is less than $\beta' u(a\overline{R}+(1-a)R_f)+(1-\beta')u(a\underline{R}+(1-a)R_f)$. The latter is what she gets if she sells her RA and buys another RA. So it does not pay to deviate.[3] *That completes the proof.*

[3]Observe that since the markets are completely segmented, the trades by type $2B$ agents in period 1 take place within the RA market. Since buying and selling prices are equal within a market, the pattern of trades is the same under NLC and under LC.

state of the world	probability	P_f	P_r
NLC	α	R_f	R'
LC	$1-\alpha$	$\lambda_f R_f$	$\lambda_r R'$

Table 6.1: Prices of assets under liquidity crunch when markets are completely segmented

Table 6.1 shows the period 1 prices of assets in the two states of the world.[4] This completes our discussion of period 1 trades and prices.

Period 0 Choice

Table 6.2 shows the probability distribution of overall returns on RA and FA. There are three uncertainties. First, there is NLC with probability α and LC with probability $1-\alpha$ in period 1. Second, agent is type 1 with probability t and type 2 with probability $1-t$. Third, RA is good with probability β and bad with probability $1-\beta$. Hence, there should be $2^3 = 8$ states of the world. But recall that type $2B$ agents always sell their bad RAs under asymmetric information in period 1 (Lemma 3.2). In this chapter, we have assumed that markets are completely segmented, and there is no diversification of risk across RAs in period 1. Therefore, with the sale proceeds, *another* RA is bought from the market which is good with probability β' and bad with probability $1-\beta'$. Therefore, there are two cases if the event in period 1

[4]Observe that in Table 5.1 and in Table 5.2, λ_r does not appear under the column of P_r. This is because in chapter 5, we had not allowed for liquidity crunch in the real asset market.

is that agent is type 2 and the RA is bad. Again, this can happen under NLC (rows 4 and 5 in Table 6.2) or under LC (rows 9 and 10 in Table 6.2). Hence, there are 10 cases in all.

Let us first consider the probability distribution of overall returns on an RA. If the agent is type 1, the asset is sold in period 1 at $P_r = R'$ under NLC, regardless of the quality of the RA since there is asymmetric information, and R' is the expected return on an RA sold in the market in period 1. Therefore, in rows 1 and 2, the return on RA under NLC is R'. Similarly in rows 6 and 7, the return on RA under LC is $\lambda_r R'$, regardless of the quality of the RA. Consider next row 3. If the agent is type 2 and the RA is good, then the return on RA is $\overline{R}$. Observe that this is regardless of the liquidity position in the RA market in period 1. This is because the liquidity position in period 1 is irrelevant for type 2 agents who need to consume in period 2 and there is no trading opportunity in period 1 since markets are completely segmented. Hence, the return on RA is the same in rows 3 and 8. Next, consider row 4. If the agent is type 2 and the RA is bad, then the agent sells her bad RA. With the sale proceeds, she buys another RA which is good with probability β'. Hence in row 4, the return is $\overline{R}$ with the joint probability $\alpha(1-t)(1-\beta)\beta'$. Observe that the state of liquidity is irrelevant for type 2 agents. Hence, again in row 9, the return is $\overline{R}$. Similarly, in row 5 and in row 10, the return on RA is $\underline{R}$. This happens when agent is type 2, the RA is bad and is sold in period 1 and another RA is bought which is also bad. Note that in row 5, the RA is sold at $P_r = R'$

	Probability	Return on RA	Return on FA
1	$\alpha t\beta$	R'	R_f
2	$\alpha t(1-\beta)$	R'	R_f
3	$\alpha(1-t)\beta$	$\overline{R}$	R_f
4	$\alpha(1-t)(1-\beta)\beta'$	$\overline{R}$	R_f
5	$\alpha(1-t)(1-\beta)(1-\beta')$	$\underline{R}$	R_f
6	$(1-\alpha)t\beta$	$\lambda_r R'$	$\lambda_f R_f$
7	$(1-\alpha)t(1-\beta)$	$\lambda_r R'$	$\lambda_f R_f$
8	$(1-\alpha)(1-t)\beta$	$\overline{R}$	R_f
9	$(1-\alpha)(1-t)(1-\beta)\beta'$	$\overline{R}$	R_f
10	$(1-\alpha)(1-t)(1-\beta)(1-\beta')$	$\underline{R}$	R_f

Table 6.2: Probability distribution of return on real asset and on financial asset when markets are completely segmented

and in row 10, $P_r = \lambda_r R'$. But since the selling and buying prices are the same within a market in each state of the world, the return in period 2 does not depend on the state of liquidity in period 1. The return in period 2 is $\underline{R}$ in row 5 and in row 10.

