Separating Trading and Banking: 
Consequences for Financial Stability*

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October 2, 2014

Abstract

We present a model to analyze the consequences of separating proprietary trading from deposit banking. Our model extends the setup of Diamond and Dybvig (1983) by differentiating between non-fungible loans and fungible securities. Endogenously, some banks use these securities to speculate and experience fundamental bank runs in bad states of the world. In some situations, traditional banking disappears completely leading to full disintermediation. Deposit insurance removes runs but induces moral hazard as banks engage more in proprietary trading. Disintermediation becomes more likely. Deposit insurance leads to a redistribution from depositors and the deposit insurance to outside investors. Separating trading from deposit banking offsets this redistribution. Nevertheless, the overall effects of separate banking on social welfare are ambiguous: Banks become more stable, reducing the costs for the deposit insurance, but the overall loan volume drops.

Keywords: Proprietary trading, disintermediation, separate banking system, Volcker Rule, Vickers Report, Liikanen Report, bank runs, deposit insurance, financial stability.

JEL-Classification: G21, G28, G01.

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*We thank Gyöngyi Lóránth and Eva Schliephake for comments and suggestions. All errors remain our own.
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1 Introduction

In recent years, we have seen a number of reform proposals aiming at fundamentally changing the structure of banking systems. The reform proposals range from a prohibition of allegedly risky activities (Volcker Rule), a ring-fencing of systemic activities (proposal by the Vickers Commission), a ring-fencing of risky activities (proposal by the Liikanen Group) to a full separation of commercial and investment banking (as under the Glass-Steagall Act). All proposals try in some way or another to separate non-traditional, market-based activities from traditional banking activities, i.e., taking deposits and granting loans. In this paper, we analyze whether such a separation is likely to increase systemic stability, and under which conditions.

We put forward a model that sticks as closely as possible to the setup by Diamond and Dybvig (1983) but enables banks to engage in proprietary trading. In our model, banks can choose between three instead of two assets. First, there is storage, which is a liquid, short-term investment. Second, there are long-term loans, which can neither be sold nor liquidated. Third, there are fungible securities. These are also long-term investments but they can be sold at the intermediate date. We assume that loans dominate securities in the long run. Nevertheless banks endogenously hold securities, but only for speculative reasons: securities are always sold at the intermediate date.

In our model, there are two kinds of agents. Consumers have preferences in the spirit of Diamond and Dybvig. Investors appear at the intermediate date and want to invest until the final date. From a modeling perspective, the only role of these investors is to determine the prices of securities (using cash-in-the-market pricing).

We discuss three different scenarios. Laissez-faire serves as a benchmark. We then analyze the introduction of deposit insurance. Finally, we discuss the introduction of separate banking, as proposed in different forms by Volcker, the Vickers Commission, or the Liikanen Group. Under *laissez-faire*, banks offer deposit contracts in order to provide liquidity insurance to consumers. On the asset side, there are two alternative strategies, both of which will be chosen in equilibrium by a subset of banks. One is the traditional Diamond-Dybvig strategy: store just enough to pay out early consumers and invest the rest in loans. The other strategy is to invest some part in risky securities and the rest in loans. If the securities perform well they can be sold at a profit, and the generated cash is used to pay out early consumers. If the securities perform poorly, there is not enough liquidity to repay consumers and the bank experiences a fundamental run. In equilibrium, just as many consumers invest in banks holding securities such that consumers are indifferent between the two bank strategies. We show that the second (risky) strategy is not bad per se: due to speculation, banks no longer need to store, hence they can invest more in loans. This is positive from a welfare perspective, given that loans have a positive NPV.
Investors also profit: they buy securities from banks, and if many banks hold securities, the market price will be low. However, risky banks are unstable and experience bank runs in bad states of the world. Safe banks never experience fundamental bank runs. In contrast, self-fulfilling runs can occur for both types of banks. Such runs involve the liquidation of loans, and thus destroy social welfare.

There is an additional, non-trivial destabilizing effect. If too many banks engage in proprietary trading, many banks will hold securities. They sell them at the interim date, hence the price will be relatively low. This implies a high yield of securities in the second period. Depositors at traditional banks are now tempted to withdraw their deposits and invest in securities instead. Traditional banks can no longer provide liquidity insurance by maturity transformation. In other words, the Jacklin critique (see Jacklin, 1987, 1993) bites endogenously, depending on the parameter constellation. When the Jacklin critique applies, the comparative disadvantage of traditional trading disappears: even more banks choose the risky strategy. Traditional banking is no longer possible; hence, there is disintermediation.

Next we introduce deposit insurance. This removes both self-fulfilling and fundamental bank runs. Hence, for banks that engage in proprietary trading there is an additional benefit from the introduction of deposit insurance because they no longer experience fundamental bank runs. Therefore, more banks start to engage in proprietary trading under the deposit insurance regime compared to laissez-faire. As a consequence, the price of securities at the interim date drops. This is beneficial only for investors. The price drops to a level where depositors do not profit. Furthermore, the condition for the Jacklin critique becomes stricter: disintermediation starts earlier (i.e., it occurs for a larger parameter range). This even harms depositors. Because the deposit insurance pays with positive probability, there are additional costs from this side. Hence, deposit insurance leads to a redistribution from the deposit insurance and depositors to investors.

We therefore consider the introduction of separate banking, i.e., banning deposit banks from proprietary trading. The ensuing equilibrium differs from laissez faire in two respects. First, those consumers that adopt the risky strategy now cannot get a suitable deposit contract, hence they must self-insure against liquidity shocks. This makes the risky strategy less attractive (fewer consumers choose it) as it forces each consumer following this strategy to hold more securities. We can show that the aggregate effect on the price of securities is ambiguous. Since deposit banks no longer engage in proprietary trading, they no longer suffer losses in the bad state of the world. In comparison to the case with deposit insurance but no restriction on proprietary trading, the distributional effects are opposite from above. With the introduction of separate banking, the deposit insurance benefits at the detriment of investors.

Second, in addition to the expected utilities of agents, we also consider aggregate loan volume. The idea is that loans to firms trigger firm growth, employment,
rents for managers and shareholders, and the like. In this respect, the introduction of separate banking has less favorable effects. Fewer consumers choose the risky strategy, and each risky consumer holds more securities and thus fewer loans. The loan volume thus drops from introducing separate banking, even in comparison to laissez-faire.

Summing up, separate banking shifts rents from investors back to the deposit insurance corporation and to depositors. Fewer consumers choose the risky strategy, and these consumers now invest directly in securities. If the securities fail, no bank runs occur and no loans are liquidated. The financial architecture becomes more stable, systemic stability increases. On the other hand, the loan volume drops. The overall welfare effect may be positive, depending on how the loan volume and investor utility are weighted in the welfare function.

Our paper is related to two recent theoretical papers dealing with the adverse effects of proprietary trading. The paper by Boot and Ratnovski (2012) shows that trading (which is scalable) crowds out relationship lending (which is not scalable), making the banking sector excessively risky. This paper makes the point that traditional banking is cannibalized by proprietary trading, but only because it can exploit a financial friction. The welfare effect can be negative. Arping (2013) also analyzes crowding-out effects. In his model, banks use trades to gamble, exploiting the safety net. Banks must be incentivized to grant traditional loans, which must thus bear a higher interest rate. The loan volume drops. But if banks are not allowed to speculate, they may gamble using their loan portfolio. Both papers thus provide a number of important insights. One important contribution of our paper concerns the joint effects of separate banking and deposit insurance. Given that proprietary trading is thought to exploit deposit insurance, we start from the liability side of the bank’s balance sheet, that is, deposits. In our paper, the changed risk of banks does not only stem from risky investment, but in particular from the reaction of depositors.

