# 20598 – Finance with Big Data

## Week 7 Lecture: Microeconomics of Banking

Clément Mazet-Sonilhac
clement.mazetsonilhac@unibocconi.it

Department of Finance, Bocconi University

# Outline

# Foreword: The Hackathon

- Extended deadline because of mid-terms : 08/11
- Talk about your results next Lecture (11/11)

# Foreword: The Hackathon

- Extended deadline because of mid-terms : 08/11
- Talk about your results next Lecture (11/11)
- Need volunteers to present their findings in class (5-10')
  - Ideally 2-3 groups

# Foreword: The Hackathon

- Extended deadline because of mid-terms : 08/11
- Talk about your results next Lecture (11/11)
- Need volunteers to present their findings in class (5-10')
  - Ideally 2-3 groups
- Tomorrow: PC Lab is optional, I'll dedicate time to Q&A about the Hackathon

# The Final Project = 2 & 3/12 + two other days

# The Final Project

## Guidelines

This applies to both Attending and Non-Attending students

But: for N-A, we will fix a date + possibility to do it on Teams

# The Final Project

## Guidelines

- When? Dec. 2th, 3th + two other days yet to decide (for Attending students)
  - For Non-Attending students: contact me to set a date

# The Final Project

## Guidelines

- When? Dec. 2th, 3th + two other days yet to decide (for Attending students)
  - For Non-Attending students: contact me to set a date
- What ? the final project can either be :
  - A paper presentation (w. or w/o. data work)
  - An empirical project exploring your own idea(s)
  - An extension of one PC Lab / Hackathon
- In group of 3 students max (same groups as for PC Labs or different)

# The Final Project

## Project examples

- Extend what you've done for the Hackathon : combine Task 1-3 with Task 6

# The Final Project

## Project examples

- Extend what you've done for the Hackathon : combine Task 1-3 with Task 6
- Extend what you've done for a PC Lab : Portfolio optimization with crypto-assets or ML-driven returns prediction

# The Final Project

## Project examples

- Extend what you've done for the Hackathon : combine Task 1-3 with Task 6
- Extend what you've done for a PC Lab : Portfolio optimization with crypto-assets or ML-driven returns prediction
- Study and replicate a paper by Dacheng Xiu or Bryan Kelly (code available !)

**"Empirical Asset Pricing via Machine Learning"**, with Shihao Gu and Bryan Kelly, **Review of Financial Studies, Vol. 33, Issue 5, 2018 Swiss Finance Institute Outstanding Paper Award**.

Chicago Booth Review | GitHub | Empirical Data (UPDATED June 2021) | SAS/Python Codes for Data | Supplemental Material | Machine Learning | Time-Series and Cross-Section of Expected Returns | Neural Networks | Big Data | Return Predictability | Deep Learning

- Any original idea is welcomed!

# The Final Project

## Project examples

- Micaela Masia (DSBA '24): Bending Spoons, McKinsey, etc.
- Final project: *Forecasting Volatility with Alternative Data: A Reinforcement Learning Approach*
    1. Build a Deep-Q model to forecast the VIX
    2. Dispersion in Financial Times news sentiment
    3. Comparison with standard econometric models

# The Final Project

## Project examples

- Micaela Masia (DSBA '24): Bending Spoons, McKinsey, etc.
- Final project: *Forecasting Volatility with Alternative Data: A Reinforcement Learning Approach*
    1. Build a Deep-Q model to forecast the VIX
    2. Dispersion in Financial Times news sentiment
    3. Comparison with standard econometric models
- Later became her research thesis (8/8, Cum Laude)

# The Final Project

## Outcome

- Outcome: 20' presentation ($\approx$ 10 slides) + 10' discussion. You can do it online.
- 30% of the final grade (50% for N-A students)
  - Quality of the oral presentation (slides + delivery) – 40%
  - Quality of the project – 40%
  - Answers to the public's questions + your own questions – 20%

# The Final Project

## Outcome

- Outcome: 20' presentation ($\approx$ 10 slides) + 10' discussion. You can do it online.
- 30% of the final grade (50% for N-A students)
  - Quality of the oral presentation (slides + delivery) – 40%
  - Quality of the project – 40%
  - Answers to the public's questions + your own questions – 20%
- Presence (in-class or online) mandatory for everyone

# The Final Project

## Logistics

- Send me an email **before Friday 15/11** with:
  - Composition of your group
  - Idea(s) for the final project
- Deadline for project submission: **Friday 6/12**
- Bring a USB key with your slides + send it to me

