
- Over past several years there was an unprecedented growth in credit.
- Increases in securitization meant that banks originating loans were able to package and sell off loans, so that they did not bear the risk of the loans.
- **Prime Example:** Pooling groups of mortgages, ranking them based on perceived risk, then selling off in *tranches* as collateralized debt obligations (CDOs). Highest tranches believed to have very little risk (AAA).
- Investors also able to buy credit default swaps: pay a fee in exchange for payment in event of default. Counterparty risk perceived to be small.
- At same time, interest rates remained low for prolonged time, providing cheap access to funds.
Some Sources of the Problems

- While securitization reduced risk of individual loans for the banks, it also reduced incentives for prudent lending.
- This led to vast expansion of credit, in particular the growth of the subprime mortgage sector.
- The expansion of credit helped to fuel rapid growth in housing prices.
- Pricing models for mortgages and related mortgage-backed securities based on historical data. Post-WWII US had not experienced nationwide decline in housing prices.
- Previous housing downturns had been regional, so pooling mortgages across regions was believed to reduce default risk.
Beginning of the Financial Crisis

- Trigger was an increase in subprime mortgage defaults, starting in Feb. 2007. This led to large increase in the cost of credit default swaps.
- Throughout summer of 2007 a number of hedge funds announce large losses, rating agencies downgraded CDOs.
- Concerns about liquidity of banks, uncertainty about how to price assets led to a huge reduction in volume of lending in short-term money markets, such as asset-backed commercial paper.
- Also drove up costs of bank lending, as seen in spread between interbank unsecured loan rate (LIBOR) and US T-bill rate, known as the TED Spread.
Figure 1
Decline in Mortgage Credit Default Swap ABX Indices
(the ABX 7-1 series initiated in January 1, 2007)

Source: LehmanLive.
Note: Each ABX index is based on a basket of 20 credit default swaps referencing asset-backed securities containing subprime mortgages of different ratings. An investor seeking to insure against the default of the underlying securities pays a periodic fee (spread) which—at initiation of the series—is set to guarantee an index price of 100. This is the reason why the ABX 7-1 series, initiated in January 2007, starts at a price of 100. In addition, when purchasing the default insurance after initiation, the protection buyer has to pay an upfront fee of (100 – ABX price). As the price of the ABX drops, the upfront fee rises and previous sellers of credit default swaps suffer losses.
Figure 2
Outstanding Asset-Backed Commercial Paper (ABCP) and Unsecured Commercial Paper

Source: Federal Reserve Board.
Throughout fall of 2007 banks continued writedowns, realizing losses. These proved to be broader than anticipated.

By early 2008, losses had spread to insurance companies, government sponsored agencies (Fannie Mae, Freddie Mac) who securitized the loans, investment banks (Bear Stearns).

A major accelerating factor was the failure of Lehman Brothers in September 2008. This lead to further declines in commercial paper market, increases in spreads, further decline in stock market prices.

All of this further reduced lending, accelerating the broader overall slowdown in housing market, and led to the reductions in overall economic activity.
Dow Jones Industrial Index, 2/07-4/09
Why did the market for mortgage-backed securities dry up when only a small portion of mortgages (subprime) were initially affected by defaults?

Similarly, why did the market for commercial paper dry up when only a fraction of firms in this market faced losses from housing sector?

Problem: Asymmetric information on locations of risks. Market participants did not know which securities were affected by default risk, which firms held bad loans.

Classic model to illustrate these effects due to Akerlof (1970).
The Lemons Model

- Akerlof’s example was the market for “lemons”: poor quality cars. Assumed sellers know quality, buyers don’t.
- Sellers: have $N$ cars of varying quality $x$, uniformly distributed on $[0, 2]$. Consume $y$ of other goods, have preferences over cars and goods, where $n$ is car sales:

\[ u(y, n) = y + \int_{n}^{N} x(t) \, dt \]

\[ = y + N - \frac{n^2}{N} \]

using $x(t) = \frac{2t}{N}$ and integrating.
- Note that sellers sell off lowest quality first, retain highest.
Distribution of Quality

\[ x(t) \]

\[ N \]

\[ t \]

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Supply of Lemons

- Sellers income $y = pn$, so given $p$ choose $n$:
  \[
  \max_n pn + N - \frac{n^2}{N}
  \]

- First order condition: $p = \frac{2n}{N}$.

- Solve for supply curve: $S(p) = \min \left\{ \frac{pN}{2}, N \right\}$.

