LECTURE 3.1

Credit Frictions and Banking Crises

ECON42240 Advanced Macroeconomics

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Where We Are

1. Time Series Methods

1.1 Time Series and Macro

1.2 Vector Autoregressions

1.3 VARs: Applications

1.4 The Kalman Filter

1.5 Solving RE Models

2. Structural Models

2.1 The RBC Model

2.2 The Phillips Curve

2.3 The New Keynesian Model

2.4 Estimating DSGE Models

2.5 The Smets-Wouters Model

3. Finance and Policy

3.1 Credit and Banking Crises

3.2 Fiscal Policy, and What Next

Last Week's Lecture

1. **The Frictions Block.**
   What Smets and Wouters add, and why.

2. **Shocks and Estimation.**
   Seven shocks, seven series, one posterior.

3. **What the Model Explains.**
   Forecasts, decompositions and responses.

4. **Our Model Against Smets and Wouters.**
   What the simplifications cost.

5. **What It Missed.**
   The model, and 2008.

Lecture Plan

1. **Credit Rationing.**
   Why the loan market need not clear.

2. **The Financial Accelerator.**
   How net worth amplifies a shock.

3. **Runs and Leverage.**
   Diamond–Dybvig, the credit squeeze, and bank leverage.

4. **Capital Regulation.**
   Capital ratios, risk weights and macro-prudential policy.

SECTION 1

Credit Rationing

The Policy Rate Is Not the Rate Firms Pay

Monetary policy sets one risk-free overnight rate. Almost no borrowing uses it:

- **What Policy Sets:** The overnight rate banks charge each other, free of default risk.
- **What a Firm Pays:** A higher rate, because a loan can go unpaid.
- **What the Gap Holds:** Default risk, collateral, and the lender's own condition.

> **Every Model in This Module Has Assumed the Gap Away**
> The RBC, New Keynesian and Smets–Wouters models each carry one interest rate.

Equal Expected Returns Fix the Loan Rate

The loan rate (r) prices default probability (p) net of collateral recovery (c):

$$r \approx \underbrace{r^f}_{\text{risk-free rate}} + \underbrace{(1-c)\,p}_{\text{risk spread}} \tag{1}$$

Better Collateral Is a Cheaper Loan
At full recovery ($c = 1$) the loan prices at the risk-free rate.

Lenders Refuse Loans Rather Than Raise the Rate

The pricing rule assumes someone lends once the rate is high enough. Banks often refuse instead:

> **Credit Rationing**
> Lenders supply fewer loans than are demanded at the going rate. Applicants who appear to be good credits may be refused.

The cause is asymmetric information. A bank cannot always tell good borrowers from bad.

Stiglitz and Weiss: The Set-Up

Every borrower seeks a loan (B), pledges collateral (C) and holds one project (Stiglitz & Weiss, 1981):

- **The Project:** A random return (R), with a density (f) set by the risk type (θ).
- **What the Bank Sees:** Types look identical. The bank cannot observe θ.

> **Mean-Preserving Spread**
> All types share one mean return. A higher θ widens the spread of R around it.

The Firm Gains from Risk

Limited liability caps the loss at the collateral, so the payoff (P) bends:

$$P(R, r) \;=\; \max\big(\, R - (1 + r)B,\; -C \,\big) \tag{2}$$

A Convex Payoff Gains from Risk
Losses stop at $-C$ and gains do not, so $E[P]$ rises with θ. A concave utility function reverses the result.

A Mean-Preserving Spread and a Convex Payoff

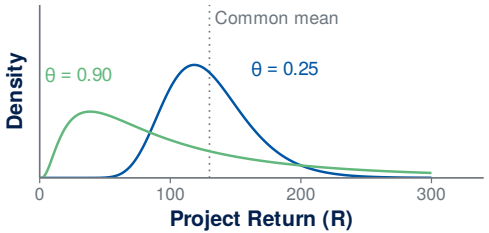

Figure 1: Two densities of R with one mean.