# The Final Project

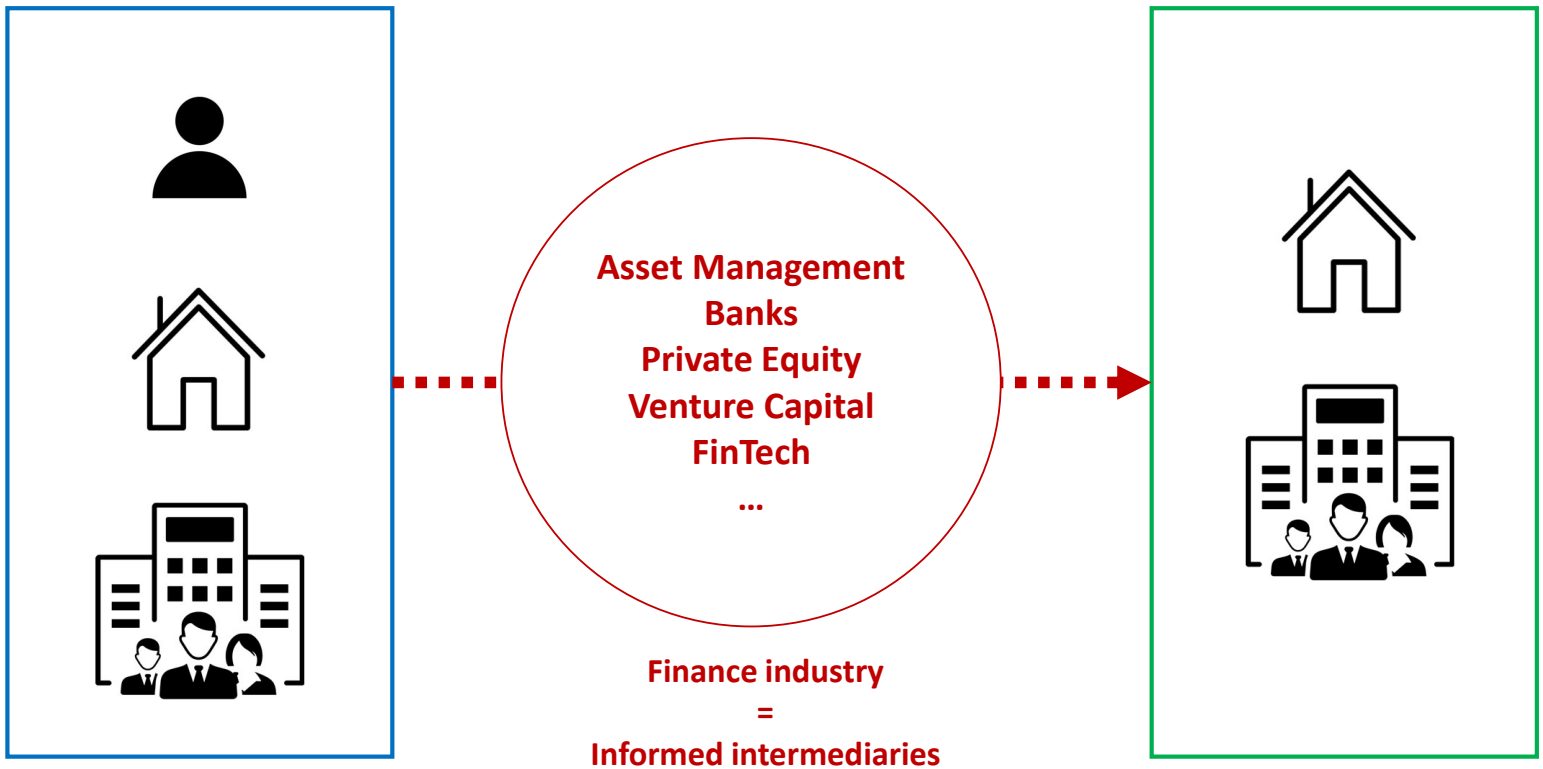
## Non-attending students

- Similar except for the deadline
- Final project due on the written exam date

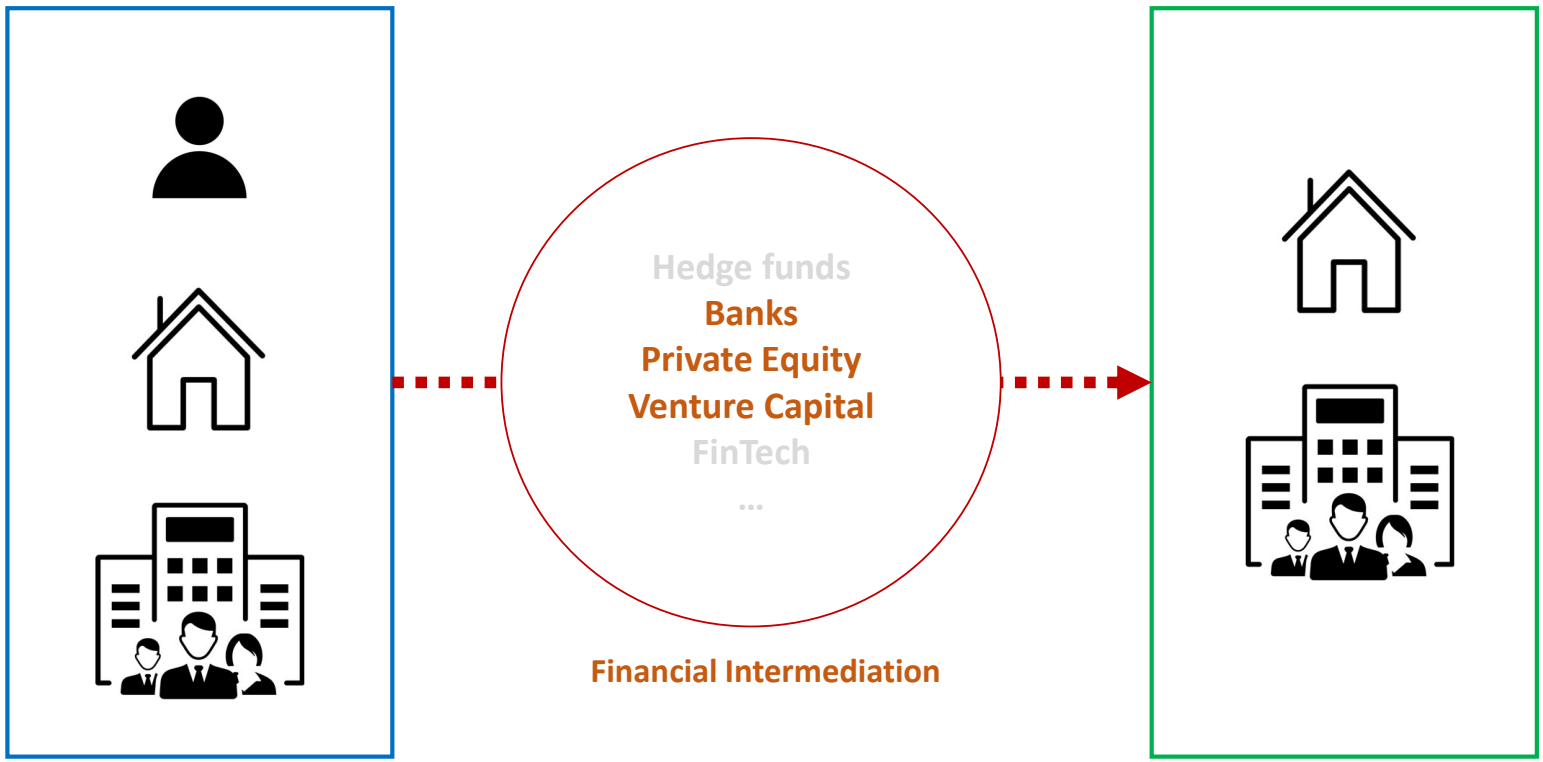
Questions?


Financial
Intermediation

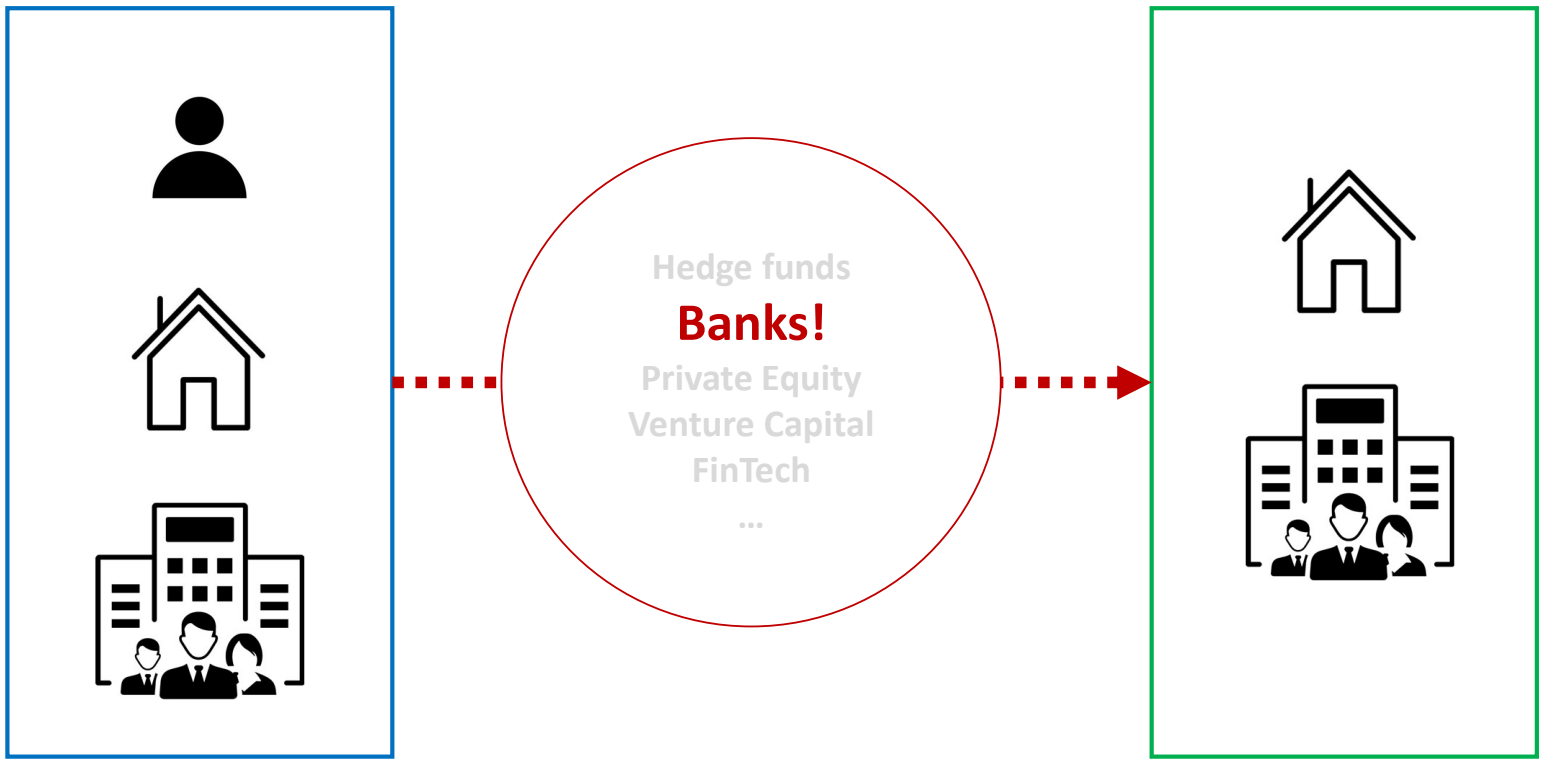
# Part II: Financial Intermediation (= Indirect Finance)