Observe that β' appears in rows 4 and 5 and then again, in rows 9 and 10. In all the other rows, β' is not appearing. This is because it is only in rows 4, 5, 9 and 10 that the agent discovers in period 1 that she is type 2 and has a bad RA and sells her RA in period 1. With the sale proceeds, she buys another RA which is good with conditional probability β' (rows 4 and 9) and bad with conditional probability $1-\beta'$ (rows 5 and 10).

Consider next the probability distribution of overall returns on FA. Observe in Table 6.2 that the return on FA (in the last column) is either R_f or $\lambda_f R_f$. In the first two rows, the return is R_f because these pertain to type 1 agents who sell under NLC. In row 3 to 5 and again in rows 8 to 10, the return is R_f because these rows pertain to type 2 agents who retain their FAs till period 2 which is when they consume. Observe that the state of liquidity in period 1 does not affect the return on FAs if the agent is type 2. It is only in rows 6 and 7 that the return on FA is $\lambda_f R_f$. These two rows pertain to type 1 agents who sell under LC.

From Table 6.2, it follows that the mathematical expectation of return on real asset (Y_r^e) is given by

$$\begin{aligned}
Y_r^e &= \alpha t\beta R' + \alpha t(1-\beta)R' + \alpha(1-t)\beta\overline{R} + \alpha(1-t)(1-\beta)\beta'\overline{R} \\
&+ \alpha(1-t)(1-\beta)(1-\beta')\underline{R} + (1-\alpha)t\beta\lambda_r R' + (1-\alpha)t(1-\beta)\lambda_r R' \\
&+ (1-\alpha)(1-t)\beta\overline{R} + (1-\alpha)(1-t)(1-\beta)\beta'\overline{R} \\
&+ (1-\alpha)(1-t)(1-\beta)(1-\beta')\underline{R} \\
&= \alpha t R' + (1-t)\beta\overline{R} + (1-t)(1-\beta)\beta'\overline{R} \\
&+ (1-t)(1-\beta)(1-\beta')\underline{R} + (1-\alpha)t\lambda_r R'
\end{aligned}$$

$$\begin{aligned}
\Rightarrow Y_r^e &= tR' - (1-\alpha)tR' + (1-t)\beta\overline{R} + (1-t)(1-\beta)[\beta'\overline{R} + (1-\beta')\underline{R}] \\
&+ (1-\alpha)t\lambda_r R' \qquad (6.3)
\end{aligned}$$

This can be rewritten as

$$Y_r^e = tR' + (1-t)\left\{\beta\overline{R} + (1-\beta)[\beta'\overline{R} + (1-\beta')\underline{R}]\right\}$$

$$- \quad (1-\alpha)t(1-\lambda_r)R'$$

After after using Lemma 3.4, we get

$$Y_r^e = R^e - (1-\alpha)t(1-\lambda_r)R' \tag{6.4}$$

Observe that under NLC ($\alpha = 1$), we have $Y_r^e = R^e$. Under LC ($\alpha < 1$), we have $Y_r^e < R^e$. Consider next the variance of Y_r. From Table 6.2,

$$\begin{aligned} V[Y_r] &= \alpha t[R' - Y_r^e]^2 + (1-\alpha)t[\lambda_r R' - Y_r^e]^2 \\ &+ (1-t)[\beta + (1-\beta)\beta'][\overline{R} - Y_r^e]^2 \\ &+ (1-t)(1-\beta)(1-\beta')[\underline{R} - Y_r^e]^2 \end{aligned} \tag{6.5}$$

Remark Note that if there is no liquidity shock (NLS) i.e. if $t = 0$, then $\beta' = 0$ (see (3.4)) and $Y_r^e(t=0) = R^e$ (see (6.4)). Hence, under NLS, the variance of the return on real asset is

$$V[Y_r](t=0) = \beta[\overline{R} - R^e]^2 + (1-\beta)[\underline{R} - R^e]^2 \tag{6.6}$$

which is the variance of the project.