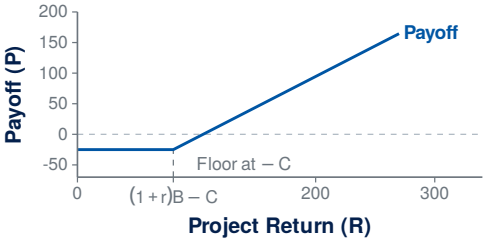

Figure 2: The borrower's payoff at r = 5.5 per cent.

> **The Floor Truncates the Left Tail**
> Extra weight on low returns lands on the floor. Extra weight on high returns raises the payoff.

Adverse Selection in the Pool

Only types above a cut-off expect a positive payoff, so only they apply:

$$E\big[P(R,r)\big] \;=\; \int_0^{\infty} P(R,r)\, f(R,\theta)\, dR \;>\; 0 \quad\Longleftrightarrow\quad \theta \;>\; \hat{\theta}(r) \tag{3}$$

where:

- $\hat{\theta}(r)$: safest type still applying

> **A Higher Rate Drives Out the Safest**
> $\hat{\theta}(r)$ rises with r. A price change alters who applies, not only how many.

The Bank's Payoff Is Concave in the Return

The bank's claim stops at principal and interest; its expected return (ρ) is:

$$\rho(\theta, r) = \int_0^{\infty} \min\big(R + C,\ (1 + r)B\big)\, f(R, \theta)\, dR \tag{4}$$

Risk Helps the Borrower and Hurts the Bank

A min where the borrower has a max, so the payoff is concave. A higher θ lowers $\rho(\theta, r)$.

Averaging Across the Applicant Pool

The bank cannot tell types apart, so it averages over applicants, the types above $\hat{\theta}$:

$$E\left[\rho(\theta, r)\right] = \frac{\int_{\hat{\theta}}^{\infty} \rho(\theta, r)\, g(\theta)\, d\theta}{1 - G(\hat{\theta})} \tag{5}$$

where:

- $g(\theta)$: density of risk types
- $G(\theta)$: cumulative distribution of types

Adverse Selection Enters Through the Cut-Off
The denominator falls as r rises.

Two Effects of a Higher Loan Rate

A higher loan rate has two opposite effects on the bank's expected return:

- **The Revenue Effect:** Every performing loan pays more, which raises the return.
- **The Selection Effect:** The pool grows riskier, which lowers the return.

> **Stiglitz and Weiss Assume an Interior Peak**
> They assume the revenue effect dominates at low rates. Beyond the peak rate ($\bar{r}$) the selection effect does.

The Bank's Expected Return Against the Loan Rate

Figure 3: Two types, in equal numbers.

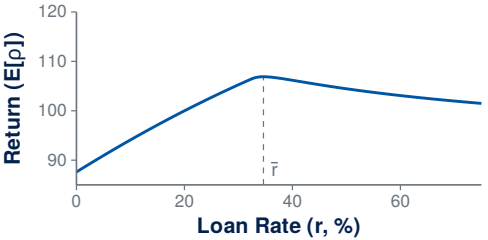

Figure 4: A continuum of types.

> **The Peak Is the Rate No Bank Will Exceed**
> The drop where the safer type leaves smooths into one peak. Here $\bar{r}$ is 35 per cent.

The Equilibrium with Credit Rationing

Banks post the loan rate, and no bank posts a rate above $\bar{r}$:

- **Low Demand:** Demand meets supply below $\bar{r}$, and every applicant borrows.
- **High Demand:** Demand at $\bar{r}$ exceeds supply, and some applicants are refused.

> **The Loan Market Need Not Clear**
> Refused applicants look identical to those served. A higher rate would lower the bank's return.

Rationing Occurs Only When Demand Is High

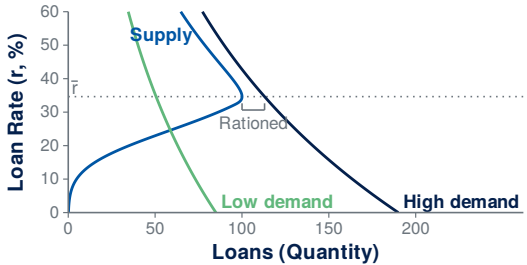

Figure 5: Loan supply and two demand curves, with the rate $\bar{r}$ marked.