The empirical literature on separate banking is also scarce. Brunnermeier, Dong, and Palia (2012) find that banks with proprietary trading (measured by non-interest activities) contribute more to systemic risk than traditional banking. This is consistent with our model: in our model, there can be runs on banks engaged in proprietary trading, but not on traditional banks. Chow and Surti (2011), Thakor (2012), and Duffie (2012) compare and assess the Volcker Rule and the proposals from the Vickers Report conceptually, but contain neither an empirical analysis nor a formal model.

A large literature was also triggered by the Gramm-Leach-Bliley Act enacted in 1999, which ended the Glass-Steagall Act of 1933 and enabled banks to combine traditional banking with securities trading (and insurance business). This literature, includes Barth, Brumbaugh, and Wilcox (2000), Boot and Schmeits (2000), De
Nicoló, Bartholomew, Zaman, and Zephirin (2003), Freixas, Lóránth, and Morrison (2007), Laeven and Levine (2007), and Schmid and Walter (2009), just to name a few notable examples.

The remainder of the paper is structured as follows. Section 2 introduces the basic model. Section 3 discusses the equilibrium in the absence of any policy intervention (“laissez-faire”). Section 4 introduces deposit insurance as a way to avoid bank runs, at the cost of bank moral hazard. Section 5 discusses different approaches of separating banks to reduce moral hazard. Section 6 concludes.

## 2 Model Setup

Consider an economy with three dates, \( t = 0, 1, 2 \). In the economy, there are a continuum of consumers, a continuum of investors, and three types of investment technologies: storage, loans, and securities.

### Consumers

Each consumer is endowed with one unit of a good that can be consumed or invested. Consumers have preferences in the spirit of Diamond and Dybvig (1983). At date 0, a consumer knows that his utility function will be either \( u(c_1) \) with probability \( \alpha \) or \( u(c_1 + c_2) \) with probability \( 1 - \alpha \). In the first case, he is called an early consumer, in the second case, he is called a late consumer. A consumer learns his type at \( t = 1 \), but his type is unobservable to others. The basic utility function is piece-wise linear,

\[
    u(c) = \begin{cases} 
        c + \delta, & \text{for } c \geq c_0 \\
        c, & \text{for } c < c_0 
    \end{cases} 
\]

with \( \delta > 0 \) and \( c_0 > 1 \). In other words, consumers are risk neutral, but they have a preference for consuming at least some minimum consumption level \( c_0 \), which can be interpreted as a target consumption level. As Figure 1 shows, the utility function has a jump at \( c_0 \). This utility function can be used to endogenize deposit contracts in an especially simple way. Early consumers want to get \( c_0 \), independent of the interest rate. The algebraic structure of our results is simplified substantially by this assumption, while the main results carry over to more conventional utility functions.

### Asset classes: Storage, loans, and securities

There are three investment technologies, each with constant returns to scale (see Figure 2). First, one can simply store the good from date 0 to date 1, or from date 1 to date 2, with a return of 1. Second, there is a non-fungible, risky asset, called loan. The loan has...
the advantage of yielding a long-term return of $R$ with probability $\rho$ per unit of investment at date 2, and zero otherwise, with $\rho R > 1$. However, loans are assumed to be illiquid. They cannot be traded but must be kept on the books of the agent that has granted the loan. Also, they can only be liquidated at prohibitive costs: the return from liquidation is negligibly low. We further assume that

$$\rho R < 1 + \frac{\delta}{c_0}. \quad (2)$$

This implies that the long-term investment is not so good that consumers do not store at all.

**Third**, there is a fungible asset, called *security*, which also has a two-point return structure. Securities yield $Y > 1$ per unit of investment at date 2 in the good state (probability $1 - \varepsilon$) and nothing in the bad state (probability $\varepsilon$). The returns of loans and securities are stochastically independent. In contrast to loans, the date-2 realization of returns can be observed already at date 1. Hence, the securities are risky only from the perspective of date 0. At date 1, securities are safe because the future (known) payoff is already fully anticipated.\(^1\)

Securities cannot be liquidated at date 1, but they can be traded. Let $p$ denote the date-1 price of a security (if the security is worthless, which occurs with probability $\varepsilon$, the price will be zero). Hence, as opposed to loans, securities also have a short-term return. One unit of investment can be turned into $p$ units of goods at date 1, where

\(^1\)This is one important difference between loans and securities. Both are risky, but the performance of the loan is not observed until it defaults. The information on the performance of the security is resolved already at the intermediate date. The intuition is here that more information is generated on securities because they are traded. This is in line with standard theory on endogenous information aggregation (Veldkamp, 2011).
the price \( p \) is endogenous. We assume cash-in-the-market pricing in the securities market at date 1. Hence, the price depends on the net amount of liquidity that is needed at date 1, or, equivalently, on the net amount of future consumption that is offered at date 1.

Figure 2: Investment technologies in the economy

<table>
<thead>
<tr>
<th></th>
<th>( t = 0 )</th>
<th>( t = 1 )</th>
<th>( t = 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>storage</td>
<td>-1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>loan</td>
<td>-1</td>
<td>( R ) (prob. ( \rho ))</td>
<td>0 (prob. ( 1 - \rho ))</td>
</tr>
<tr>
<td>security</td>
<td>-1</td>
<td>( Y ) (prob. ( 1 - \varepsilon ))</td>
<td>0 (prob. ( \varepsilon ))</td>
</tr>
</tbody>
</table>

We assume that \( \rho R > (1 - \varepsilon) Y \). This implies that neither banks nor consumers want to hold securities until maturity. Securities are meant for trading and speculation only: with probability \( 1 - \varepsilon \), the price of the security increases, and the security can be sold at a profit. On a bank’s balance sheet, securities would thus appear in the trading book, not in the banking book.

**Investors.** There is cash-in-the-market pricing for securities at the interim date, which means that the price depends on the net volume supplied at that date. We assume that potential buyers (investors) have some demand function, induced by their utility function.\(^2\) For simplicity, we choose the utility function such that the demand function becomes linear.

Assume that a mass 1 of investors is born at date 1. These investors have the utility function \( U(c_1, c_2) = c_1 + \log(y_0 + y_1 c_2)/y_1 \), where \( y_0 \) and \( y_1 \) are positive parameters. They maximize

\[
\max_{c_1, c_2} c_1 + \frac{\log(y_0 + y_1 c_2)}{y_1} \quad \text{s. t.} \quad c_2 = (w - c_1) \cdot Y/p. \tag{3}
\]

The first-order condition yields

\[
c_1 = w - \frac{1 - p y_0}{y_1} Y \quad \text{and} \quad c_2 = \frac{y - y_0}{p y_1} Y. \tag{4}
\]

\(^2\)It is important to provide a microeconomic foundation for cash-in-the-market pricing because the utility of investors needs to be taken into account in the subsequent welfare analysis.
Solving the latter expression for $p$ yields

$$p = \frac{Y}{y_0 + y_1 c_2}. \quad (5)$$

Thus, if at date 1, consumers or intermediaries sell a net aggregate of $s$ securities to investors, the consumption of investors is $c_2 = sY$. Consequently, the price will be

$$p = \frac{Y}{y_0 + y_1 s Y}, \quad (6)$$

which is decreasing in $s$. The more securities consumers want to sell, the more investors must consume at date 2, and the lower the price $p$ will be. Because the benefit from holding securities depends on the aggregate volume of securities, the return from holding securities does not have constant returns to scale. This will generate an interior solution in the model equilibrium. The time structure of the game is given in Figure 3.