Next, consider the financial asset. From Table 6.2,

$$\begin{aligned} Y_f^e &= (1-\alpha)t\lambda_f R_f + [1-(1-\alpha)t]R_f \\ &= [1-(1-\alpha)t(1-\lambda_f)]R_f \end{aligned} \tag{6.7}$$

Remark If $\alpha = 1$ or $\lambda_f = 1$ or $t = 0$, then $Y_f^e = R_f$. In other words, if there is NLC or NLS, then $Y_f^e = R_f$. If there is a LS and an LC, then $Y_f^e < R_f$.

Claim 6.1 *$Y_r^e > Y_f^e$ under A.3.1 and A.6.1.*

Proof: From (6.4) and (6.7), we have

$$\begin{aligned} Y_r^e - Y_f^e &= R^e - (1-\alpha)t(1-\lambda_r)R' - [1-(1-\alpha)t(1-\lambda_f)]R_f \\ &= (R^e - R_f) + (1-\alpha)t[(1-\lambda_f)R_f - (1-\lambda_r)R'] \\ &= (R^e - R_f) + (1-\alpha)t[(R_f - R') - \lambda_f R_f + \lambda_r R'] \end{aligned}$$

Under A.6.1, $\lambda_r > \lambda_f$. Hence, we have

$$\begin{aligned} Y_r^e - Y_f^e &> (R^e - R_f) + (1-\alpha)t[(R_f - R') - \lambda_f R_f + \lambda_f R'] \\ &= (R^e - R_f) + (1-\alpha)t[(R_f - R') - \lambda_f(R_f - R')] \\ &= (R^e - R_f) + (1-\alpha)t(1-\lambda_f)(R_f - R') \end{aligned}$$

Since $R' < R^e$ (see Claim 3.1), we have

$$\begin{aligned} Y_r^e - Y_f^e &> (R^e - R_f) + (1-\alpha)t(1-\lambda_f)(R_f - R^e) \\ &> (R^e - R_f)\Big\{1 - (1-\alpha)t(1-\lambda_f)\Big\} \\ &> 0 \end{aligned}$$

using A.3.1. *This completes the proof.*

Consider next the variance of Y_f. From Table 6.2, it follows that

$$V[Y_f] = (1-\alpha)t[\lambda_f R_f - Y_f^e]^2 + [1-(1-\alpha)t][R_f - Y_f^e]^2$$

Substituting for Y_f^e using (6.7), we get

$$V[Y_f] = (1-\alpha)t\Big[\lambda_f R_f - [1-(1-\alpha)t(1-\lambda_f)]R_f\Big]^2$$

$$
\begin{aligned}
&+ \quad [1-(1-\alpha)t]\Big[R_f - [1-(1-\alpha)t(1-\lambda_f)]R_f\Big]^2 \\
&= \quad (1-\alpha)tR_f^2\Big[\lambda_f - 1 + (1-\alpha)t(1-\lambda_f)]\Big]^2 \\
&+ \quad [1-(1-\alpha)t]R_f^2\Big[(1-\alpha)t(1-\lambda_f)\Big]^2 \\
&= \quad (1-\alpha)tR_f^2(1-\lambda_f)^2[(1-\alpha)t-1]^2 \\
&+ \quad [1-(1-\alpha)t]R_f^2(1-\alpha)^2t^2(1-\lambda_f)^2 \\
&= \quad (1-\alpha)tR_f^2(1-\lambda_f)^2[1-(1-\alpha)t]^2 \\
&+ \quad [1-(1-\alpha)t]R_f^2(1-\alpha)^2t^2(1-\lambda_f)^2 \\
&= \quad (1-\alpha)tR_f^2(1-\lambda_f)^2[1-(1-\alpha)t] \qquad (6.8)
\end{aligned}
$$

Remark Note that if $t = 0$ or $\alpha = 1$ or $\lambda_f = 1$, then $V[Y_f] = 0$. In other words, if there is NLS or NLC, then $V[Y_f] = 0$. On the other hand, if there is LS and LC, then $V[Y_f] > 0$.