> **Banks Set the Rate, Not an Auctioneer**
> Supply bends back above $\bar{r}$ because the bank's return falls there. Whelan calls the bend a bit misleading.

Which Channel Tightens Rationing in a Recession

In a recession credit demand may be high, and collateral loses value. Whelan argues both can make rationing more likely.

- **Stiglitz and Weiss's Opposite Result:** Raising collateral can lower the bank's return, by attracting wealthier, less risk-averse, riskier borrowers (Stiglitz & Weiss, 1981).

> **Question**
> Which channel binds first in Ireland in 2009? What evidence would separate the two?

Take answers from the room.

SECTION 2

The Financial Accelerator

Collateral Is Worth Less in a Recession

Asset values fall in a recession, so c falls and the spread $(1 - c)p$ widens:

> **Net Worth**
> Net worth is a borrower's assets less its debts: what the borrower can pledge.

Wider spreads cut investment, which deepens the same recession.

Collateral Sorts Household Borrowing Rates

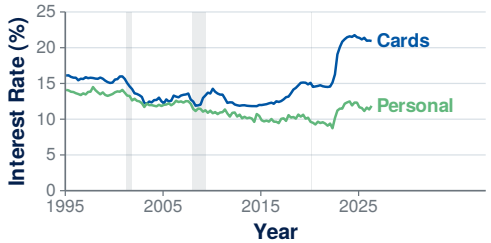

Figure 6: No collateral: card and personal loans (%).

Figure 7: Collateral: car loans and mortgages (%).

> **The Ranking Follows the Collateral**
> Both secured rates sit below both unsecured rates in every US quarter since 1995.

Net Worth and the External Finance Premium

Borrowed funds cost more than a firm's own funds. The balance sheet sets the gap (Bernanke & Gertler, 1989):

> **External Finance Premium**
> The excess cost of borrowed funds over internal funds. A higher ratio of net worth to assets lowers it.

Bernanke and Gertler put the premium into a real business cycle model. Net worth falls with output, so the premium rises in a recession.

How the Accelerator Loop Closes

A shock that cuts net worth starts a chain that cuts it again:

$$\text{net worth} \downarrow \rightarrow \ \text{premium} \uparrow \rightarrow \ \text{investment} \downarrow \rightarrow \ \text{output} \downarrow \rightarrow \ \text{asset prices} \downarrow$$

Lower Asset Prices Cut Net Worth Again

The last arrow closes the loop, so the effect outlasts the shock. In a boom the loop runs in reverse.

Risk Spreads Rise in and After Recessions

Figure 8: Moody's Aaa and Baa yields less the 10-year Treasury, monthly, 1970–2026.

> **The Baa Spread Peaked at Six Points in 2008**
> Its highest reading before 2007 was 3.8 points, in October 1982.

What the Accelerator Adds to a New Keynesian Model

Bernanke, Gertler and Gilchrist put the mechanism into a New Keynesian model (Bernanke et al., 1999):

- **What Changes:** Firms' balance sheets price their borrowing, rather than one rate.
- **What Follows:** After a 25 basis point cut in the policy rate, output and investment respond more on impact and more persistently.

> **A Propagation Mechanism, Not a New Shock**
> Volatility comes from shock size and propagation strength. The accelerator adds only to the second.

A Widening Spread Deepens the Same Recession

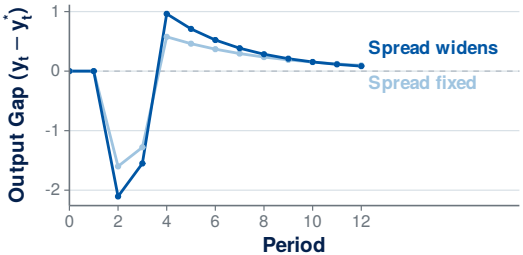

Figure 9: Output gap after a two-period demand shock, IS-MP-PC model, spread fixed or widening.

> **A Reduced Form, Not the BGG Model**
> The spread widens 0.3 points per point of negative gap, and the trough deepens from −1.6 to −2.1.