# Part II: Financial Intermediation (= Indirect Finance)

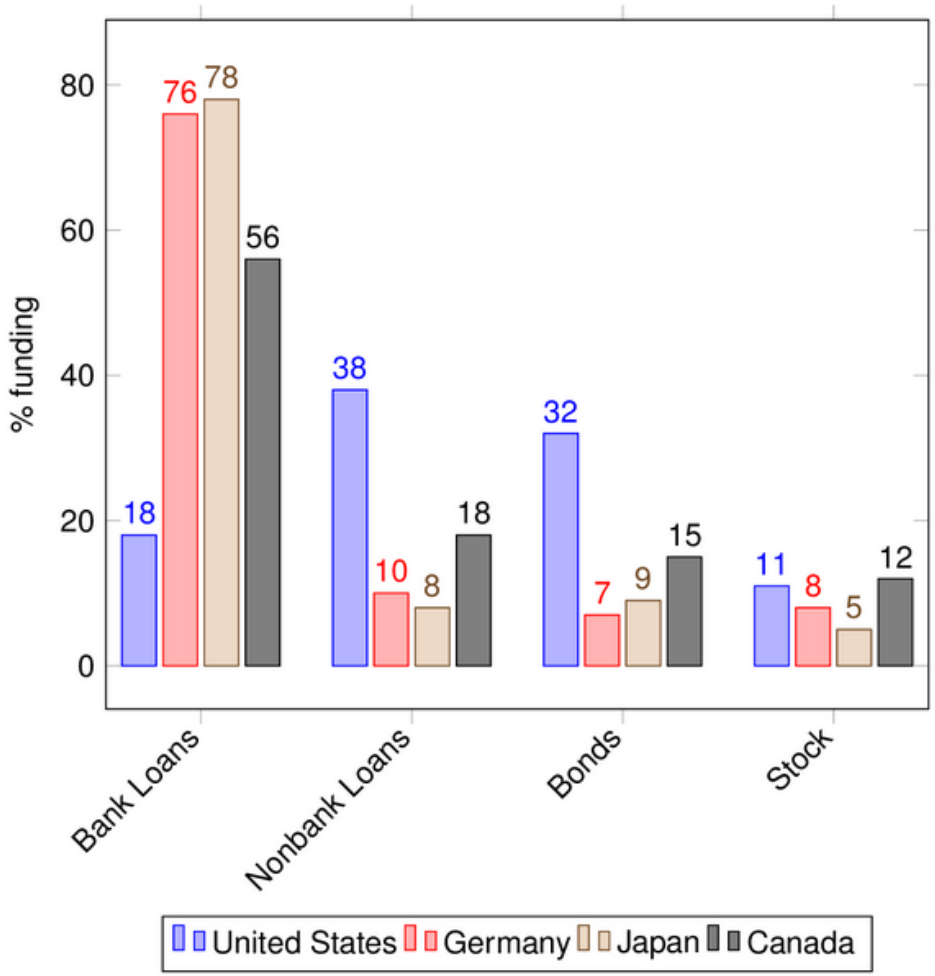


# Part II: Financial Intermediation (= Indirect Finance)



# Part II: Financial Intermediation (= Indirect Finance)

## Banks



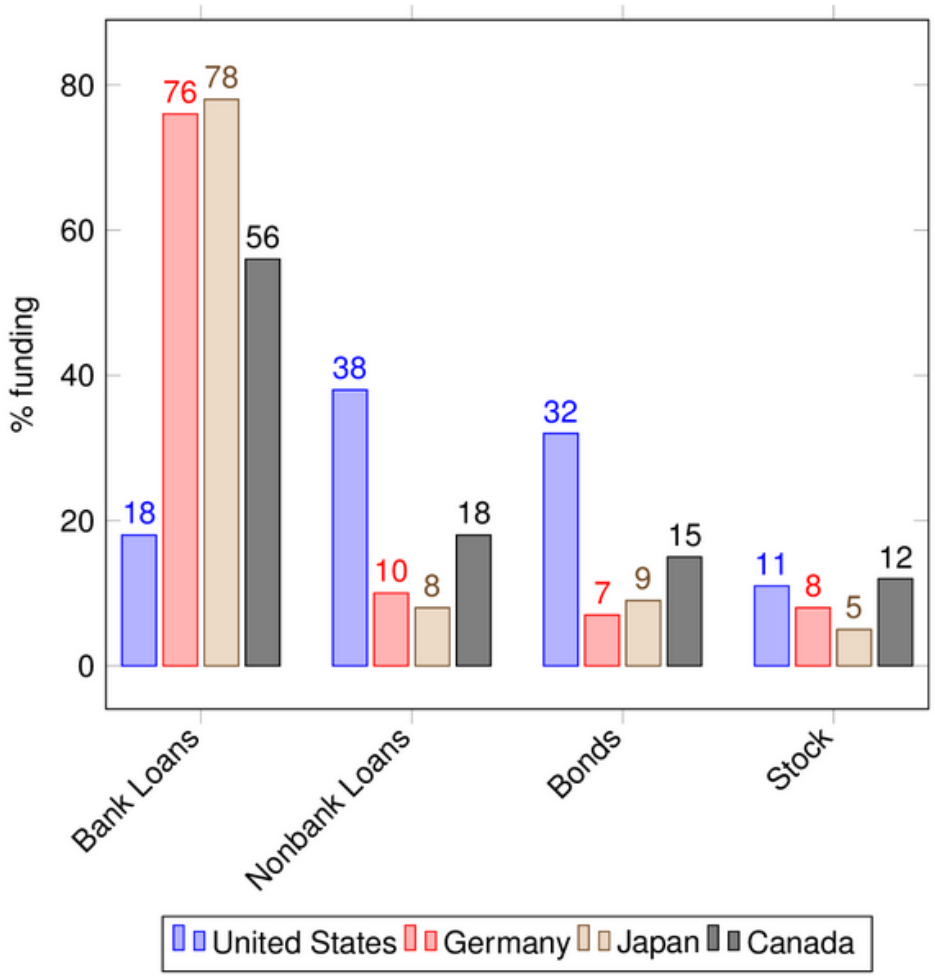

Sources of external funds for nonfinancial businesses:

Percentages of gross flows 1970–2000

Source: Hackethal and Schmidt (2004)

# Part II: Financial Intermediation (= Indirect Finance)

## Banks




Sources of external funds for nonfinancial businesses:

Percentages of gross flows 1970–2000

Source: Hackethal and Schmidt (2004)

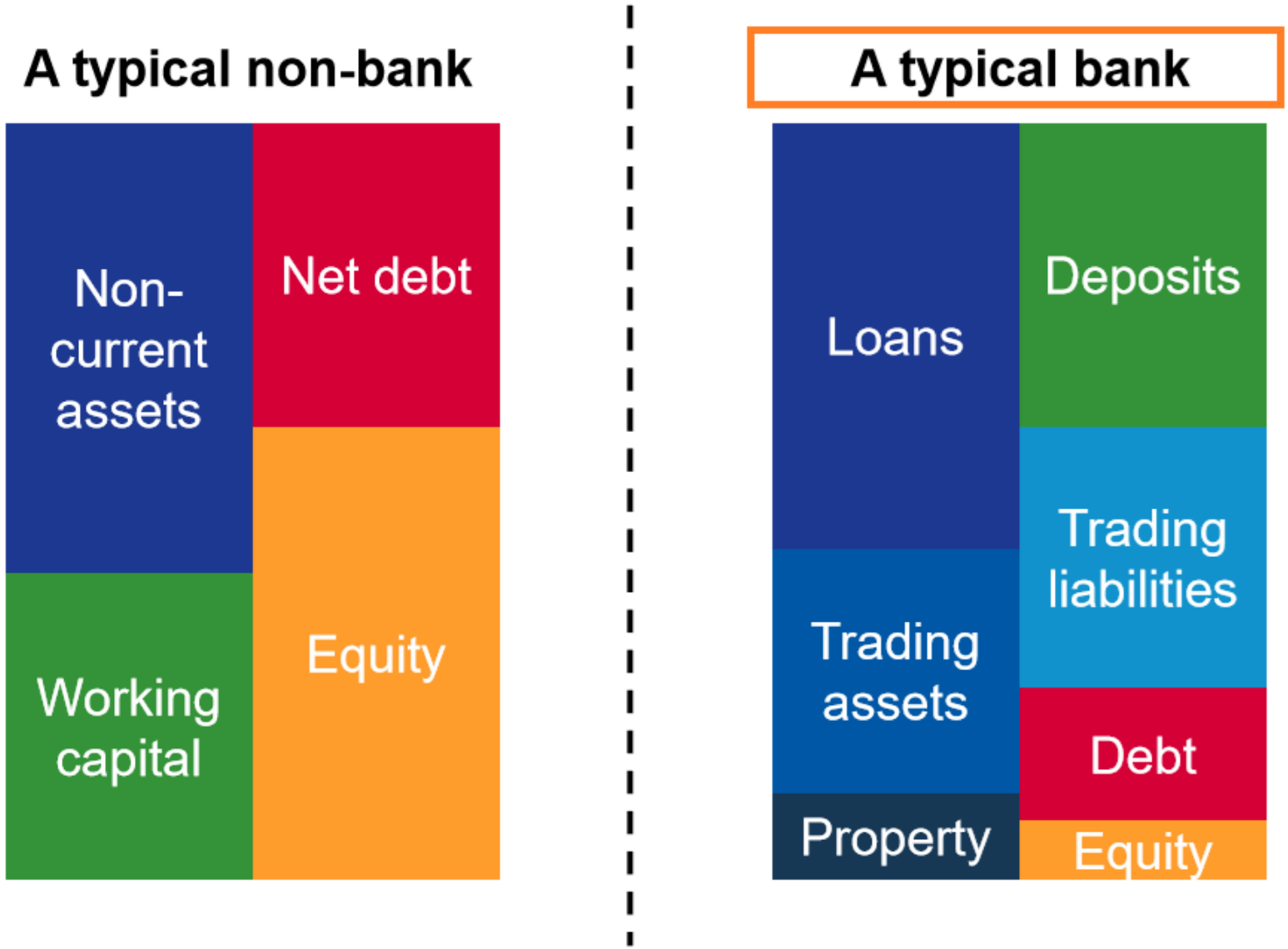
- Motivation: Banks provide most external funding - why ?
- NB : Nonbanks = investment banks, mortgage lenders, private equity funds, FinTechs