Figure 3: Sequence of events

$t = 0$ Financial intermediaries (banks) may form. Banks choose their investment strategies (storage, loans, securities) and funding strategies. If they fund with deposits, they announce short and long deposit rates $r_1$ and $r_2$.
* Consumers invest directly or deposit in banks; banks invest.

$t = 1$ The security’s future performance ($Y$ or 0) is observed.
* Realization of liquidity shocks: consumers observe whether they are early or late types.
* Opening of securities market: banks sell or buy assets (among themselves and from investors), the security price depends on the realization of the future performance.
* Consumers can withdraw deposits from banks.

$t = 2$ Loans pay out $R$ (probability $\rho$), otherwise 0. Securities pay out $Y$ (probability $1 - \epsilon$), otherwise 0.
* Banks pay out late withdrawers.

3 Laissez-Faire

We start the discussion in a laissez-faire environment. There is no deposit insurance in place, and there are no legal restrictions on bank assets.

In our framework, deposit banks form endogenously. The reason is slightly different from that in Diamond and Dybvig (1983). Households would like to invest in loans,
because they have the best long-term performance. However, if they need to consume early, they are stuck with the loans because of the assumption that these cannot be traded. As a consequence, they prefer to deposit their money at a financial intermediary. The intermediary offers a demand deposit.

Consumers can withdraw their deposit at date 1, the promised gross deposit rate at that date is $r_1$. If they wait until date 2, the gross return is $r_2$. We assume that, if the bank is unable to honor all claims at some date, consumers get a pro rate share of the bank’s resources. Financial intermediaries (banks) are assumed to operate under perfect competition. They attract consumers by announcing their investment plans and repayment schedules. Moral hazard between bankers and depositors is thus ruled out. In fact, due to the perfect competition, the bankers’ only role is to maximize the expected utility of his bank’s depositors. We can thus identify a bank with its depositors.

**Some Basic Observations.** We start with a couple of observations. *First*, in equilibrium, consumers will deposit their entire wealth at a bank. If they stored part of their wealth, and if they found out at date 1 that they are late consumers, they would want to buy either loans or securities. But loans cannot be traded, and securities have a lower long-term return than loans. Hence, depositing at a bank yields a better expected return.

*Second*, each bank will promise its early depositors $r_1 = c_0$. A short deposit rate of $r_1 < c_0$ would mean that early depositors would falls short of their threshold consumption with certainty; this is undesirable (at least, if $\delta$ is not too small). A rate of $r_1 > c_0$ would imply that depositors forego the positive long-term return. Consequently, we can set $r_1 = c_0$ for all banks.

*Third*, in equilibrium, there are only two possible investment strategies for a bank. It either invests nothing in the security (safe strategy), or alternatively it stores nothing (risky strategy). Because the long-term return of the security is dominated by the loan, the security is only used for “speculation” (short-term investment in hope of a high return). That implies that it crowds out storage. With probability $\varepsilon$, the security fails and repays nothing, not even in the short run. In this case, all early depositors fall short of their target consumption $c_0$. Hence, if the security does not fail, it must return more than storage. Thus, mixing the security and storage makes no sense: it bears the same risk as having only securities and no storage, but has a lower expected return. The banking market is thus segmented: there are safe banks, holding storage and loans, and there are risky banks, holding securities and loans. The securities are never held until termination, but are sold at date 1.
3.1 Safe Banks

As argued above, safe banks hold only two assets: storage goods and loans. They need to store $\alpha r_1 = \alpha c_0$ for the expected withdrawals of early consumers. They invest the remaining $1 - \alpha c_0$ in loans, yielding an expected return of $(1 - \alpha c_0) \rho R$. Because of perfect competition between banks, this return must be distributed completely between the mass $1 - \alpha$ of late consumers. Each late consumer can thus be promised a deposit rate of

$$r_{2\text{safe}}^2 = \frac{1 - \alpha c_0}{1 - \alpha} \rho R.$$  (7)

Let us assume that this contract is incentive compatible for now. Whether this is true depends on the yield $y$ on the security. If $y$ is high, thus securities are cheap to buy at date 1, then even late depositors have an incentive to withdraw their money early and use the money to buy securities instead. The condition for incentive compatibility is $r_{2\text{safe}}^2 \geq y r_1$. We will discuss this condition below, when we have endogenized $y$.

Of course, even if the bank offers consumers the deposit contract with deposit rates $r_1$ and $r_2$ as specified, there is always a run equilibrium. If all (or too many) late consumers withdraw their money early, loans need to be liquidated. Because the liquidation value is assumed to be zero, nothing will be left for late consumers that do not withdraw. It is hence optimal in that case to withdraw. Like in Diamond and Dybvig (1983), such a run equilibrium can be switched off by implementing a deposit insurance scheme. The consequences of a deposit insurance scheme on the equilibrium is discussed in Section 4.

In the good equilibrium, early depositors receive $c_1 = r_1 = c_0$. They meet their target consumption level, hence their utility is $u(c_1) = c_0 + \delta$. Late depositors also meet their target level, hence the aggregate expected utility of a consumer from an ex-ante perspective is

$$EU_{\text{safe}} = \alpha (c_0 + \delta) + (1 - \alpha) \left( \frac{1 - \alpha c_0}{1 - \alpha} \rho R + \delta \right)$$

$$= \rho R - \alpha c_0 (\rho R - 1) + \delta.$$  (8)

For comparison, let us check how much a consumer could achieve by investing his endowment in loans. If the consumer is an early type, he misses $c_0$ and does not obtain the utility add-on of $\delta$. If he is a late type, he can reap the return from the loans. Due to the budget constraint, he cannot get more than $\rho R/(1 - \alpha)$, thus in expected terms $(1 - \alpha) \rho R/(1 - \alpha) = \rho R$. The expected utility is then $\rho R + (1 - \alpha) \delta$. A comparison with the above $EU_{\text{safe}}$ shows that the deposit contract from a safe bank increases consumers’ utility if condition (2) holds, hence if loans are not too attractive.
3.2 Risky Banks

Risky banks follow a different strategy. As argued above, they hold only securities and loans, but not storage goods. There are two scenarios. If the security fails, it is worth nothing (probability $\varepsilon$). Still, the bank needs to pay out early depositors. It needs to liquidate loans, but the liquidation value is assumed to be zero. Late investors will run. Still, with probability $\varepsilon$, neither early nor late depositors get any return. They certainly also miss their target consumption level $c_0$. In other words, with probability $\varepsilon$, banks that follow the risky strategy are unable to insure consumers against the risk of a liquidity shock.

This clear disadvantage of the risky strategy must be compensated by a benefit. With probability $1 - \varepsilon$, the security will pay out $Y$ at date 2, it is then worth $p$ at date 1. If a bank holds $s$ securities, these will be worth $sp$ at date 1. Because of perfect competition, banks take $p$ as given. Banks must pay out the promised $\alpha c_0$ to early depositors. They will not want to hold more securities then necessary (since $(1 - \varepsilon)Y < \rho R$, they would then prefer to hold loans). Hence, $sp = \alpha c_0$. Each bank holds $s = \frac{\alpha c_0}{p}$ securities.