What the Accelerator Does Not Capture

The accelerator amplifies shocks inside a linearised model. Some financial events are not linear:

- **Rationing:** A refusal to lend, not a larger coefficient on the rate.
- **Market Closure:** A sovereign bond market can close completely, and abruptly.

> **Whelan's Own Limit on the Programme**
> He writes that DSGE models should incorporate financial amplification. Forecasting serious crises is probably too much to ask.

Sovereign Default Closes the Same Loop

A government can default, and the pricing rule applies to a sovereign borrower:

- **The Premium:** A tenth chance of writing off half the debt costs about five points.
- **The Trap:** A rate that high can exceed what the government can afford to pay.
- **The Closure:** Markets may stop buying, and default goes from unlikely to likely.

> **The Euro Area Removed the Usual Backstop**
> Euro area central banks may not buy government bonds in the primary market. In 2016 the UK and US had high debt and low yields.

Would You Withdraw from a Sound Bank?

Your bank’s loans are sound. You hear that other depositors are withdrawing.

> **Question**
> Do you withdraw your deposit today? What would change your answer?

Take answers from the room.

SECTION 3

Runs and Leverage

A Bank Is Funded by People Who Can Leave

A bank's liabilities are other people's money, repayable sooner than its assets mature:

Assets (uses of funds)		Liabilities and equity (sources)	
Cash	15	Deposits	100
Loans	95	Equity capital	10
Total	**110**	**Total**	**110**

Leverage
Leverage is assets divided by equity, here 11. A loss of 10 wipes out the owners.

Maturity Transformation Is the Business Model

Savers want money back on demand, and borrowers need funds for years. The bank serves both:

> **Maturity Transformation**
> Borrowing short and lending long, with a cash buffer against withdrawals.

The arrangement that makes banks useful also makes a run possible.

Diamond and Dybvig: A Deposit Contract with Two Equilibria

One deposit contract supports two equilibria, on one balance sheet (Diamond & Dybvig, 1983):

- **The Good Equilibrium:** Only those who need money early withdraw, and the bank survives.
- **The Run Equilibrium:** Everyone withdraws because everyone expects everyone else to.

> **A Rational Run on a Sound Bank**
> Withdrawing early is a best response when others do. Beliefs, not the loan book, pick the equilibrium.

A Run Makes the Bank More Insolvent

A run started by a false rumour can leave a bank genuinely insolvent:

1. **First:** Cash, reserves at the central bank and government securities go.
2. **Then:** Long customer loans and property, sold quickly and therefore cheaply.
3. **The Result:** Asset values fall further behind liabilities than before the run.

> **Fire Sale**
> A fire sale is a forced quick sale. The price falls below what an orderly sale reaches.

Why a Run Cuts the Supply of Credit

Assets equal liabilities plus equity. Rearranging gives the bank's loan book:

$$\text{Loans} = \text{Deposits} + \text{Borrowings} + \text{Equity} - \text{Cash} - \text{Securities} \tag{6}$$

The Credit Crunch Is an Identity Plus Four Behaviours
Four of the five terms shift against lending, so lending adjusts.

Four Margins of the Credit Squeeze

Four terms in the identity turn against lending at once:

- **Deposits Leave:** Customers who lose faith in banks hold cash instead.
- **Borrowings Dry Up:** Bond markets and other banks stop funding a bank they distrust.
- **Cash Rises:** The bank hoards reserves against further withdrawals.
- **Securities Rise:** New funds go into assets that can be sold quickly.

> **New Lending Stops First**
> Calling in loans is hard, so repayments are hoarded. Housebuilding, durables and new firms suffer first.

Contagion and the Funding That Runs Fastest

One failure puts other banks under pressure, and modern funding is quicker:

- **Look-Alike Banks:** Two banks with similar loan books look identical to a depositor.
- **Non-Deposit Funding:** Bond and interbank lenders are uninsured, and run faster than depositors.
- **Mark-to-Market:** One bank's fire sale lowers what other holders mark the asset at.

> **Bank Failures Arrive in Batches**
> The system can look healthy one minute and unstable the next.