- Average quality supplied at price $p$:
  \[
  \mu(p) = \frac{\int_0^{\frac{pN}{2}} x(t) \, dt}{\frac{pN}{2}} = \frac{p}{2}
  \]

  If $p > 2$ then $S(p) = N$ and $\mu(p) = 1$. 
Buyers have no cars, income $m$. Place greater utility weight on cars:

$$U(y, n) = y + \frac{3}{2} \int_0^n x(t) dt = y + \frac{3}{2} \mu n$$

Buyers’ problem:

$$\max_n y + \frac{3}{2} \mu(p)n \text{ s.t. } y + pn = m$$

Linear indifference curves (perfect substitutes), so demand curve is:

$$D(p) = \begin{cases} 
0, & p > \frac{3}{2} \mu \\
\left[0, \frac{m}{p}\right], & p = \frac{3}{2} \mu \\
\frac{m}{p}, & p < \frac{3}{2} \mu 
\end{cases} \quad (1)$$
Breakdown of the Market

- Note that we have:

\[ \mu(p) = \frac{p}{2} < \frac{2}{3}p \]

- So there is no \( p \) such that \( p \leq \frac{3}{2} \mu \) and thus demand is zero for all \( p > 0 \).

- The market breaks down even though at any given price between 0 and 3 there are sellers who are willing to sell their cars at a price which buyers are willing to pay.

- The **asymmetric information** leads to a market breakdown. Any price which is attractive to sellers of good cars is even more attractive to sellers of lemons. So cars on market are biased toward low quality – adverse selection.

- The uncertainty about the locations of risks, both of individual mortgages in the securitized assets and of individual firms in the commercial paper market, may have contributed to the liquidity problems.
Figure: Market Failure
Why did Bear Stearns and Lehman Brothers suddenly collapse, when their positions were not noticeably worse than any investment banks which survived?

Perhaps this was due to self-fulfilling beliefs. Investors became concerned that they would fail, and so withdrew assets (or were reluctant to lend).

This in turn caused the banks to sell off assets at a loss to meet funding needs, which exacerbated the troubles and led the beliefs to come true.

Basic model of this: Diamond-Dybvig (1983) bank run model.
Diamond-Dybvig Model

- Three periods: 0, 1, 2. Large number \( N \) consumers, each endowed with 1 unit of good in period 0.
- Production technology converts 1 unit of good at 0 into \( 1 + r \) at date 2. If technology interrupted at date 1, only returns 1 and nothing is produced at date 2.
- Two types of consumers: early (want to consume in period 1) and late (consume in period 2).
- At date 0 agents don’t know their type, only know that there is probability \( t \) they will be early consumer.
- Expected utility = \( tU(c_1) + (1 - t)U(c_2) \).
Role of Banks

- If no banks: all agents invest, then if early consumer $c_1 = 1$, if late $c_2 = 1 + r$.

- Banks: agents deposit at 0, receive $c_1$ at 1 or $c_2$ at 2. If agent withdraws, randomly allocated to place in line, whether early or late consumer.

- Free entry in banking means in equilibrium banks earn zero profits. The banks set deposit contract to maximize depositor utility.

- If only early consumers withdraw at 1, bank must interrupt a fraction $x$ of projects, where: $Ntc_1 = Nx$.

- This leaves remaining fraction to pay out to late consumers at 2: $N(1 - t)c_2 = (1 - x)N(1 + r)$.

- Eliminate $x$ and rearrange:

$$c_2 = \frac{1 + r}{1 - t} - \frac{t(1 + r)}{1 - t} c_1$$
Note $c_1 = c_2$ is feasible. Here:

$$MRS = \frac{tU'(c_1)}{(1 - t)U'(c_2)} = \frac{t}{1 - t}$$

But for optimal contract, bank chooses:

$$\max_{c_1, c_2} tU(c_1) + (1 - t)U(c_2) \text{ s.t. } c_2 = \frac{1 + r}{1 - t} - \frac{t(1 + r)}{1 - t}c_1$$

At optimum:

$$MRS = \frac{tU'(c_1)}{(1 - t)U'(c_2)} = \frac{t(1 + r)}{1 - t} > \frac{t}{1 - t}$$

So $U'(c_1) > U'(c_2) \Rightarrow c_1 < c_2$. 
Figure 15.8  The Equilibrium Deposit Contract Offered by the Diamond–Dybvig Bank

\[ c_2 = \frac{(1 + r)}{(1 - t)} \]

\[ c_1 = \frac{1}{t} \]

\[ c_1 = c_2 \]

Slope = \( \frac{-t(1 + r)}{(1 - t)} \)
The no-bank allocation \( c_1 = 1, \ c_2 = 1 + r \) is also feasible. Assume \( U'(1) > U'(1 + r)(1 + r) \).

Then at no-bank allocation:

\[
\frac{tU'(1)}{(1 - t)U'(1 + r)} > \frac{tU'(1 + r)(1 + r)}{(1 - t)U'(1 + r)} = \frac{t(1 + r)}{1 - t} = \frac{tU'(c_1)}{(1 - t)U'(c_2)}
\]

So \( c_1 > 1, \ c_2 < 1 + r \).