This is the advantage of investing in securities: because they are profitable in the short run, banks need to hold fewer securities than they would have to hold storage goods. A bank can invest $1 - s = 1 - \frac{\alpha c_0}{p}$ in loans. The expected return is $(1 - \frac{\alpha c_0}{p}) \rho R$, thus each late depositor can be promised

$$r^\text{risky}_2 = \frac{1 - \frac{\alpha c_0}{p}}{1 - \alpha} \rho R. \quad (9)$$

What happens if the security fails? The bank will have to liquidate some of its loans. The liquidation value is zero, however. The bank must thus liquidate everything, the bank virtually disappears completely. Neither early nor late depositors receive anything. The aggregate expected utility of a consumer from an ex-ante perspective is thus

$$EU^\text{risky} = \varepsilon \cdot 0 + (1 - \varepsilon) \left( \alpha c_0 + (1 - \alpha) r^\text{risky}_2 + \delta \right)$$

$$= (1 - \varepsilon) \left( \alpha c_0 + (1 - \alpha) \frac{1 - \frac{\alpha c_0}{p}}{1 - \alpha} \rho R + \delta \right). \quad (10)$$

3.3 Equilibrium

In equilibrium, consumers must be indifferent between investing in banks following the risky or safe strategy. The process leading to the equilibrium looks as follows. Assume that very few banks follow the risky strategy. Then there are hardly any
securities on the market at date 1, hence the few securities will be expensive, \( p \) will be high. Risky banks can promise depositors a high long deposit rate \( r_{2}^{\text{risky}} \), leading to a high expected utility \( EU^{\text{risky}} \). More depositors are attracted to risky banks, which leads to more securities on the interim market, and to a higher \( y \). The equilibrium will be reached if \( p \) is such that

\[
EU^{\text{risky}} = EU^{\text{safe}}.
\]  

(11)

Solving for \( p \) yields

\[
p^* = (1 - \varepsilon) \left( \frac{\rho R - \varepsilon}{\rho R} - \frac{\rho R + \delta}{\alpha c_0 \rho R} \right)^{-1}.
\]  

(12)

This value of \( p \) can now be used to establish the fraction of banks (called \( \lambda \)) playing the risky strategy. The aggregate number of securities offered on the market is \( \lambda s = \lambda \frac{\alpha c_0 Y}{p} \). These are all bought by investors at date 1. Their consumption at date 2 is then

\[
c_2 = \lambda s Y = \lambda \frac{\alpha c_0 Y}{p}.
\]  

(13)

Solving (5) for \( c_2 \), we also know that \( c_2 = \frac{1 - y_0 p}{y_1 p} \). Taking both into account and solving for \( \lambda \) yields

\[
\lambda \frac{\alpha c_0 Y}{p} = \frac{1 - y_0 p}{y_1 p},
\]

\[
\lambda = \frac{1}{y_1 \alpha c_0 Y} \left( 1 - y_0 p \right)
\]

\[
= \frac{1}{y_1 \alpha c_0 Y} \left( 1 - y_0 \left( \frac{\rho R - \varepsilon}{\rho R} - \frac{\rho R + \delta}{\alpha c_0 \rho R} \right)^{-1} \frac{1 - \varepsilon}{Y} \right).
\]

(14)

(15)

3.4 Safe Banks Only

Consider again the price \( p \) as given by (12). There are boundaries on this price. If \( p > 1 \), then investors have to pay more for a security at date 1 than they get out at date 2. Hence, they will not buy a security at a price \( p > 1 \). In other words, if (12) yields a price \( p > 1 \), then the price that risky banks would have to get for their securities is so high that investors will not pay it. The risky strategy does not work, and there are only safe banks. Solving the equation \( p = 1 \) for \( \varepsilon \) yields the critical

\[
\varepsilon_{\text{max}} = 1 - \left( \frac{\rho R - \varepsilon}{\rho R} - \frac{\rho R + \delta}{\alpha c_0 \rho R} \right),
\]

(16)

For \( \varepsilon > \varepsilon_{\text{max}} \), no banks follow the risky strategy.
3.5 Disintermediation

We have postponed the discussion of the incentive compatibility condition (late depositors should not withdraw early) until we have determined the equilibrium price $p$. By now, $p$ is determined by (12). Hence, even in a safe bank, late investors will withdraw early if withdrawing and investing in securities gives a higher yield than leaving the deposit in the bank. The condition for the existence of a no-run equilibrium is thus

$$r^\text{safe}_2 > r_1 Y/p,$$

$$\frac{1 - \alpha c_0}{1 - \alpha} \rho R > c_0 Y \cdot \frac{1}{1 - \varepsilon} \left( \frac{\rho R - \varepsilon}{\rho R} - \frac{\rho R + \delta}{\alpha c_0 \rho R} \right).$$

(17)

Solving for $\varepsilon$ yields

$$\varepsilon > \varepsilon_\text{min} = \frac{(1 - \alpha c_0) \rho R - (1 - \alpha) c_0 Y}{(1 - \alpha c_0) \alpha \rho R^2 - (1 - \alpha) (\rho R + \alpha c_0 + \delta) Y} \alpha \rho R.$$  

(18)

What happens if $\varepsilon$ is below this critical value? The security is then relatively attractive, and so is the risky strategy in general. As a consequence, the securities market at date 1 will be flooded with securities; the price will be low, and the yield $y$ will be high. As a consequence, late depositors from safe banks will prefer to withdraw and invest in securities. This behavior is anticipated by safe banks. Banks will not follow the safe strategy, or equivalently, a bank that follows the safe strategy does not attract any deposits. The risky strategy becomes relatively more attractive, which implies a further decline in $p$. This regime with $\varepsilon < \varepsilon_\text{min}$ is called the disintermediation regime. Note that, in this regime, disintermediation is never complete. We will show now that some banks still follow the risky strategy, but they suffer runs with positive (endogenous) probability.

How does the equilibrium in the disintermediation regime look like? First of all, safe banking does not work any longer. There is a different safe strategy (safe in the sense that it does not depend on the return of any asset). Banks can offer a short return of $r_1 \rightarrow 0$. The budget constraint then implies that they can offer $r_2 \rightarrow \rho R/(1 - \alpha)$. The expected utility of a consumer from this strategy is then

$$EU^\text{safe} = (1 - \alpha) \left( \frac{\rho R}{(1 - \alpha) + \delta} \right) = \rho R + (1 - \alpha) \delta.$$ 

The risky strategy looks differently. Risky banks can still offer some maturity transformation, they can offer $r_1 = c_0$ as before. There are runs on risky banks, but only with (endogenous) positive probability. If runs would occur with certainty, then the risky strategy would be unattractive. No bank would follow the risky strategy, and no securities would be offered to investors, thus the date-1 price $p$ for securities would be high. This would mean that the incentive condition for risky banks would hold, and no runs could occur. The risky strategy would then be highly attractive. Hence,
many banks would choose the risky strategy, entailing a high security volume and a low date-1 price \( p \). Hence, an equilibrium must have the property that the incentive constraint for risky banks is binding, and runs occur with positive probability \( \pi \).