You Are Hired to Run a Bank

Investors give you ten million and expect a return. The opening balance sheet:

Assets (uses of funds)		Liabilities and equity (sources)	
Cash and reserves	9	Deposits	50
Loans	50	Equity capital	10
Branch network	1		
Total	**60**	**Total**	**60**

Return on Equity: 15 per Cent

Loans at 5 per cent plus fees bring in 3.5. Deposits at 1 per cent and branches cost 2.0.

Leverage Raises the Return on Equity

Two banks hold equity of 10 each. Both lend at 3 per cent and borrow at 2:

	Small bank	Big bank
Reserves and loans	9 + 91	9 + 191
Deposits and borrowings	90 + 0	90 + 100
Leverage	10	20
Return on equity	9.3 per cent	19.3 per cent

Halving the Capital Ratio Roughly Doubles the Return

Equity is 10 per cent of assets, then 5 per cent. The loan margin is unchanged.

Bankers Gain from Holding Less Capital

Higher leverage and riskier assets raise profits. Two groups gain from taking the risk:

- **Shareholders:** Some accept a risk of total loss for a high return most years.
- **Chief Executives:** Bonuses are paid on this year's profit and are not repaid later.

> **The Private Incentive Runs Toward Leverage**
> Bankers' self-interest cannot be relied on to hold enough capital against losses.

Short-Term Funding Ended Bear Stearns and Lehman

Long-term funding costs more, because its lenders cannot exit. Short-term lenders can refuse to roll over:

- **Bear Stearns:** Repo lenders refused to renew, and reserves ran out in days.
- **Lehman:** Equity was about three per cent of assets, so leverage was over thirty.

> **A Wholesale Run Needs No Queue Outside a Branch**
> Neither firm was funded by insured retail deposits. Wholesale lenders left instead.

Adrian and Shin: Leverage Targeting

A trading bank holds leverage at ten by buying and selling securities (Adrian & Shin, 2010):

	Start	Prices up 1 per cent	Prices down 1 per cent
Securities	100	101, then 110	99, then 90
Equity	10	11	9
Debt	90	90, then 99	90, then 81
Leverage	10	9.2, then 10	11, then 10

Leverage Targeting Makes Demand Rise with Price
Higher prices produce buying and lower prices produce selling: demand slopes upward.

Leverage Grows with the Balance Sheet

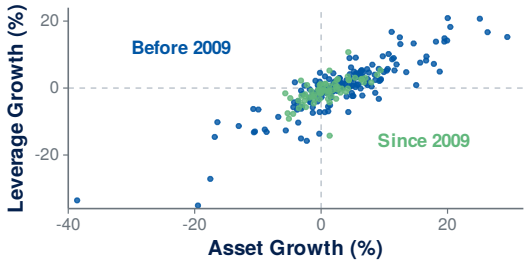

Figure 10: US broker-dealers: quarterly log growth of leverage against assets (%), 1970–2026.

> **Dealer Leverage Still Rises with Assets**
> The fitted slope is 0.84 before 2009 and 0.67 since. Adrian and Shin's sample ended in the 2000s.

What Should a Capital Rule Limit?

Leverage raises the return on equity, and bankers' self-interest cannot be relied on to limit it.

> **Question**
> You may impose one rule on bank balance sheets. What does it limit, and how would a bank get round it?

Take answers from the room.

SECTION 4

Capital Regulation

What Counts as Regulatory Capital

Capital rules exist because the private incentive runs toward leverage. Two classes of capital absorb losses:

- **Tier 1:** Equity capital and the most deeply subordinated bonds.
- **Tier 2:** Other subordinated bonds, which rank behind depositors and senior debt.

> **Regulatory Capital**
> Tier 1 plus Tier 2: the cushion that takes losses before depositors and senior bondholders do.

Weighting Assets by Regulatory Risk

The 1988 Basel Accord set regulatory capital (K) against risk-weighted assets (RWA):

$$K \geq 0.08 \times \text{RWA} \tag{7}$$

Risk-Weighted Assets
Each asset times its weight: zero for OECD government debt, 50 per cent for mortgages, 100 for corporate bonds.