# Part II: Financial Intermediation (= Indirect Finance)

- Since we're interested in technologies that can have disruptive effect on banking, we'll spend today's class learning about various facets of financial intermediation.
- We start with 1-0-1 banking knowledge
- Then I'll put on my economist hat to give you details about :
  - the consequences of information frictions
  - why intermediaries are potentially fragile


Banks: What and Why ?

# What is a Bank from an Accounting Perspective ?



# What is a Bank from an Accounting Perspective?

## Example : JPM vs. Google

### Balance Sheet: JP Morgan Chase

2015, end of year USD billion

| Assets | | Liabilities and Net Worth | |
|---|---|---|---|
| Cash and Reserves | 20 | Total Deposits | 1280 |
| Investment and Securities | 1290 | Demand/Checkable Deposits | 392 |
| | | Savings/Time Deposits | 663 |
| Loans | 835 | | |
| Commercial and Industrial | 155 | Total Debt and Borrowings | 519 |
| Consumer | 476 | Short-term debt | 256 |
| Real Estate (Mortgages) | 95 | Long-term debt | 263 |
| Other | 108 | | |
| Loan Loss Reserves | (13.5) | Other Liabilities | 304 |
| Property | 14.3 | | |
| Other Assets | 157.2 | Equity | 247 |
| Total | 2370 | Total | 2370 |

# What is a Bank from an Accounting Perspective ?

## Example : JPM vs. Google

### Balance Sheet: Google

2015, end of year USD billion

| Assets | | Liabilities and Net Worth | |
|---|---|---|---|
| Cash and Cash Equivalents | 73 | | |
| Other Current Assets | 17 | Current Liabilities | 19 |
| Long-term Assets | 57 | Long-term Debt | 2 |
| of which: | | | |
| Fixed Assets | 30.7 | Other liabilities | 6 |
| Goodwill | 15.8 | | |
| Other Intangibles | 3.8 | | |
| Investments | 6.52 | Equity | 120 |
| Total | 147 | Total | 147 |

# What is a Bank from an Accounting Perspective ?

## Example : JPM vs. Google

- JPM's balance sheet is (was) **16 times larger** than Google's
- Accounting Equity/Assets is 10% for JPM and 80% for Google $\rightarrow$ **high leverage for JPM**
- But market value of equity of JPM is almost 1/3 : 970 vs 356 billion (in 2015)

# Banks are big and complex

Source : Wikipedia

# Banks are big and complex

Source : Wikipedia

| Rank | Bank name | Total assets [hide] (2021) (US$ billion) |
|---|---|---|
| 1 | Industrial and Commercial Bank of China Limited | 5,866.00 |
| 2 | China Construction Bank | 4,532.05 |
| 3 | Agricultural Bank of China | 4,354.56 |
| 4 | Bank of China | 4,113.36 |
| 5 | JPMorgan Chase | 3,954.68[4] |
| 6 | Mitsubishi UFJ Financial Group | 3,737.31 |
| 7 | HSBC | 2,958.15 |
| 8 | Bank of America | 2,434.08 |
| 9 | BNP Paribas | 2,429.26 |
| 10 | Crédit Agricole | 2,256.72 |

# Banks are big and complex

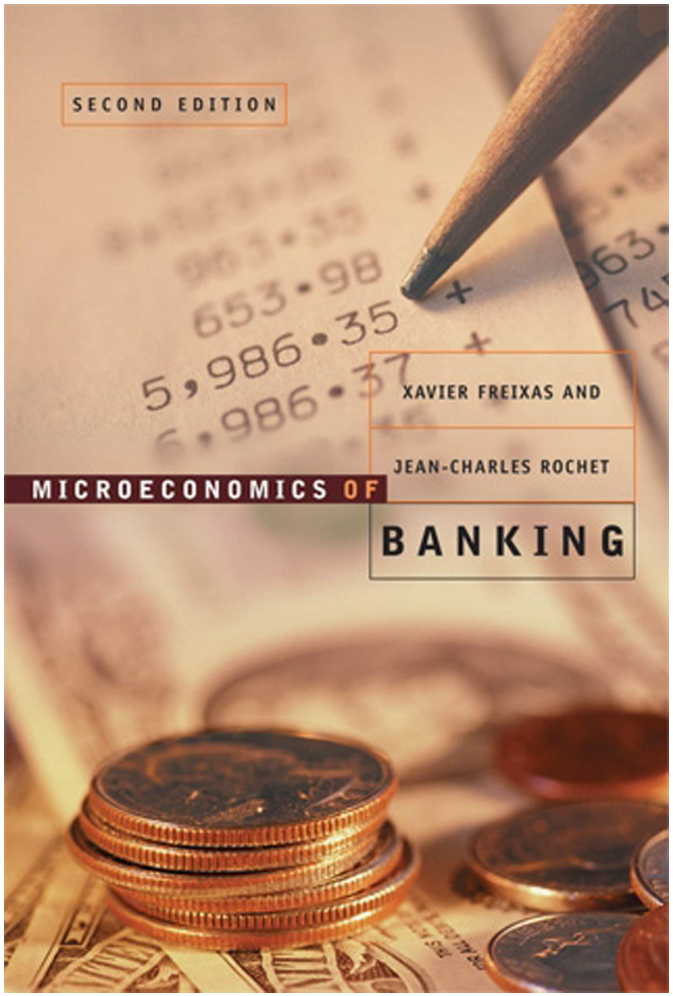
Source : Wikipedia

| Rank | Bank name | Market cap [hide] (US$ billion) |
|---|---|---|
| 1 | JPMorgan Chase | 400.37[6] |
| 2 | Industrial and Commercial Bank of China | 295.65 |
| 3 | Bank of America | 279.73 |
| 4 | Wells Fargo | 214.34 |
| 5 | China Construction Bank | 207.98 |
| 6 | Agricultural Bank of China | 181.49 |
| 7 | HSBC Holdings PLC | 169.47 |
| 8 | Citigroup Inc. | 163.58 |
| 9 | Bank of China | 151.15 |
| 10 | China Merchants Bank | 133.37 |

# Why do Banks Exist ?

This first part of the course is drawn from this great textbook:

- Freixas-Rochet, 2nd Edition
- Microeconomics of Banking



# Why do Banks Exist ?

# Why do Banks Exist ?

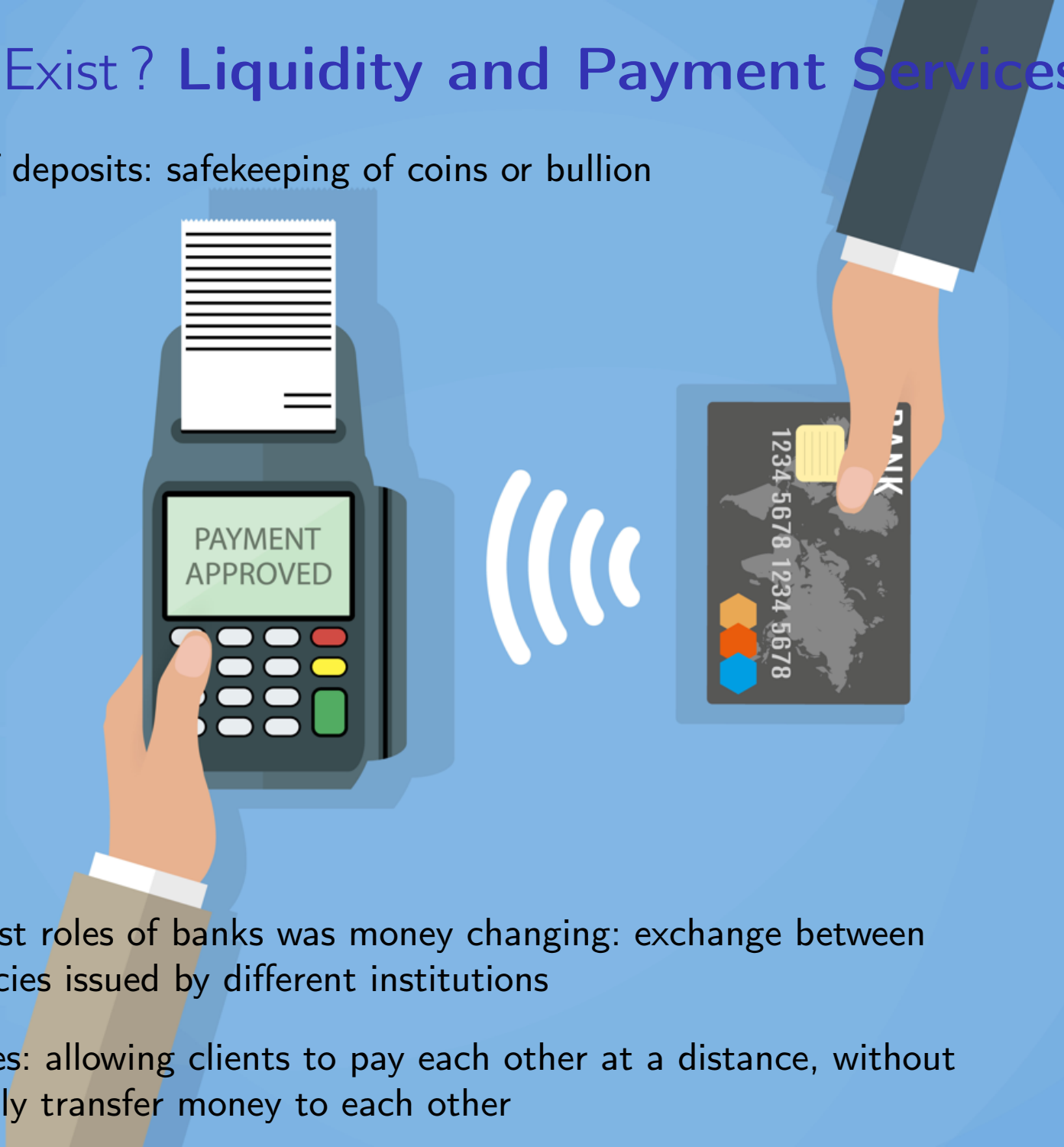
1. Liquidity and Payment Services
2. Managing Risk
3. Screen Projects and Allocate Funds
4. Asset Transformation

# Why do Banks Exist ?

1. Liquidity and Payment Services
2. Managing Risk
3. **Screen Projects and Allocate Funds**
4. **Asset Transformation**

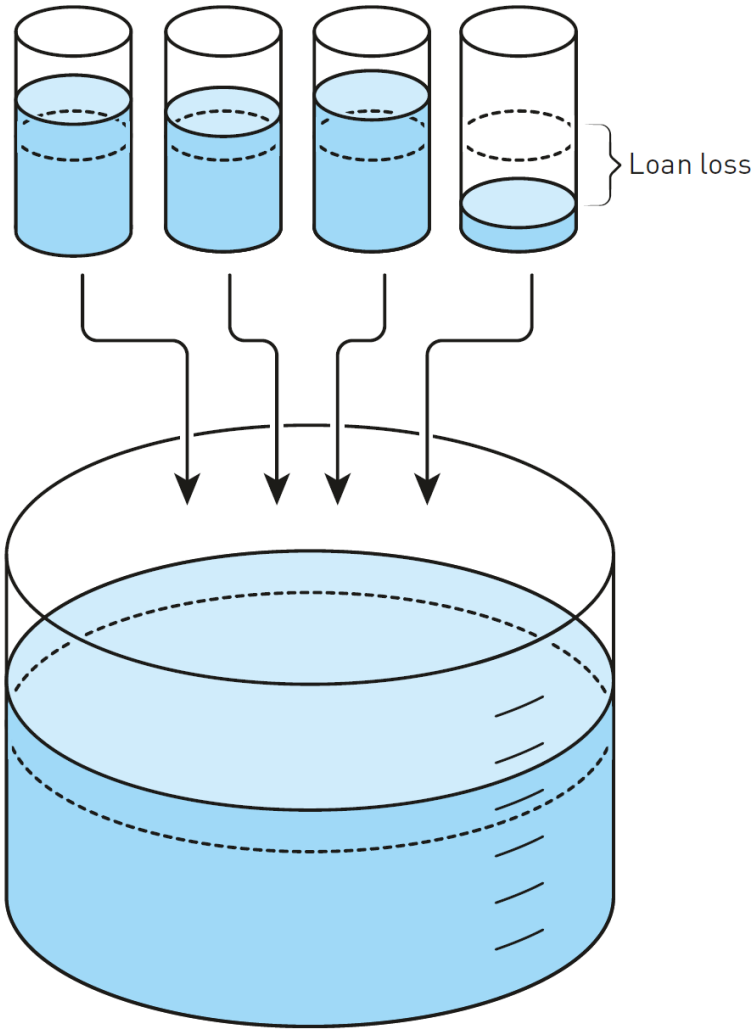
# Why do Banks Exist ? **Liquidity and Payment Services**

- Management of deposits: safekeeping of coins or bullion




- One of the oldest roles of banks was money changing: exchange between different currencies issued by different institutions
- Payment services: allowing clients to pay each other at a distance, without having to directly transfer money to each other

# Why do Banks Exist? **Managing Risk**




A bank will always incur losses on a few of its loans. But as long as the bank lends responsibly, the losses across all loans will be small and predictable.

- Diversification allows banks to hedge liquidity, credit and IR risks

# Why do Banks Exist? **Screen Projects and Allocate Funds**

- Banks determine which projects get financed. What is a good project?