Because \( r_1 = c_0 \) and \( r_{2\text{ risky}} \) is as in (9), and incentive compatibility for depositors at the risky bank means \( r_1 Y / p \leq r_{2\text{ risky}} \), we receive

\[
p = \frac{r_1 Y / r_{2\text{ risky}}}{\frac{c_0 y}{1 - \alpha}} = \frac{1 - \frac{\alpha c_0}{\rho R}}{1 - \frac{\alpha c_0}{\rho R}}, \quad \text{hence}
\]

\[
p = \frac{1 - \frac{\alpha c_0}{\rho R}}{1 - \alpha c_0} = \frac{\rho Y}{(1 - \alpha) Y + \alpha \rho R}.
\]

This value of \( p \) implies that

\[
r_{2\text{ risky}} = \frac{1 - \frac{\alpha c_0}{\rho R}}{1 - \alpha c_0} = \frac{\rho Y}{(1 - \alpha) Y + \alpha \rho R}.
\]

We can now use (14) to calculate the fraction \( \lambda \) of banks that follow the risky strategy. Only one question remains open. What is the probability \( \pi \) of a run on a risky bank? This probability pops out of the consumers’ indifference condition. The expected utility from depositing at a risky bank is

\[
EU_{\text{risky}} = (1 - \pi) (1 - \varepsilon) \left( \alpha r_1 + (1 - \alpha) r_{2\text{ risky}} + \delta \right)
\]

\[
= (1 - \pi) (1 - \varepsilon) \left( \alpha c_0 + \frac{(1 - \alpha) \rho Y}{(1 - \alpha) Y + \alpha \rho R} + \delta \right).
\]

Consumers must be indifferent, thus \( EU_{\text{risky}} = EU_{\text{safe}} \). This equation can be solved for \( \pi \), yielding the equilibrium probability of a run on a risky bank.\(^3\)

### 3.6 Numerical Example

As a numerical example, take \( \alpha = 0.2 \), \( c_0 = 1.2 \), \( \delta = 1.5 \), \( \rho = 1 \), \( R = Y = 2 \), \( y_0 = 1 \) and \( y_1 = 0.5 \). With these parameters, (16) yields \( \varepsilon_{\text{max}} = 6.85\% \), and (18) yields \( \varepsilon_{\text{min}} = 2.97\% \). Figure 4 shows the different regimes. For \( \varepsilon > 6.85\% \), we see the regime with safe banks only, and for \( \varepsilon < 2.97\% \), we see the disintermediation regime. But let us start with describing the intermediate regime.

\(^3\)Note the following differences between our results (especially in the disintermediation regime) and those from the model of Diamond and Dybvig (1983). In their model (depending on parameters), there are two equilibria, one with runs and one without. Nothing can be said about the probability of a run. In our disintermediation regime, runs occur with (endogenous) positive probability. There is another self-fulfilling equilibrium in which consumers believe there will be a run, and thus they panic and withdraw themselves, causing a run. We concentrate on the “good” equilibrium in which there can be runs, but these are not panic runs, but fundamental ones (even if only on the margin, because incentive compatibility just holds).
A safe bank offers consumers a short return of $r_1$ and a long return of $r_2^{\text{safe}}$; neither depends on $\varepsilon$. The green lines are perfectly horizontal. A risky bank also offers consumers a short return of $r_1$, but a long return of $r_2^{\text{risky}}$ which depends on $\varepsilon$. If the security is more risky, consumers want to be compensated for bearing this risk by having a higher return. The red line that shows $r_2^{\text{risky}}$ is thus increasing.

We can calculate (and plot) the price $p$ that would enable risky banks to offer a long return of $r_2^{\text{risky}}$. In order to have an expression in monetary units, which can be plotted into the figure, consider $p/Y r_2^{\text{safe}}$ instead (blue dashed curve). We see that $p/Y r_2^{\text{safe}}$ increases in $\varepsilon$, which shows that also $p$ increases in $\varepsilon$. The reason is that a higher $\varepsilon$ implies more risk, making the security less attractive. Fewer banks choose the risky strategy, hence fewer securities are offered on the date-1 market: the price increases.

When the blue dashed curve hits the upper green line (at $\varepsilon = 6.85\%$), we have $p/Y r_2^{\text{safe}} = r_2^{\text{safe}}$ and thus $p/Y = 1$. As discussed on page 12, from this page on, investors do not demand securities to a sufficient degree to make risky banking attractive. Only safe banks remain.

When the blue dashed curve hits the lower green line (at $\varepsilon = 2.97\%$), we have $p/Y r_2^{\text{safe}} = r_1$. For yet lower $\varepsilon$, the incentive compatibility condition fails to hold for safe banks. We run into the disintermediation region. In this region, the equilibrium is fundamentally different from the intermediate regions. No bank chooses the safe strategy (this would lead to a run with certainty). Some consumers do not deposit at banks at all. Some still deposit at banks that opt for the risky strategy. For these banks, incentive compatibility just holds, and they experience a run with positive probability.
3.7 Welfare Analysis

In the model, welfare consists of two components: the expected utility of consumers, and that of investors. However, the utility function of the two are different: consumers want to consume either at date 1 or date 2 and have a jump in their utility. Investors want to consume at both dates, and are risk-averse. Hence, aggregating the two components into one welfare function would be problematic. Instead, we discuss each welfare component separately. If some parameter change lets both components move into the same direction, the direction of aggregate welfare is unambiguous. If the single components move into different directions, then the aggregate welfare effect would depend on the weighting of the components.

Consumers’ Expected Utility. Let us start with consumers’ utility. There are three regimes. If $\varepsilon > \varepsilon_{\text{max}}$, there are no risky banks, hence the expected utility is $EU_{\text{safe}} = \rho R - \alpha c_0 (\rho R - 1) + \delta$. In the intermediate regime, there are risky banks, but consumers are indifferent between safe and risky banks. Hence again, $EU_{\text{safe}} = \rho R + (1 - \alpha) \delta$. Finally, for $\varepsilon < \varepsilon_{\text{min}}$, we are in the disintermediation regime. The utility from the safe choice is $EU_{\text{safe}} = \rho R + (1 - \alpha) \delta$. Again, consumers are indifferent between safe and risky banks, so the aggregate expected utility is exactly the same. Summing up,

$$EU_{\text{consumers}} = \begin{cases} 
\rho R + (1 - \alpha) \delta, & \text{disintermediation regime} \\
\rho R - \alpha c_0 (\rho R - 1) + \delta, & \text{otherwise}
\end{cases} \quad (22)$$

Assumption (2) implies that the utility is lower in the disintermediation regime.

Investors’ Expected Utility. Now turn to the investors’ utility. Entering the optimal consumption (given by (4) on page 7) into the investors’ utility function (see (3) on page 7) yields

$$EU_{\text{investors}} = w + (1 - \varepsilon) \frac{y_0 p/Y - (1 + \log p/Y)}{y_1}. \quad (23)$$

Taking the derivative with respect to $p$ shows that the utility decreases in the price, at least as long as $c_2 \geq 0$. This is intuitive: investors prefer to buy the securities cheap. Looking at Figure 4 reveals one property. The price $p$ is low and constant in the disintermediation regime, then jumps up at the point $\varepsilon_{\text{min}}$. The price must always (weakly) increase at the point $\varepsilon_{\text{min}}$, because below this point, incentive compatibility for safe banks is violated; above this point, it must hold.

Above the point $\varepsilon_{\text{min}}$, the price increases gradually until the point $\varepsilon_{\text{max}}$. At that point, the securities market ceases to exist. But investors can store their wealth instead, which is equivalent to a virtual price $p/Y = 1$. 

16
We learn one thing: disintermediation leads to a redistribution effect. Depositors are worse off, but investors gain from disintermediation.

One more fact is interesting: within the intermediate regime, having more banks choosing the risky strategy is good for welfare. Depositors are indifferent, but investors profit because more banks invest in risky securities, which reduces their price \( p \). The risky strategy is not bad per se, only if it leads to a breakdown of the liquidity insurance mechanism.