Bank of Ireland's Own Numbers

In June 2015 Bank of Ireland's capital was 15.9 per cent of weighted assets, in billions:

$$\underbrace{0.159 \times 52.6}_{\text{on weighted assets}} = 8.4 = \underbrace{0.064 \times 131}_{\text{on all assets}} \tag{8}$$

Weighting Turns 6.4 per Cent into 15.9
The average risk weight, 52.6 billion over 131 billion, is 0.40.

Basel 2 Let Banks Model Their Own Risk

The crude buckets were replaced just before the crisis:

- **More Buckets:** Ratings agencies' assessments set finer weights within each class.
- **Internal Models:** Big banks were allowed to assess their own assets' riskiness.
- **Mortgages:** Treated as less risky than the original accord had assumed.
- **Disclosure:** Better public reporting of financial account information.

> **Northern Rock's Risk-Weighted Assets Fell by 44 per Cent**
> Its June 2007 accounts: £33.9 billion under Basel 1, £18.9 billion under Basel 2.

The Value at Risk Estimate

The internal model rests on one number, estimated from past returns:

> **Value at Risk**
> A ten-day, 99 per cent Value at Risk of fifty million sets a tail threshold. Ten-day losses exceed it one time in a hundred.

Provisions cover the expected loss. Capital covers the tail beyond it.

From Value at Risk to Risk-Weighted Assets

Basel's 1996 market-risk rule sets capital at three times Value at Risk (VaR) or more; the 8 per cent rule then sets RWA:

$$0.08 \times \text{RWA} \;=\; K \;=\; 3 \times \text{VaR} \quad\Longrightarrow\quad \text{RWA} \;=\; 37.5 \times \text{VaR} \tag{9}$$

The Bank's Model Sets Its Own Denominator
A lower Value at Risk is a lower requirement. No schedule of weights intervenes.

How Value at Risk Was Gamed

The estimate depends on choices made by the party being regulated:

- **The Sample:** Returns from 2005 to 2007 made risk look low in 2008.
- **The Tail:** The method says nothing about how bad the one per cent case is.
- **Asymmetric Positions:** Selling insurance against rare events shows small steady gains.

> **Honohan's Judgement on UBS**
> He writes that gaming the risk models was perhaps inevitable.

Haldane and Madouros: The Dog and the Frisbee

A dog catches a frisbee by holding its gaze angle steady, not by physics (Haldane & Madouros, 2012):

- **The Complaint:** Thousands of parameters from short samples are not robust.
- **The Proposal:** Simplified standardised measures of credit and market risk instead.

> **Simple Against Risk-Sensitive Is Not a Settled Question**
> A published reply defends risk weights. The simple side has not won the argument.

Capital Rules Can Worsen a Credit Crunch

A bank heading below its required ratio can raise equity or cut risk-weighted assets:

> **Lending Sits in the Denominator**
> Raising equity dilutes owners at a poor price. Cutting risk-weighted assets means repaying debt or buying government bonds, not lending.

Capital requirements can therefore deepen a credit crunch in a recession.

Micro Prudence Can Make the System Unstable

Rules that make each bank prudent can destabilise all of them together:

- **In the Upswing:** Rising asset prices raise equity, and the rules permit expansion.
- **In the Downswing:** Falling prices erode equity, and every bank sells at once.
- **What the Model Said:** Short estimation windows made measured risk low in booms.

> **Crockett: Risk Builds in the Upswing**
> He suggests treating risk as rising in upswings and materialising in recessions.

Adrian and Shin's leverage-targeting table shows the downswing's forced sales.

LEVERAGE TARGETING

What Macro-Prudential Policy Does

The tools, from Hanson, Kashyap and Stein (Hanson et al., 2011):

- **Time-Varying Capital:** Higher ratios in booms, lower in recessions.
- **Higher Quality Capital:** More common equity, less reliance on preference shares.
- **Contingent Capital:** Debt that converts to equity when the ratio falls far enough.
- **Liquidity Rules:** Discourage short-term debt, favour fire-sale-proof assets.

> **Macro-Prudential**
> Macro-prudential regulation targets the stability of the whole system.