# Why do Banks Exist? **Screen Projects and Allocate Funds**

- Banks determine which projects get financed. What is a good project?
- Banks can invest in technologies that allow them to screen loan applicants and monitor their projects

# Why do Banks Exist? **Screen Projects and Allocate Funds**

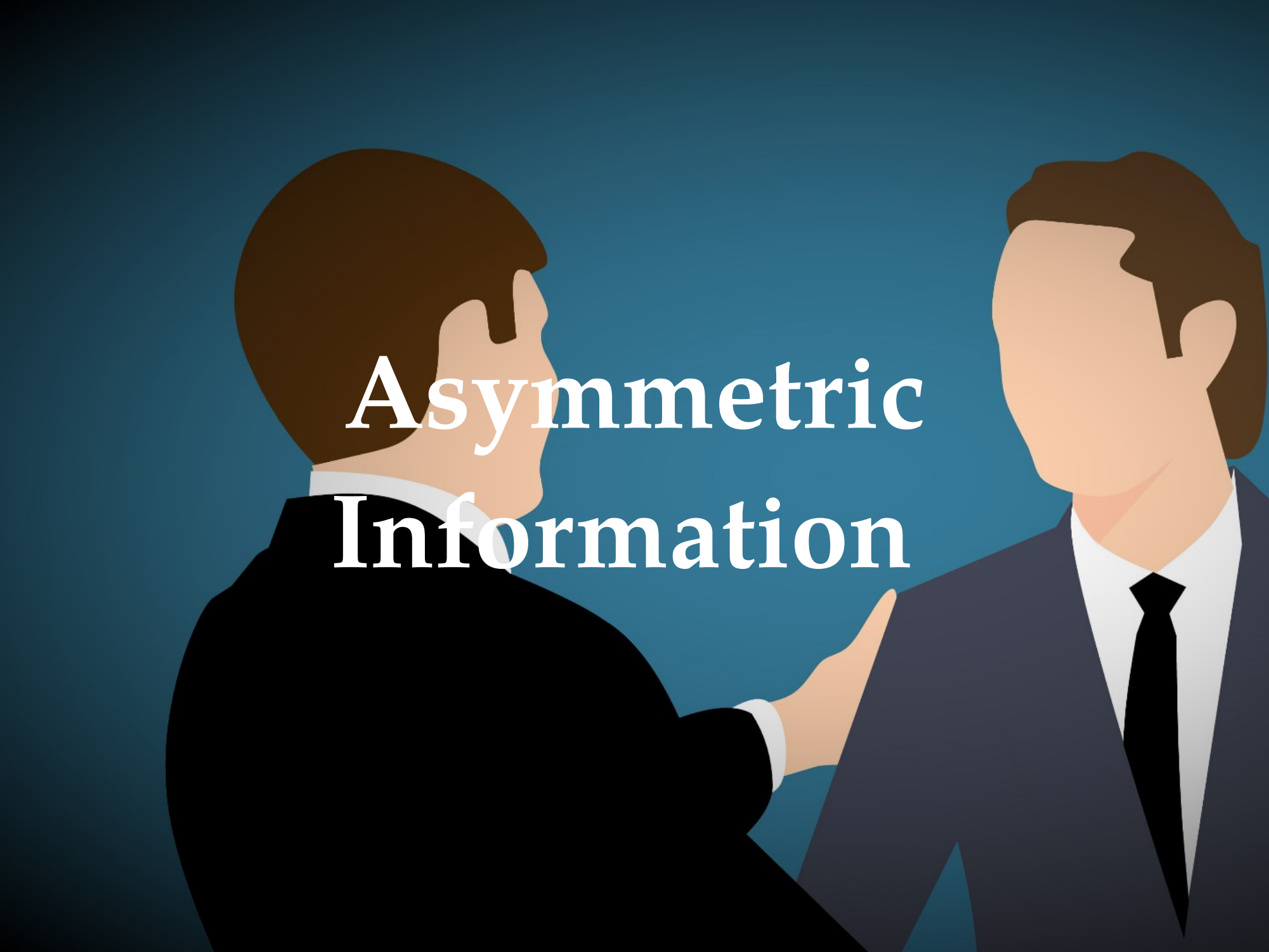
- Banks determine which projects get financed. What is a good project?
- Banks can invest in technologies that allow them to screen loan applicants and monitor their projects
  - Example of *technology*: banks develop long-term relationships with their borrowers, which lowers information costs and allows them to monitor more effectively

# Why do Banks Exist? **Screen Projects and Allocate Funds**

- Banks determine which projects get financed. What is a good project?
- Banks can invest in technologies that allow them to screen loan applicants and monitor their projects
  - Example of *technology*: banks develop long-term relationships with their borrowers, which lowers information costs and allows them to monitor more effectively

$\Rightarrow$ Banks reduce information frictions!

- Asymmetric information (this week)
- Search frictions (next week)


Asymmetric
Information

# Information Frictions : Asymmetric information

- Asymmetric information is one of the most important concepts in financial economics (Akerlof, Spencer and Stiglitz, Nobel Prize 2001)
- Arises whenever in a transaction one side has more (relevant) information than the other side

# Information Frictions : Asymmetric information

- Asymmetric information is one of the most important concepts in financial economics (Akerlof, Spencer and Stiglitz, Nobel Prize 2001)
- Arises whenever in a transaction one side has more (relevant) information than the other side
- It comes in two flavors:
    1. Adverse selection: before agreeing on some transaction, one of the two parties has some relevant information that is not known to the other party
    2. Moral hazard: after agreeing on some transaction, one party can take an action to its own benefit that is not observed by the other party.

# Adverse selection (Akerlof, 1970)

- Imagine there is a transaction to be made: a health insurance is about to win a client; a lender is about to make a loan; somebody is about to buy a used car
- In each of these examples, there is one side that is better informed than the other :
  - the health insurance may not know how bad a risk the customer is (whilst the customer knows)
  - the lender may not know how reliable the borrower really is (whilst the borrower knows)
  - the buyer of the car may not know whether it has hidden defects (whilst the seller knows)
- In such situations, markets don't function very well

# The Curse of Adverse selection

- In our examples,
  - the insurance will ask for a relatively high premium (because the most risky patients will be most keen on getting insurance)
  - the lender may ask for a relatively high interest rate
  - the buyer of the car may only be willing to buy at a steep discount in price (reflecting the average quality of cars on the market)

# The Curse of Adverse selection

- In our examples,
  - the insurance will ask for a relatively high premium (because the most risky patients will be most keen on getting insurance)
  - the lender may ask for a relatively high interest rate
  - the buyer of the car may only be willing to buy at a steep discount in price (reflecting the average quality of cars on the market)
- But then, the best types :
  - the healthiest clients seeking insurance,
  - the safest borrowers asking for a loan,
  - the sellers of excellent used cars

... may withdraw from the market because they can no longer attain reasonable conditions for the transaction.

# The Curse of Adverse selection

What can be done against adverse selection?

# The Curse of Adverse selection

What can be done against adverse selection?

Answer: reduce or eliminate information asymmetries

# The Curse of Adverse selection

What can be done against adverse selection?

Answer: reduce or eliminate information asymmetries

How?

# How to reduce information asymmetries?

- Government regulation to increase information

# How to reduce information asymmetries?

- Government regulation to increase information
- Private collection of information
  - health examination before taking insurance

# How to reduce information asymmetries?

- Government regulation to increase information
- Private collection of information
  - health examination before taking insurance
- But, free-rider problem:

# How to reduce information asymmetries?

- Government regulation to increase information
- Private collection of information
  - health examination before taking insurance
- But, free-rider problem: if you generate private information about an asset and act based on it, others may observe and imitate your actions (Grossman-Stiglitz paradox)

# How to reduce information asymmetries?

- Government regulation to increase information
- Private collection of information
  - health examination before taking insurance
- But, free-rider problem: if you generate private information about an asset and act based on it, others may observe and imitate your actions (Grossman-Stiglitz paradox)
- One can solve the free-rider problem if, after acquiring information, the asset is purchased exclusively by the informed intermediary

$\rightarrow$ Bank informed lending

# Informed Lending

- Broad consensus in the banking literature: one key activity of banks is information acquisition
- Banks acquire information ex-ante (before the loan is approved) to know more about their borrowers and mitigate adverse selection.
- They keep collecting further information ex-post (after the loan has been made) to ensure that the money is not used for improper purposes (monitoring)

# Informed Lending

- Broad consensus in the banking literature: one key activity of banks is information acquisition
- Banks acquire information ex-ante (before the loan is approved) to know more about their borrowers and mitigate adverse selection.
- They keep collecting further information ex-post (after the loan has been made) to ensure that the money is not used for improper purposes (monitoring)
- Ex: Most banks that lend to construction firms have their own construction engineers that regularly visit the construction site and evaluate progress before the next tranche of the loan is paid out.

# Relationship Lending

- By acquiring information over the course of a credit agreement, banks are better informed about the borrower than anyone else $\rightarrow$ banks learn by lending
- It is therefore quite natural that many banks, especially small ones with dense branch networks, invest in building long-lasting relationships with their borrowers.

$\rightarrow$ What are the consequences for borrowers ?

# Relationship Lending

- By acquiring information over the course of a credit agreement, banks are better informed about the borrower than anyone else → banks learn by lending
- It is therefore quite natural that many banks, especially small ones with dense branch networks, invest in building long-lasting relationships with their borrowers.