Next consider the variance of Y, V[Y]. From (6.1), we have

$$
V[Y] = a^2V[Y_r] + (1-a)^2V[Y_f] + 2a(1-a)\sigma \qquad (6.9)
$$

where σ is the covariance between Y_r and Y_f. From Table 6.2, it follows that

$$
\begin{aligned}
\sigma \quad &= \quad \alpha t\beta R'R_f + \alpha t(1-\beta)R'R_f + \alpha(1-t)\beta\overline{R}R_f \\
&+ \quad \alpha(1-t)(1-\beta)\beta'\overline{R}R_f + \alpha(1-t)(1-\beta)(1-\beta')\underline{R}R_f \\
&+ \quad (1-\alpha)t\beta\lambda_r R'\lambda_f R_f + (1-\alpha)t(1-\beta)\lambda_r R'\lambda_f R_f \\
&+ \quad (1-\alpha)(1-t)\beta\overline{R}R_f + (1-\alpha)(1-t)(1-\beta)\beta'\overline{R}R_f
\end{aligned}
$$

$$
\begin{aligned}
&+ \quad (1-\alpha)(1-t)(1-\beta)(1-\beta')\underline{R}R_f - Y_r^e Y_f^e \\
&= \quad \alpha t R' R_f + (1-t)\beta \overline{R} R_f + (1-t)(1-\beta)\beta' \overline{R} R_f \\
&+ \quad (1-t)(1-\beta)(1-\beta')\underline{R}R_f + (1-\alpha)t\lambda_r R' \lambda_f R_f - Y_r^e Y_f^e \\
&= \quad \Big[\alpha t R' + (1-t)\beta\overline{R} + (1-t)(1-\beta)\beta'\overline{R} \\
&+ \quad (1-t)(1-\beta)(1-\beta')\underline{R} + (1-\alpha)t\lambda_r R'\Big] R_f \\
&+ \quad (1-\alpha)t\lambda_r R'\lambda_f R_f - (1-\alpha)t\lambda_r R' R_f - Y_r^e Y_f^e
\end{aligned}
$$

Using (6.3), we get

$$
\begin{aligned}
\sigma &= Y_r^e R_f - (1-\alpha)t\lambda_r(1-\lambda_f)R'R_f - Y_r^e Y_f^e \\
&= Y_r^e(R_f - Y_f^e) - (1-\alpha)t\lambda_r(1-\lambda_f)R'R_f
\end{aligned}
\tag{6.10}
$$

Using (6.7), we get

$$
\begin{aligned}
\sigma &= Y_r^e(R_f - Y_f^e) - \lambda_r R'(R_f - Y_f^e) \\
&= (R_f - Y_f^e)(Y_r^e - \lambda_r R')
\end{aligned}
\tag{6.11}
$$

Claim 6.2 *Let A.3.1 hold. Then $\sigma = 0$ under NLC ($\alpha = 1$) and $\sigma > 0$ under LC ($\alpha < 1$).*

Proof: First, consider NLC i.e. $\alpha = 1$. From (6.7), we have $Y_f^e(\alpha = 1) = R_f$. Hence, clearly, from (6.11), it follows that $\sigma(\alpha = 1) = 0$. Next, consider LC. In (6.11), observe that $R_f > Y_f^e$ since R_f is the highest value of Y_f and Y_f^e

is the mean of Y_f (see Table 6.2). So we need only show that $Y_r^e - \lambda_r R' > 0$. From (6.4), we have

$$Y_r^e = R^e - (1-\alpha)t(1-\lambda_r)R'$$

Subtracting $\lambda_r R'$ from both sides, we get

$$\begin{aligned} Y_r^e - \lambda_r R' &= R^e - [\lambda_r.1 + (1-\lambda_r).(1-\alpha)t]R' \\ &> R^e - R' \end{aligned}$$

Bur $R^e - R' > 0$ (Claim 3.1). *This completes the proof.*

As mentioned already, in this chapter, we use the mean variance approach. We assume

A.6.2 *Let Y be the stochastic return on portfolio. Then the expected utility of a risk averse agent E (EU^E) is given by*

$$EU^E = Y^e - \frac{1}{2}\rho V[Y] \quad (6.12)$$

where ρ is absolute risk aversion.

Using (6.2) and (6.9) in (6.12), we get

$$EU^E = aY_r^e + (1-a)Y_f^e - \frac{1}{2}\rho\Big[a^2V[Y_r] + (1-a)^2V[Y_f] + 2a(1-a)\sigma\Big] \quad (6.13)$$

Proposition 6.2 *Suppose that markets are completely segmented. Assume that we have NLC with probability α and LC with probability $1-\alpha$. Let A.6.1 and A.6.2 hold, along with A.3.1. If $\alpha = 1$,* [5]*, $a^* > 0$. If $0 < \alpha < 1$ and $V[Y_f] > \sigma$, then $a^* > 0$.*