Deposit contract provides more consumption smoothing than no-bank allocation.

There is a **good equilibrium** where early consumers withdraw at 1, consume \( c_1 > 1 \). Late consumers withdraw at 2, consume \( 1 < c_2 < 1 + r \). Late consumer has no incentive to withdraw early.
However suppose that a late consumer believes that all other late consumers will withdraw at 1. If bank liquidates all of its assets it gets $N$, cannot meet withdrawal demands $(N - 1)c_1 > N$. (Since $N$ large, $c_1 > 1$.)

So each late consumer has the options:
- Go to bank at 1, hope to be at start of line and get $c_1$.
- Wait until period 2, get zero.

So anticipating that all other late consumers will withdraw at 1 makes it optimal for any individual late consumer to also withdraw at 1.

The bank run is an equilibrium. Belief that others will withdraw is self-fulfilling, leading to bank failure.

There is FDIC insurance for deposits at deposit banks, but no insurance at investment banks and investment funds.
Defining Properties of Assets

- Rate of return
- Risk
- Maturity
- Liquidity

Characteristics of Financial Intermediaries

- Borrow from one group of economic agents and lend to another.
- Well-diversified with respect to both assets and liabilities.
- Transform assets.
- Process information.
Banks: take deposits from lenders, paying interest rate $r_1$. Make loans to borrowers at interest rate $r_2$.

Some borrowers will default on loans. Fraction $a$ of borrowers are “good,” will repay loans. Fraction $1 - a$ are “bad,” receive no future income, will default.

Asymmetric Information: Banks can observe borrowers’ income realizations, but can’t distinguish good and bad borrowers when they apply for loans.

Good borrowers are identical, facing interest rate $r_2$ choose loan amount $L$.

Bad borrowers want imitate good borrowers (would like to borrow more, but would reveal type). So they also choose to borrow $L$. 
Banks lend to large number of borrowers, so fraction of loans defaulted on is $1 - a$.

Bank profit:

$$\pi = L - L + \frac{aL(1 + r_2)}{1 + r_1} + \frac{(1 - a)0}{1 + r_1} - \frac{L(1 + r_1)}{1 + r_1}$$

$$(1 + r_1)\pi = aL(1 + r_2) - L(1 + r_1) = L[a(1 + r_2) - (1 + r_1)]$$

There is free entry among banks, so in equilibrium $\pi = 0$. Therefore:

$$r_2 = \frac{1 + r_1}{a} - 1 > r_1$$

Borrowers must pay a risk premium due to the chance of default. If $a = 1$, $r_2 = r_1$. If $a \downarrow \Rightarrow r_2 \uparrow$. 
Figure 9.3
Asymmetric Information in the Credit Market and the Effect of a Decrease in Creditworthy Borrowers
Reduction in Creditworthiness of Borrowers

- With a fall in $a$, we’ve seen that $r_2$ increases.
- Default premium increases: even good borrowers face higher loan rates.
- Budget constraint shifts in. Consumption falls for all borrowers.
- Matches observations from the current financial crisis increase in credit market uncertainty, reduction in lending, decrease in consumption expenditures.
Figure 9.4
Interest Rate Spread
Borrowers need incentives not to default on their debts. These incentives typically provided by collateral requirements.

This is due to limited commitment: borrowers cannot commit to repay loans. Even if they can afford repayment in future, may choose not to repay. “Strategic default.”

Examples: House is collateral for a mortgage loan, car is collateral for a car loan.

Collateral can also support borrowing for other purposes, such as home equity lines for consumption purchases.

A fall in the value of the collateral can lead to a large reduction in borrowing, consumption.
Assume housing is illiquid: can’t be sold in the current period. However, it is possible to borrow against housing wealth, with a collateral constraint.

- \( H \) = quantity of housing owned by consumer. \( p \) = price of housing.

- Lifetime budget constraint:

\[
c + \frac{c'}{1 + r} = y - t + \frac{y' - t' + pH}{1 + r}
\]

- Collateral constraint:

\[-s(1 + r) \leq pH\]

Borrowing today restricted by value of collateral.
Figure 9.5
Limited Commitment with a Collateral Constraint
Collateral constraint implies a bound on current consumption:

\[ c \leq y - t + \frac{pH}{1 + r} \]

For constrained consumers, fall in value of collateral will lead to one-for-one reduction in consumption:

\[ c = y - t + \frac{pH}{1 + r} \]

So reduction in price of housing \( p \) can lead to fall in consumption.

Here we take \( p \) as exogenous, but fall in \( p \) can have an amplifier effect in equilibrium. Initial fall leads to less consumption, less borrowing. Reduces demand for housing, which can further drive down house prices.

Again this parallels what we’ve seen in the financial crisis and recession.
Figure 9.6
The Relative Price of Housing in the United States
Figure 9.7
Percentage Deviations from Trend in Aggregate Consumption