**Loan Volume.** The volume of loans does not enter the utility function. However, in reality (or in a slightly richer model), a higher loan volume can lead to firm growth, less unemployment, higher product variety, and so forth. Therefore, let us calculate the loan volume in the different regimes. Start with the intermediate regime. A fraction \( \lambda \) of banks follows the risky strategy, and thus has a loan volume of \( 1 - s = 1 - \frac{\alpha c_0}{p} \). A fraction \( 1 - \lambda \) chooses the safe strategy and has a loan volume of \( 1 - \alpha c_0 \). The fraction \( \lambda \) is given by \( \lambda = \frac{1 - p y_0/Y}{y_1 \alpha c_0} \). The aggregate loan volume is thus

\[
L = (1 - \lambda)(1 - \alpha c_0) + \lambda \left(1 - \frac{\alpha c_0}{p}\right)
= \left(1 - \frac{1 - p y_0/Y}{y_1 \alpha c_0}\right)(1 - \alpha c_0) + \frac{1 - p y_0/Y}{y_1 \alpha c_0} \left(1 - \frac{\alpha c_0}{p}\right).
\]

(24)

The loan volume thus depends on the number of safe and risky banks, but indirectly on the price of securities. Does this \( L \) increase or decrease in the price \( p \)? There are two effects. Because \( p Y > 1 \), risky banks hold more loans than safe banks. An increase in \( p \) is equivalent to less risky banks: less risky banks buy less securities, thus \( p \) increases. Therefore, a higher \( p \) means more safe banks and less loans. But on the other hand, each single risky bank needs to hold fewer securities if \( p \) is higher, thus it can grant more loans. There are two channels into opposite directions. Consider the derivative,

\[
\frac{\partial L}{\partial p} = \frac{Y - p^2 y_0}{p^2 y_1 Y}.
\]

(25)

This derivative is positive for

\[
p > \frac{\sqrt{Y}}{\sqrt{y_0}}.
\]

(26)

In the numerical example, the critical value is \( p = \sqrt{2} \), which again is equivalent to an \( \varepsilon = 4.13\% \), which is between \( \varepsilon_{\text{min}} = 2.97\% \) and \( \varepsilon_{\text{max}} = 6.85\% \). Hence, the reaction of the loan volume in the intermediate regime is ambiguous.
The transition from the intermediate regime to the disintermediation regime comprises both of the above channels, plus one more: consumers following the safe strategy now invest only in loans, nothing else. This shows that disintermediation does not necessarily reduce the loan volume.

4 Deposit Insurance

In our discussion, we have concentrated on the no-run equilibrium. But like in Diamond and Dybvig (1983), a second equilibrium exists in which all depositors suspect other depositors to run and then panic themselves. Like in Diamond and Dybvig (1983), this panic equilibrium can be eliminated by introducing deposit insurance.

Deposit insurance works as follows. Banks pay a premium to the deposit insurance. For now, assume that the premium is zero. In return, the deposit insurance guarantees the deposits of consumers at date 1. We assume that the payment comes from government money that would otherwise have been used for something else, e.g., the provision of public goods.\footnote{Otherwise, there are many choices that the state can make: gather the necessary money from taxing early depositors, or from late depositors, or from investors. We do not want to go to deeply into the question of optimal taxation; therefore we take the short-cut and assume that the money is already there. This assumption is often used in models on bank runs, for example in Allen, Carletti, Goldstein, and Leonello (2012).}

As in the benchmark case (laissez-faire), banks will follow different strategies. We differentiate again between the safe strategy, in which banks do not invest in securities, and the risky strategy, in which banks do. The general structure of the different equilibria is also comparable to the laissez-faire case. In a disintermediation regime, maturity transformation (and liquidity insurance) will be incompatible with the safe strategy. In an intermediate regime, safe and risky banks will coexist. In a “safe banks only”-regime, the risky strategy will be impossible. Let us start with discussing the intermediate regime.

Intermediate Regime. For banks that follow the safe strategy (safe banks), the bad equilibrium is eliminated by deposit insurance. In the good equilibrium, safe banks cannot fail because they bear no risk. Consequently, in equilibrium, the deposit insurance never pays to depositors at safe banks. Hence, the depositors’ expected utility is unchanged, $EU^{safe}$ is given by (8) on page 10.

Risky banks hold the risky security, hence they fail if the security fails. In the absence of deposit insurance, depositors would run on the bank, loans would have
to be liquidated, and the expected utility would be zero (see (10) on page 11). Now in the presence of deposit insurance, the depositors’ expected utility depends on when the deposit insurance pays. For example, if the deposit insurance injects money into the bank before loans are liquidated, late depositors could benefit from the returns at date 2. We assume that the deposit insurance does not pay to the bank, but only to depositors after the bank has paid as much as it could. This does not need to be welfare-optimal, and we will discuss alternatives below.

If the security pays out $Y$, depositors get $r_1 = c_0$ if they withdraw early, and $r_2$ if they consume late. The late deposit rate $r_2$ is influenced by the yield $y$ on the security, hence it may differ from the value under the absence of deposit insurance. If the security pays out nothing (probability $\varepsilon$), it is optimal for all depositors to withdraw early, ensuring at least a payoff of $r_1$. In all scenarios, the target consumption level $c_0$ is met. The expected utility of an investor at a risky bank is then

$$EU_{risky} = (1 - \varepsilon)\left(\alpha c_0 + (1 - \alpha) r_2 + \delta\right) + \varepsilon\left(c_0 + \delta\right)$$

$$= c_0 + (1 - \varepsilon)\left(1 - \alpha\right)\left(\frac{1 - \alpha c_0}{1 - \alpha} \rho R - c_0\right) + \delta. \quad (27)$$

**Equilibrium.** In equilibrium, depositors must again be indifferent between depositing at a safe or risky bank, $EU_{safe} = EU_{risky}$. Solving for $y$ yields

$$p = (1 - \varepsilon)\left(1 - \varepsilon\right)\left(\frac{\rho R - (1 - \alpha) c_0}{\rho c_0 \rho R}\right)^{-1}. \quad (28)$$

As in the laissez-faire regime, it is possible that $p$ is so low that the incentive constraint for safe banks is violated.

**Safe Banks Only.** If the term $p$ in (28) exceeds $Y$, that implies that in order to make the risky strategy attractive for banks, investors would have to pay a price $p > Y$. But then, they would be better off storing the money. In that case, risky banking is unattractive. Solving $p \leq Y$ for $\varepsilon$ yields

$$\varepsilon \leq \varepsilon_{max} = \frac{\alpha c_0 (Y - 1) \rho R}{(Y - \alpha c_0) \rho R - c_0 (1 - \alpha) Y}. \quad (29)$$

A comparison with (16) on page 12 shows immediately that the region with “safe banks only” has shrunk.
**Disintermediation.** Like under laissez-faire, it is again possible that depositors withdraw from safe banks because the securities market at date 1 is just too attractive. They will withdraw if \( r_1 > p / Y r_{2}\text{safe} \). The condition for the existence of the intermediate regime is thus

\[
c_0 < p / Y r_{2}\text{safe}, \\
= \frac{1 - \varepsilon}{Y} \left( 1 - \varepsilon \frac{\rho R - (1 - \alpha) c_0}{\alpha c_0 \rho R} \right)^{-1} \frac{1 - \varepsilon}{Y} \cdot \frac{1 - \alpha c_0}{1 - \alpha} \rho R.
\] (30)

Solving for \( \varepsilon \) yields

\[
\varepsilon > \varepsilon_{\text{min}} = \frac{(1 - \alpha c_0) \rho R - (1 - \alpha) c_0 Y}{(1 - \alpha c_0) \alpha \rho R^2 - (1 - \alpha) (\rho R - (1 - \alpha) c_0) Y} \alpha \rho R.
\] (31)

A comparison with the limiting \( \varepsilon_{\text{min}} \) from (18) on page 13 shows that \( \varepsilon_{\text{min}} \) has increased. The disintermediation region has thus grown.