Proof: From (6.13), we have

$$\begin{aligned} \frac{\partial EU^E}{\partial a} &= Y_r^e - Y_f^e - \frac{1}{2}\rho\Big\{2aV[Y_r] - 2(1-a)V[Y_f] + 2\sigma - 4a\sigma\Big\} \\ &= Y_r^e - Y_f^e + \rho\Big\{V[Y_f] - \sigma\Big\} \\ &- \rho a\Big\{V[Y_r] + V[Y_f] - 2\sigma\Big\} \qquad (6.14) \\ \left.\frac{\partial EU^E}{\partial a}\right|_{a=0} &= Y_r^e - Y_f^e + \rho\Big\{V[Y_f] - \sigma\Big\} \end{aligned}$$

We have already shown that under A.3.1 and A.6.1, $Y_r^e - Y_f^e > 0$ (Claim 6.1). Consider the second term. Under NLC i.e. $\alpha = 1$, it is easy to check from (6.8) that $V[Y_f](\alpha = 1) = 0$. Also, $\sigma(\alpha = 1) = 0$ (Claim 6.2). Hence, under NLC, $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$. Therefore, $a^* > 0$ under NLC[6]. Next, under LC, if $V[Y_f] > \sigma$, then $\left.\frac{\partial EU^E}{\partial a}\right|_{a=0} > 0$. Therefore, $a^* > 0$ if $V[Y_f] > \sigma$ under LC. *This completes the proof.*

[5] In chapter 3, we had shown that $a^* > 0$ under NLC when markets are fully integrated.

[6] From (6.14), using the first order condition, it is easy to check that

$$a^*(\alpha = 1) = Min\left[1, \frac{m}{\rho V[Y_r](\alpha = 1)}\right]$$

6.3 Conclusion

In this chapter, we have studied the case of completely segmented markets. We considered real estate as an example of real asset. We have argued that under the prevailing conditions in the asset markets in many less developed economies like India, there is separation of the real asset and the financial asset markets. Black money is used to a large extent in real estate transactions. The financial asset markets are relatively more transparent. Also, liquidity in the secondary markets is a serious issue in the financial markets as compared to the real asset market. Moreover, the asymmetric information problem is serious in the real asset market.

These institutional realities lead to an interesting pattern of trades in equilibrium in the secondary markets. We have shown how investors trade their *lemons* for another asset within the same market. We have also shown the conditions under which in the primary market, risk averse agents choose to invest in the real assets.

Chapter 7

Conclusions and Implications

There are several issues in the context of banking. In chapter 2, we studied one of them viz. bank runs. The findings in chapter 2 on bank runs have important implications for policy. To prevent bank runs, broadly, three types of policies have been suggested. First is the idea of unitary banking, the more modern version of which is narrow banking. Second popular approach is to devise insurance guarantee schemes that will prevent bank runs. The pitfalls of such schemes in the presence of moral hazard have been highlighted in Kane (1985,1989). Indeed, Demirguc-Kunt and Detragiche (1997) provide evidence that countries with an explicit deposit insurance scheme have been more prone to financial market failures. Third is the focus on the liabilities of a bank's balance sheet. In this thesis (chapter 2), we have explored the third route. We have examined the role of equity capital in preventing bank runs. Further, we examined the question - Should the return to the depositor be fixed or state contingent?

The policy of unitary banking or narrow banking focuses on the asset side of the balance sheet. It takes it for granted that there are no conditions or restrictions on depositors. On the other hand, the complete focus on the liabilities side of the balance sheet ignores the possible diversity in the asset portfolio of the commercial banks. The question is really more general - how much capital should a bank have, how binding should the restrictions be on the (demand) depositors and how narrow should the banking be on the assets side? The more binding the restrictions on the depositors, the less the need for narrow banking. It is difficult to say very much on the optimum solution. It is this that the market needs to discover (Hayek, 1968).

In our model (chapter 2), we focussed on the liabilities side of the balance sheet of a commercial bank. On the asset side, we did not allow for a diversified portfolio. Even so, there were some implications for policy. We had shown that if banks have adequate equity capital, then risk averse depositors can get full insurance. Our model suggests that, in the present world system of global banks, there is enough risk neutral global capital to ensure that risk averse depositors in any one country can be offered full insurance against liquidity shocks, provided, of course, there is competition among banks.[1] Many transition economies, unwilling to open up their financial markets to global competition, are trying to provide full insurance to depositors by adopting the left over regulations of currently developed countries. However, these regulations are a legacy of a world order, when

[1] As in the case of pure insurance, if banks are not competitive, depositors cannot be fully insured.

banks had to be regulated for political, rather than pure economic reasons. More importantly, such regulations were initially made when competition among banks, especially with foreign ones, was not the order of the day. It is more important for transition economies to generate competition, rather than devising policies to obtain the market outcome without free competition among banks[2].