Loan-to-Value Limits in Ireland

In Ireland and Spain, rising house prices raised net worth and funded borrowing:

> **Loan-to-Value Limit**
> A cap on a mortgage as a share of the house's value. Ireland also caps loan to income.

A limit can bind on a sound borrower and still stabilise the system.

Section 2 showed net worth lowering the cost of borrowing.

NET WORTH AND THE PREMIUM

What Basel 3 Raised and What It Left Undone

Basel 3 raised requirements. Whelan lists what it left undone:

- **What It Raised:** Common equity to 7 per cent, plus a cyclical buffer.
- **The Leverage Cap:** A maximum leverage ratio of 33.3, which he calls very high.
- **The Buffer's Weakness:** Regulators may not wish to declare credit growth dangerous.
- **The Pace:** Phased in over years, and the structural reforms uncoordinated.

> **Progress That Could Go Further**
> Whelan writes that the regulations definitely represent progress, and could go further.

US Bank Capital on Weighted and Unweighted Assets

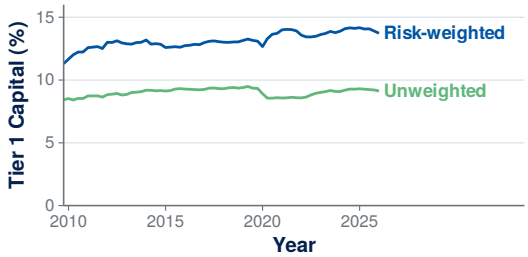

Figure 11: Tier 1 capital over risk-weighted and over average assets, US banks, 2009–2026 (%).

> **The Ratio of the Lines Is the Risk Weight**
> Both lines divide the same Tier 1 capital. Unweighted over weighted, the average risk weight, is 0.67.

Which Rule Would You Have Written in 2006

Basel 2 let banks model their own risk. Haldane and Madouros would have used a cruder rule.

> **Question**
> You are writing one capital rule for 2006, knowing nothing about 2008. Weighted or unweighted, and what does your choice cost?

Take answers from the room.

Before Lecture 3.2

1. **Play:**
   Pull the BAA spread over Treasuries from FRED, against recession dates.

2. **Apply:**
   The problem set issued today, on Smets–Wouters and on credit rationing.

3. **Read:**
   Blanchard, Dell'Ariccia and Mauro on rethinking macroeconomic policy (Blanchard et al., 2010).

Next Lecture

Lecture 3.2 is the last lecture, and it closes the module:

1. **Fiscal Policy.**
   Multipliers, debt, and Ricardian equivalence.
2. **After the Crisis.**
   What the field changed, and did not.
3. **What Is Still Missing.**
   Summers and Caballero on the core's limits.
4. **Verdicts on the Three Opening Claims.**
   Lecture 1.1's claims, judged against the critics.

Thank you

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BACKUP

Appendix

Notation, Part I

Symbol	What it is	First met
r^f	risk-free rate	Equal Expected Returns Fix the Loan Rate
r	loan rate	Equal Expected Returns Fix the Loan Rate
p	default probability	Equal Expected Returns Fix the Loan Rate
c	collateral recovery	Equal Expected Returns Fix the Loan Rate
B	loan	Stiglitz and Weiss: The Set-Up
C	collateral	Stiglitz and Weiss: The Set-Up
R	random return	Stiglitz and Weiss: The Set-Up
f	density	Stiglitz and Weiss: The Set-Up
θ	risk type	Stiglitz and Weiss: The Set-Up

Notation, Part II

Symbol	What it is	First met
P	payoff	The Firm Gains From Risk
$\hat{\theta}(r)$	safest type still applying	Adverse Selection in the Pool
ρ	expected return	The Bank's Payoff Is Concave in the Return
$g(\theta)$	density of risk types	Averaging Across the Applicant Pool
$G(\theta)$	cumulative distribution of types	Averaging Across the Applicant Pool
$\bar{r}$	peak rate	Two Effects of a Higher Loan Rate
K	regulatory capital	Weighting Assets by Regulatory Risk
RWA	risk-weighted assets	Weighting Assets by Regulatory Risk
VaR	Value at Risk	From Value at Risk to Risk-Weighted Assets

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