→ What are the consequences for borrowers ?

- This is double edged sword:
  - better informed relationship lenders offer more reliable access to credit
  - but can also afford charging higher interest because they enjoy an information monopoly over their long-term borrower (Sharpe, 1990)

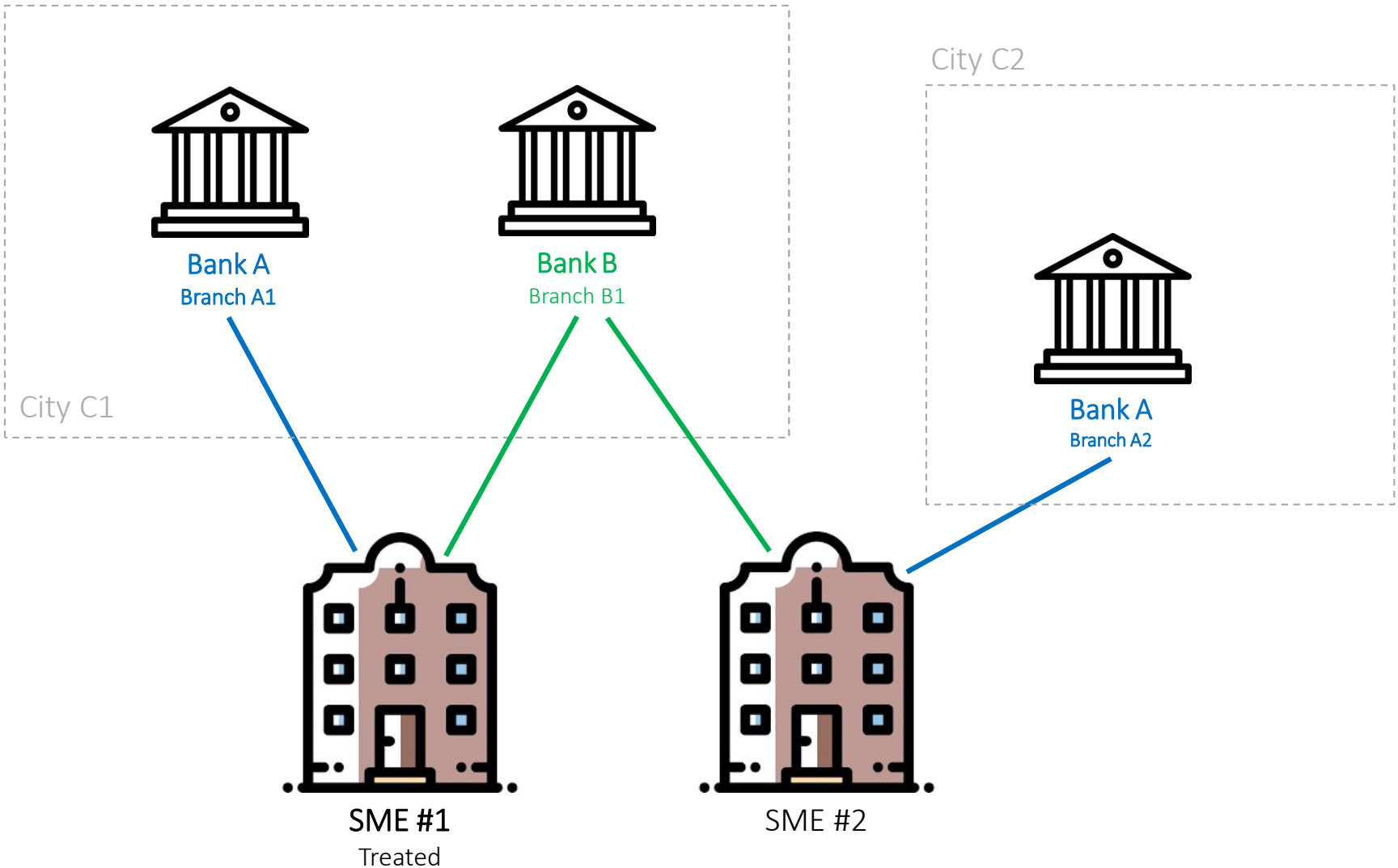
# Relationship banking: geographic proximity matters

- Most relationship lenders are in close geographic proximity to their borrowers and have a dense branch network.
- Degryse and Ongena (2005) find in a study of Belgian banks that banks are geographically close to customers:
  - The median borrower is located around 4 minutes and 20 seconds from the lender at a travel speed of 20 mph, i.e. 2.25 km distance.
- Evidence that the quality of a bank's information deteriorates substantially with increasing distance to its borrowers, see e.g. Granja, Leuz and Rajan (2018).
- In other words, credit-relevant information is to a substantial share of local nature.

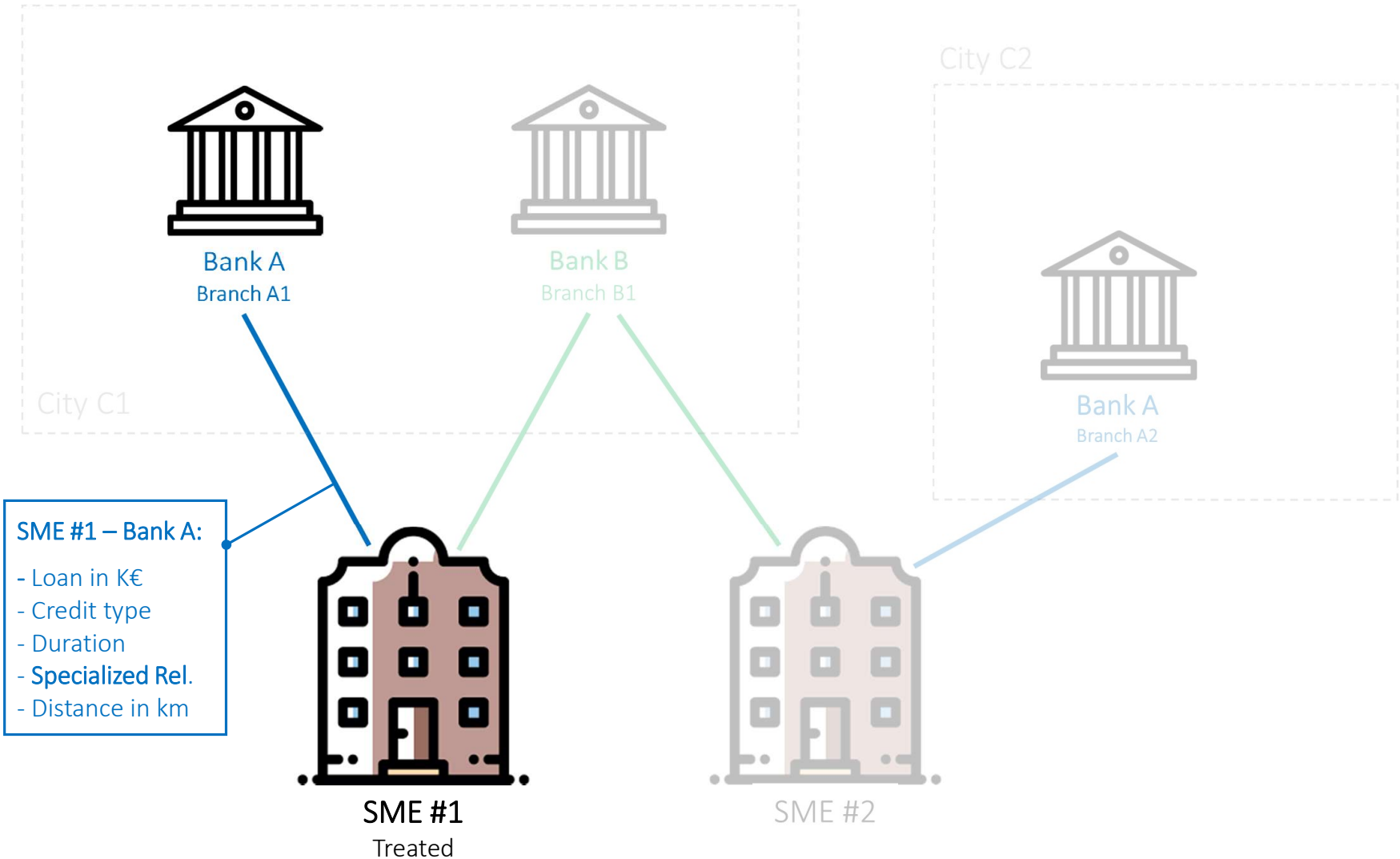
# Relationship banking: specialization matters