Our model suggests that free and competitive banking has its advantages. However, our model abstracts from the need to protect 'uninformed, incompetent and free-riding depositors' (Tirole, 1994; p. 476). Once we take that into account this factor and the objectives of state policy, the conclusions can be different.

The literature on unitary banking (and later, narrow banking) had emphasized the role of 100% reserves. The underlying assumption, it seems, was that it is optimal to let the depositors withdraw from the bank *on demand* unconditionally. The recent literature suggests, in the context of panic bank runs, that it is optimal to have some restriction on the depositors. This may take various forms like suspension of convertibility, contingent pay-out, etc. (see section 2.6). In the light of this analysis, can we say something about the East Asian crisis in 1997-98? One difficulty in parts of East Asia was that there were sudden and large withdrawals from the local banks. One view (e.g. Radelet and Sachs, 1998) is that panic played an important

[2] White (1984) reports, "The solidity of the Scottish banking system was not a matter of sheer luck, but is attributable to the freedom of the banks to make themselves solid and the competitive pressure on them to do so."

role in some places. These bank runs, in turn, had led to or aggravated the economic crisis in general and the currency crisis in particular in some parts of East Asia. In the aftermath of the crisis, this had strengthened the view that there ought to be restrictions on capital account convertibility (Cooper, 1999). But observe that a restriction on sudden and large withdrawals from the commercial banks would have achieved the same objective. Restriction on capital account convertibility is not necessary for this purpose. There may be other reasons for imposing restrictions on capital account convertibility. We are not going into that issue here but if sudden and large withdrawals from banks are the cause of the economic crisis in general and the currency crisis in particular, then a solution is to take corrective measures at the source rather than impose restrictions on capital account convertibility.

Deposit insurance has prevented bank runs but it has encouraged moral hazard. Several economists (e.g. Kane 1985, 1989) have suggested that deposit insurance is not an appropriate policy. Even so, the situation we face is one in which banking sector is subject to various regulations and enjoys various facilities. So the policy issue is how to steer the banking sector *in its present conditions* towards a point where they are neither subject to any unnecessary regulations nor do they enjoy any extra-ordinary facilities. At another level, as our model suggests, the role of the government is ultimately no more than ensuring that there is no breach of contract between agents.

Separation of Ownership and Management

Jensen and Meckling (1976) had shown that the separation of ownership and management is costly. On the other hand, Chandler (1959, 1977) had emphasized the positive role played by the separation of ownership and management. But the theoretical underpinnings for this view were not very clear. Recently, Acemoglu (1999) has shown that when ownership and management are combined, then the equilibrium is inefficient. Our model also suggests that the separation of ownership and management is useful (chapter 3). We made a distinction between real and financial assets and argued that investing in financial assets amounts to delegation of management and hence it leads to a *commitment to ignorance*. In the case of real assets, the owner knows the quality of the assets owned and this leads to a difficulty in selling the asset, should a liquidity shock occur. So separation of ownership and management can be useful.

Significance of A.4.1

In A.4.1, we assumed that $R' < R_f$. Recall that this assumption was necessary for getting $a^* < 1$. So what is the significance of this assumption? Recall that $R_f \equiv R^e - m$. So the assumption can be rewritten as $m < R^e - R'$. This means that the cost of delegation (m) must be small otherwise all investment is made in real assets! There are no financial assets and there is no financial asset market if the cost of delegation is high. Now if we look at some parts of Africa and Asia, it is indeed the case that the organized formal financial markets are virtually non-existent. Almost all investment is made by people in their own small farm, factory or trade, or they invest in gold or real estate. In the context of our model, this happens if m is 'very large'. What can account for a large m? In what follows, we give a broader interpretation to m and explain why it can indeed be large in emerging or developing economies.