**Proposition 1** Due to the introduction of deposit insurance, the disintermediation region grows, and the region with only safe banks shrinks.

We need to describe the disintermediation regime. Safe banking is not possible. Like in the laissez-faire regime, as an alternative to safe deposit banks, consumers can just invest their wealth in loans, giving them an expected utility of \( \rho R + (1 - \alpha) \delta \). The risky strategy now looks differently from before. The incentive constraint fails to hold even for risky banks in the disintermediation regime. But because deposit insurance is in place, runs cannot act as a counterweight. Hence, with deposit insurance, even the maturity transformation function of risky banks is destroyed. Households must privately invest in securities. If they invest all wealth in the security, they receive \( p \) with probability \( 1 - \varepsilon \). If \( p > c_0 \), their expected utility is \( (1 - \varepsilon) (p + \delta) \). Solving the indifference condition shows that the according price does not violate incentive compatibility. Consequently, we must have \( p = c_0 \). Indifference between the safe and risky strategy must still hold, which implies that the minimum consumption \( c_0 \) is missed with positive probability.

Figure 5 uses the same parameters as Figure 4. There is one main difference. Because more banks choose the risky strategy in the presence of deposit insurance (moral hazard), ceteris paribus, the price \( p \) is lower. Consequently, the disintermediation is larger: it starts at a higher \( \varepsilon_{\text{min}} \). With our parameters \( \varepsilon_{\text{min}} = 15.15\% \), up from 2.97\%. At the same time, \( \varepsilon_{\text{max}} = 30.00\% \), up from 6.85\%. The parameter \( \varepsilon \) ranges only from 0 to 20\% in the figure; the “safe-banks-only” regime is thus not visible here.
Welfare. Welfare consists of three components: consumers, investors, and the deposit insurance. For consumers, the expected utility is given by (22). The expected utility in each regime is unchanged, but the limits between regimes have moved. Investors’ expected utility is given by (23), with $p/Y = 1$ in the “safe banks only”-regime. Because the introduction of deposit insurance lowers $p$, it benefits investors.

The deposit insurance pays nothing in the disintermediation regime, because there are no deposit banks left. In the “safe banks only”-regime, it pays nothing in equilibrium because there are no runs. In the intermediate regime, it pays $\lambda \varepsilon c_0$, because there are $\lambda$ risky banks, and the security fails with probability $\varepsilon$, in which case the insurance pays the depositors $c_0$. Because $\lambda$ decreases in $p$, and $p$ increases in $\varepsilon$, the expected payment is higher in the neighborhood of the disintermediation regime, and lower near the “safe banks only”-regime.

We find the typical moral hazard effect. Deposit insurance makes risky banking relatively attractive. This induces more banks to choose the risky strategy, which in turn increases the bill for the deposit insurance. This leads us to the following proposition.

**Proposition 2** In equilibrium, the introduction of deposit insurance harms depositors and benefits investors.

5 Separate Banking

The moral hazard effect described in Proposition 1 is independent from whether the deposit insurance scheme is explicit or implicit. For example, during the financial crisis, some political leaders announced that deposits in their country were
safe, thus implicitly increasing the coverage of deposit insurance. To limit moral hazard, regulators have thought about separating the refinancing through deposits from proprietary trading, i.e., investing in securities. Our model can analyze the consequences of such proposals.

Assume now that deposit banks are not allowed to invest in securities. Consequently, deposit banks are forced to choose the safe strategy. To stick to the above wording, we call these banks simply safe banks. The expected utility of a depositor at a safe bank is $EU_{\text{safe}}$ as given by (8) on page 10.

However, if there are no banks investing in securities, the price of securities will be high at date 1, turning them into an attractive investment opportunity. Some consumers may choose to invest directly in these securities. There are two possible strategies for consumers. First, consumers could insure their liquidity shock at a deposit bank, but try to retain some money. They could invest this money in securities, at least as long as the return from securities is higher than that from loans.

In that case, securities would serve as a substitute for loans. Hence, consumers would keep buying securities until $\rho R = (1 - \varepsilon) p$. In our numerical example, $\rho R = Y$, which would imply $p = Y / (1 - \varepsilon) > Y$ in equilibrium. However, this is inconsistent: from the perspective of investors, storage would then be the dominant investment.

The second strategy is similar to the risky strategy from above: consumers could use securities as a substitute for storage. Some consumers could invest sufficient money in securities to obtain the target consumption level $c_0$ if the securities succeed. The rest, they would invest in loans. That way, they would run the risk of falling short of $c_0$, but on the other hand be able to hold more loans. The investment in loans would not be made directly, but via a deposit bank that promises a very small $r_1 \approx 0$ to early consumers. That way, late consumers can get $\rho R / (1 - \alpha)$, and the expected return from investing in a loan is $(1 - \alpha) \rho R / (1 - \alpha) = \rho R$.

A single consumer takes the price $p$ as given. If he invests $s$ in the security, the return at date 1 is $sp$. To obtain the target consumption level $c_0$, he must invest

$$s = \frac{c_0}{p}. \quad (32)$$

The remaining $1 - s$ can be invested in loans (indirectly through a deposit bank). His expected utility is

$$EU_{\text{risky}} = \varepsilon \left( \alpha \cdot 0 + (1 - \alpha) \left( (1 - s) \frac{\rho R}{1 - \alpha} + \delta \right) \right)$$

$$+ (1 - \varepsilon) \left( \alpha (s p + \delta) + (1 - \alpha) (s Y + (1 - s) \frac{\rho R}{1 - \alpha} + \delta) \right)$$

$$= \rho R + (1 - \alpha \varepsilon) \delta - \frac{\rho R - (1 - \varepsilon)(1 - (1 - p) \alpha) Y}{p} c_0. \quad (33)$$
Equilibrium. Again, \( EU^{\text{risky}} = EU^{\text{safe}} \) must hold. Solving for \( p \) yields

\[
p^* = \frac{\rho R - (1 - \alpha)(1 - \varepsilon) Y c_0}{c_0 \rho R - (c_0 + \delta) \varepsilon} \frac{c_0}{\alpha}.
\]  

(34)

Safe Banks Only. If the above \( p^* \) exceeds \( Y \), then the strategy of risky banks does not work out, because investors prefer to store their wealth rather than to buy the securities from the risky banks. Solving for \( \varepsilon \) yields

\[
\varepsilon < \varepsilon_{\text{max}} = \frac{c_0}{c_0 + \alpha \delta} \frac{(1 - \alpha) Y - (1 - \alpha Y) \rho R}{Y}.
\]  

(35)

Disintermediation. The incentive constraint is again \( r_1 < p / Y r_2^{\text{safe}} \). We can calculate the critical \( \varepsilon_{\text{min}} \),

\[
\varepsilon_{\text{min}} = \left(1 - \frac{1 - \alpha c_0}{1 - \alpha} \rho R\right) \frac{\rho R}{(1 - \alpha c_0) \rho R + \alpha (c_0 + \delta)}.
\]  

(36)

Proposition 3 The introduction of separate banking reduces moral hazard of deposit banks to zero. Some households now invest directly in securities. The parameter range with financial contagion is smaller than with deposit insurance only. The parameter range with “safe banks only” is larger.