A Broader Interpretation of the Cost of Delegation

Broadly, in the context of financial assets, there are two kinds of instruments - equity and debt. First consider equity. Investment in equity requires some conditions to be met. There has to be effective regulation of corporate sector. The weaker this regulation and enforcement, the greater is the (expected) leakage in the shifting of funds from households to corporate sector for economic activity and in the flow of returns from the corporate sector to households. The more the (expected) leakage, the less is the *realized* (expected) return on *delegated* funds. In other words, there is *effectively* a high cost of delegation. This restricts investment in financial assets. Agents are forced to invest in real assets. Note that typically regulation gets weaker as we move from developed countries to developing or emerging economies. So investment in real assets increases as we move from developed countries to developing or emerging economies[3].

[3] One interpretation of real assets or non-financial assets is the capital in owner-managed firms. It is true that in developed countries also, there is considerable investment in small owner-managed firms. But a part of this is essentially the new start-ups that are being

After considering equity, let us next consider the other instrument - debt. The finance literature emphasizes the bankruptcy element in the context of the riskiness of the debt. But, as macroeconomics emphasizes, typically debt is fixed in nominal terms. If a debt instrument is used by the corporate sector to finance projects, then the investors' claims are fixed in nominal terms. But in emerging economies or developing countries, there is a serious (potential) inflation problem (e.g. Indonesia (1997-98) or Russia (1990s)). If inflation occurs, this eats into the real value of funds delegated. This is another leakage in the context of financial assets, another cost for households in delegating. In contrast, if they invest in a real asset/owner-managed firm, then they are not prone to this risk. So the investment in real assets is pushed up. Note that the inflation risk is more serious in developing economies than in developed countries. So in developing countries, investment in real assets is relatively higher than in developed countries.

So in emerging economies, there are difficulties in using either instrument. In other words, the effective cost of delegation (m) is high. This is over and above the standard agency cost. So if we interpret m as the comprehensive cost of delegation, it includes

tried by innovative people. Some of these succeed while most fail. Those that succeed, typically do not remain in the category of owner-managed firms. They become large corporations with professional managers. The others which do not succeed, typically close down. At any point of time in developed countries, there is substantial investment in these kinds of firms. This is an ongoing activity, with new firms replacing old ones. On the other hand, the owner-managed firms in developing economies are not the transitory kinds that are experimenting. Each is virtually permanent.

(1) the (standard) agency cost, *and*

(2) the leakage due to weak regulation and enforcement, and

(3) the loss due to inflation.

Focussing on the first case alone in the context of emerging/developing economies is, to some extent, missing the wood for the trees. If there is a serious (potential) inflation problem (and indexing is absent), then who will invest in bonds or deposits? Similarly, if there is hardly any meaningful regulation of the corporate sector, the financial intermediaries and the capital markets, then will any small investor, in a developing economy, invest in equity directly or indirectly [4]? Most investment is likely to be made in real assets.

It is true that it is only in the first case (the standard agency cost) that the cost is certain; in the last two cases, the cost is stochastic. It is not certain that there will be a leakage due to weak regulation. Nor is the inflation certain. In our model, we have taken m to be a certain cost. There is scope for improvement by taking a stochastic m. But we doubt if the essence of the story will change. Real assets are in demand in emerging economies because effectively, the return on financial assets is low.

There are other explanations of this phenomenon in the literature. Iyigun and Owen (1999) explain this phenomenon in terms of the technology gap between the developed and the developing countries. Typically, investment

[4] La Porta et. al. (1998) find evidence 'consistent with the hypothesis that small, diversified shareholders are unlikely to be important in countries that fail to protect their rights.' (p. 1113)

in financial assets amounts to delegation of management to professionals. In developed economies, investment in financial assets is relatively more important. So professionals are relatively more important in developed economies. In contrast, in developing economies, entrepreneurs play an important role. Iyigun and Owen (1999)

> 'show how skill-biased technological progress leads to changes in the composition of aggregate human capital; as technology improves, individuals spend less time to the accumulation of human capital through work experience and more to the accumulation of human capital through professional training. Thus, ... entrepreneurs play a relatively more important role in intermediate-income countries and professionals are relatively more abundant in richer economies.'

In our model (chapter 3), we made a distinction between real assets and financial assets. One way to interpret a real asset is to consider a non-financial asset like an owner-managed firm. An investment in financial asset typically amounts to delegating management. Recall that in our model, by assumption, the technology is the same for the owner-managed firm and for the delegated management firm. Yet, there is a difference between the two kinds of investment. In our model, agents invest in real assets because the *net* return on financial assets is low in developing or emerging economies.