Figure 6: Regimes for Differing Default Probability \( \varepsilon \)

The parameters for Figure 6 are as before. In comparison to the scenario with deposit insurance but no separate banking, both \( \varepsilon_{\text{min}} \) and \( \varepsilon_{\text{max}} \) have decrease. We now have \( \varepsilon_{\text{min}} = 4.85\% \) (in comparison to 15.15\% before), and \( \varepsilon_{\text{max}} = 16.00\% \) (in comparison to 30\% before). In comparison to the laissez-faire scenario, the
disintermediation region is larger, and the safe-banks-only region is smaller. This does not need to be the case, there are two countervailing effects. First, with separate banking, risky banks are not allowed to use deposit contracts to finance themselves. This makes risky banks less attractive, so there are fewer of them, leading to a reduction in $p$. On the other hand, the consumers that choose the risky strategy have to self-insure against the liquidity shock, which makes each single risky consumer hold more securities. This leads to an increase in $p$. The aggregate effect on $p$ is ambiguous. Because the border of the disintermediation regime is given by the incentive constraint $r_1 > p/Y r_2^{safe}$, the effect on this border is also ambiguous. In other words, with deposit insurance and separate banking, the financial system can be more (or less) stable than under laissez faire.

Welfare. Welfare consists again of three components: consumers, investors, and the deposit insurance. The consumers’ expected utility is identical to (22) on page 16, with the only difference that the border of the disintermediation regime has changed. Importantly, the consumers’ expected utility takes one constant value in the disintermediation regime, and another constant value in the other regimes.

The investors’ expected utility is identical to (23) on page 16, with the only difference that the price $p$ has changed. In comparison to the deposit-insurance case, the price $p$ is higher, other parameters constant. Hence, investors suffer from the introduction of separate banking.

The deposit insurance’s expected utility stems only from its expected payments. Because in equilibrium, safe banks never fails and risky banks are not covered by deposit insurance, there are no scenarios in which the deposit insurance makes payments. This is an improvement in comparison to the absence of separate banking: there, in the intermediate regime, the deposit insurance had to pay with positive probability. The most important properties are summarized in the following proposition.

**Proposition 4** In comparison to the case with deposit insurance, the introduction of separate banking (weakly) benefits consumers and the deposit insurance corporation, and it harms investors.

### 6 Conclusion

We have started from the classical setup by Diamond and Dybvig (1983), with one important modification. We add an additional investment opportunity. “Loans” are
assumed to be completely illiquid, they can neither be sold not liquidated; “securities” can be sold at the interim date. This modification is needed to be able to differentiate between traditional banking (involving deposits and loan granting) and proprietary trading (involving also the speculation with securities).

Some of the results of the model are intuitive and comply with conventional wisdom. For example, we find a typical moral hazard effect: the introduction of deposit insurance creates an externality between banks and the deposit insurance corporation and induces banks to engage more in proprietary trading. This nicely captures the idea that universal banks “exploit” deposit insurance for speculation purposes. Under separate banking, when deposit banks are not allowed to engage in proprietary trading, the moral hazard is reduced, at least to some degree.

Other results are not quite as straightforward. For example, the introduction of deposit insurance, even if it is free, does not necessarily benefit depositors. Abstracting from self-fulfilling runs, banks that follow the traditional strategy do not benefit because they are safe anyway. Banks that engage in proprietary trading benefit, but this benefit is eaten up completely because, in equilibrium, depositors must be indifferent between the two strategies. On the contrary, deposit insurance may even harm depositors. It induces more banks to engage in proprietary trading. Consequently, the securities are relatively cheap at the interim date and promise a higher yield. Depositors are thus tempted to withdraw their deposits at the interim date leading to disintermediation. This destabilizes traditional banking, at the detriment of depositors.

We abstained from calculating social welfare by aggregating agents’ utilities as the effects are somewhat arbitrary given differing utility functions. Rather, we focused on the distributional effects of the introduction of deposit insurance and separate banking on the various subgroups. We found that the introduction of deposit insurance benefits investors, at the detriment of depositors and, of course, the deposit insurance corporation. The introduction of separate banking leads to the opposite distributional effect: investors suffer, whereas depositors and the deposit insurance corporation benefit. Still, the equilibrium with both deposit insurance and separate banking is not the same as under laissez faire. First, the panic equilibrium disappears completely. Second, depositors may be better or worse off; the same applies to investors.

Some questions are left open for future research. For example, we discussed the introduction of separate banking in a banking system with deposit insurance. However, we have not differentiated between the proposals of Volcker, Vickers and Liikanen. The approaches differ, for example, in whether banks are allowed to hold investment and deposit bank subsidiaries under the roof of one holding. In our model, being allowed to have a subsidiary that holds securities is equivalent to being allowed to directly hold securities. Hence, in order to discuss differences between the three
proposals, one would have to extend the model, for example by letting also loans bear some macro risk, and by allowing for diversification effects between loans and securities.

Furthermore, banks in our model finance with deposits only. They do not issue equity or non-deposit debt instruments. Therefore, in a future paper, we want to introduce equity in the model. We can then analyze the interaction between different regulatory instruments, e.g., separate banking and capital requirements. Moreover, our model just like that by Diamond and Dybvig (1983) features multiple equilibria. In addition to the good equilibrium in which depositors do not panic, there is the notorious panic equilibrium. In our discussion, we have mostly focused on the first. However, deposit insurance is (also) intended to eliminate panic runs. But it is impossible to calculate the probability with which panic runs would have occurred in the absence of deposit insurance. To tackle this question, one could combine our model with a global-games environment, as used in Goldstein and Pauzner (2005); Ennis and Keister (2009, 2010); Allen, Carletti, and Leonello (2011), just to give a few examples. Finally, there is one further type of systemic risk that seems to have played an important role in the recent financial crisis (see Hellwig, 2009; Brunnermeier, 2009) namely asset price contagion. An interesting question is whether separate banking is useful to insulate traditional banking from asset price contagion.

Our paper has interesting policy implications. Universal banks may indeed exploit deposit insurance to fund their speculation activities, implying high costs for the deposit insurance. However, as banks use securities as substitutes for storage (liquidity), they may need to hold less liquidity and can invest more in loans. Hence, a separation of banking and trading makes banks more stable, but it also reduces the overall loan volume. Interestingly, some depositors will still be subject to asset risk because they now invest directly in securities. The overall effects on social welfare are therefore ambiguous.
A Definitions of Parameters and Variables

\[ \begin{align*}
\alpha & \quad 0.2 \quad \text{fraction of early consumers} \\
c_0 & \quad 1.2 \quad \text{target consumption threshold of depositors} \\
\delta & \quad 1.5 \quad \text{utility add-on for consumption} \geq c_0 \\
R & \quad 2.0 \quad \text{long-term return of the loan, if successful} \\
\rho & \quad 1.0 \quad \text{probability that the loan has a positive return} \\
Y & \quad 2.0 \quad \text{long-term return from the security in the good state} \\
\varepsilon & \quad \text{varies} \quad \text{probability of the bad state (security returns 0)} \\
y_n; y_1 & \quad 1; \frac{1}{2} \quad \text{shape parameters for liquidity supply at date } t = 1 \\
r_1 & \quad \text{promised return on deposits at date } t = 1 \\
r_2 & \quad \text{stochastic return on deposits at date } t = 2 \\
\lambda & \quad \text{fraction of banks following the risky strategy}
\end{align*} \]

The second column shows the parametrization we use for numerical examples. The shock probability \( \varepsilon \) is exogenous, but we let it vary between 0 and 0.2 in the illustrations, in order to produce different regimes. The variables below the line are endogenous.

References