Another explanation for the existence of owner managed firms in the literature is in terms of the cost of monitoring. Locay (1990) assumes that altruistic households have less need to monitor their members than firms, giving households, a comparative advantage over professionally managed firms at low levels of output. So, in his/her model, household production takes care of a moral hazard problem, which is essentially an asymmetric information problem. Note that it is the information problem *within* the household production unit that is taken care of. But there is another asymmetric information problem *between* the household and the outsiders. The household may know the quality of the project it is managing but the outsiders do not know. If the household is hit by a liquidity shock and it needs to sell its production unit, then the outsiders' valuation may be less than the intrinsic value. This is because the outsider does not know the quality of the project. It is possible that the project is a *lemon*. Moreover, the investment in an owner-managed firm is risky since it is typically not diversified. In our model, we have tried to capture these aspects. It will be interesting to have a model that captures both the advantages of owner managed firms (as in Locay) as well as the disadvantages (as in chapter 3 of this thesis).

Liquidity

Liquidity is a very commonly used concept in the literature on Money, Banking and Finance. The term tends to be used in various different senses. In this thesis, we have made an attempt at a closer look at the concept. In our model in chapter 3 and its extensions in chapter 4, 5 and 6, we incorporated both *liquidity shock* and *liquidity crunch*. In our model, liquidity shock is the state in which an agent has assets but not the goods to consume. Liquidity crunch is a state in the market in which there is scarcity of goods relative to the availability of assets. Besides, liquidity shock and liquidity crunch, the other important concept is that of an *illiquid asset.* We have not modeled an illiquid asset[5]. It will be interesting to have a model incorporating all the three together viz. liquidity shock, illiquid asset and liquidity crunch. In a sense, the Diamond and Dybvig (1983) model does have all three elements. But there is scope for a model that explicitly also allows for an important characteristic of an illiquid asset i.e. it takes time to sell an illiquid asset. Such a model could clearly bring out the differences between the various notions of liquidity. Having said that, we hasten to add that it was the DD model (and Bryant (1980) that laid the foundation and paved the way for a large literature on not just liquidity and bank runs but also banking and finance in general.

[5]Instead, we have a *real asset* in our model. Recall that there is asymmetric information on the quality of the real asset in period 1. So it sells at a price less than that of the financial asset (under no liquidity crunch in either the real asset or the financial asset market) in period 1 even though the technology is the same in both the cases. But in our model, it does not take time to sell the RA or the FA. Both are sold immediately in the spot market. One important characteristic of an illiquid asset is that it takes time to sell the asset. There is no scope in our model in its present form for incorporating this feature. But observe that one reason why it takes time to sell an asset is that there is asymmetric information on the quality of the asset and it takes time to acquire information and remove this asymmetry in information. We do have asymmetric information on the quality of the real asset but, of course, it is not the same thing as the real asset being illiquid.

Market Integration

Globalization has received a lot of attention in the recent past. Barring the aftermath of the East Asian crisis in 1997-98, there has been considerable emphasis on integration of international capital markets. But even in the aftermath of the East Asian crisis, there has been criticism of some aspects like *sudden* inflows and outflows of funds across borders. But other than that, international capital market integration is receiving attention and policy makers are trying ways to improve international integration. In this chapter, however, we have seen how even *domestic* integration of markets in emerging economies may be problematic. This is not the place to say whether or not (orderly ?) international capital market integration should be pursued. But the issue is really integration - domestic or international. It seems that the domestic integration of markets is not an important item on the reform agenda.[6] While the problem of international capital market

[6]There have been some policies occasionally. In 1997, the Government of India launched a voluntary disclosure scheme under which anybody could disclose her black money without any questions being asked but, of course, after paying some taxes. This tax rate was effectively lower than what the honest tax payers had paid on their incomes. This led to a criticism of the scheme since the scheme would condone and encourage tax evasion. On the benefit side, in the long run context of the development of the financial markets, one advantage was ignored in this criticism. This was the fact that after disclosure, black money became legal and hence could be invested *anywhere*. In particular, money obtained after selling real assets could be used to invest in financial assets. Earlier, money earned in illegal transactions had to be either consumed or again invested in illegal transactions. This led to distortions. There is reason to believe that after disclosure, markets became

integration involves the additional difficulties of exchange rate fluctuations and sovereign risk, the domestic integration of markets should be relatively simpler. But it seems that the domestic integration is not a priority in policy making.

more integrated. But, of course, it is not clear at all that this is the best policy that could work to bring about better integration of markets since it involves condoning tax evasion.

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