- Geographic proximity is not the only way to gain market power
- Duquerroy et al., (2022) show that industrial specialization at branch-level matters for access to credit:
  - SMEs transferred from specialized to non-specialized loan officer suffer from credit loss
- In other words, industry-relevant information is also at stake

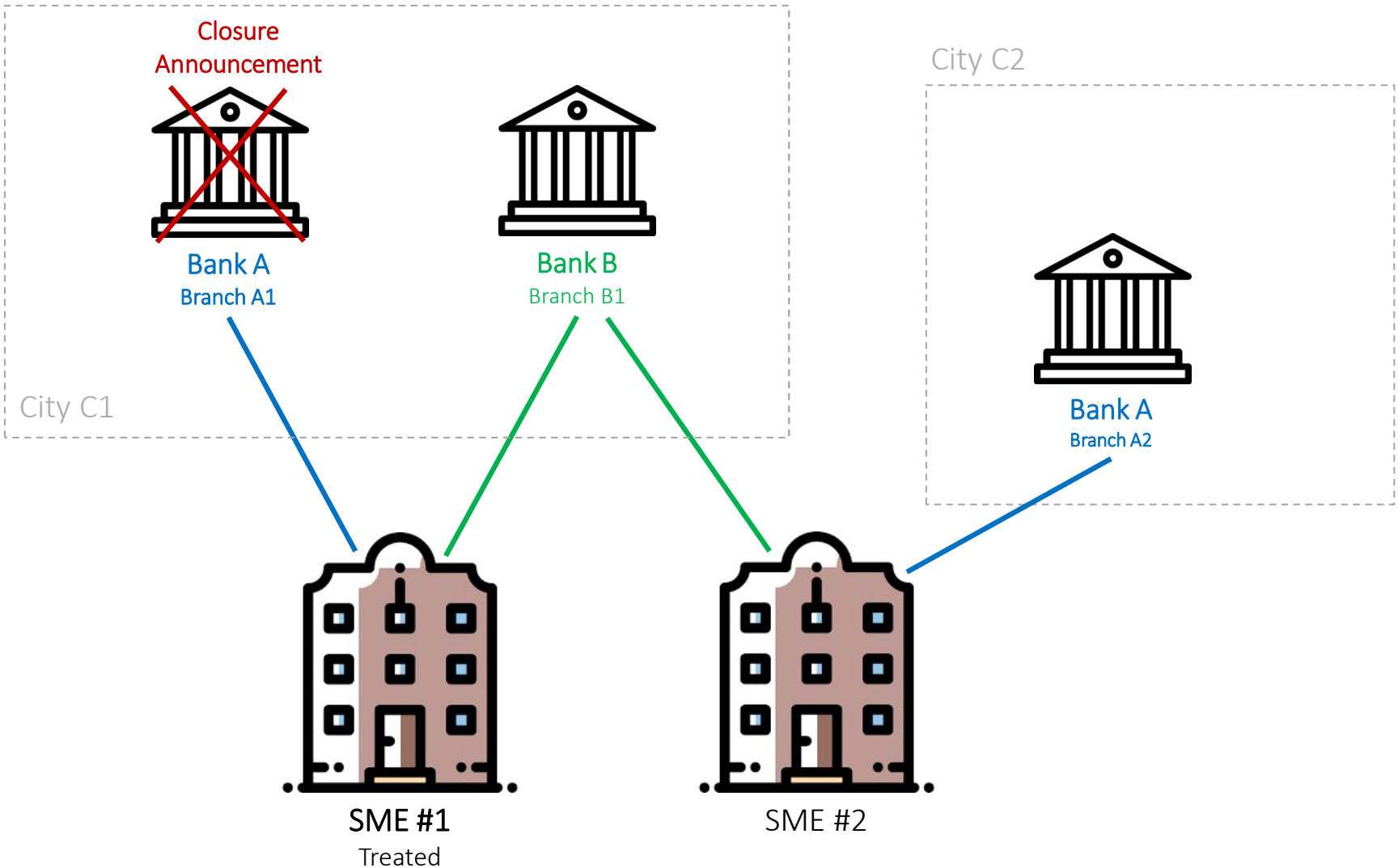
# Relationship banking: specialization matters



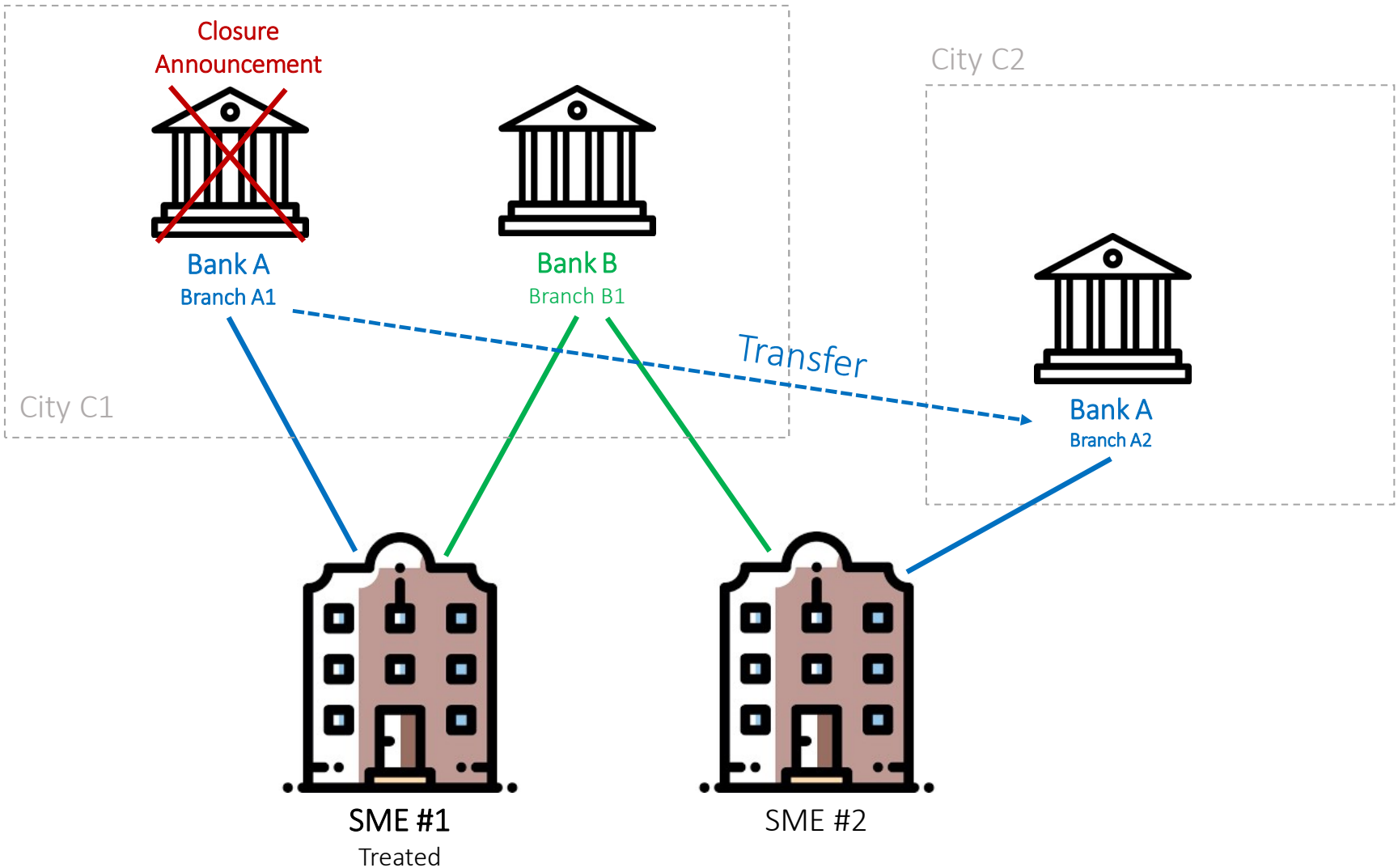
# Relationship banking: specialization matters



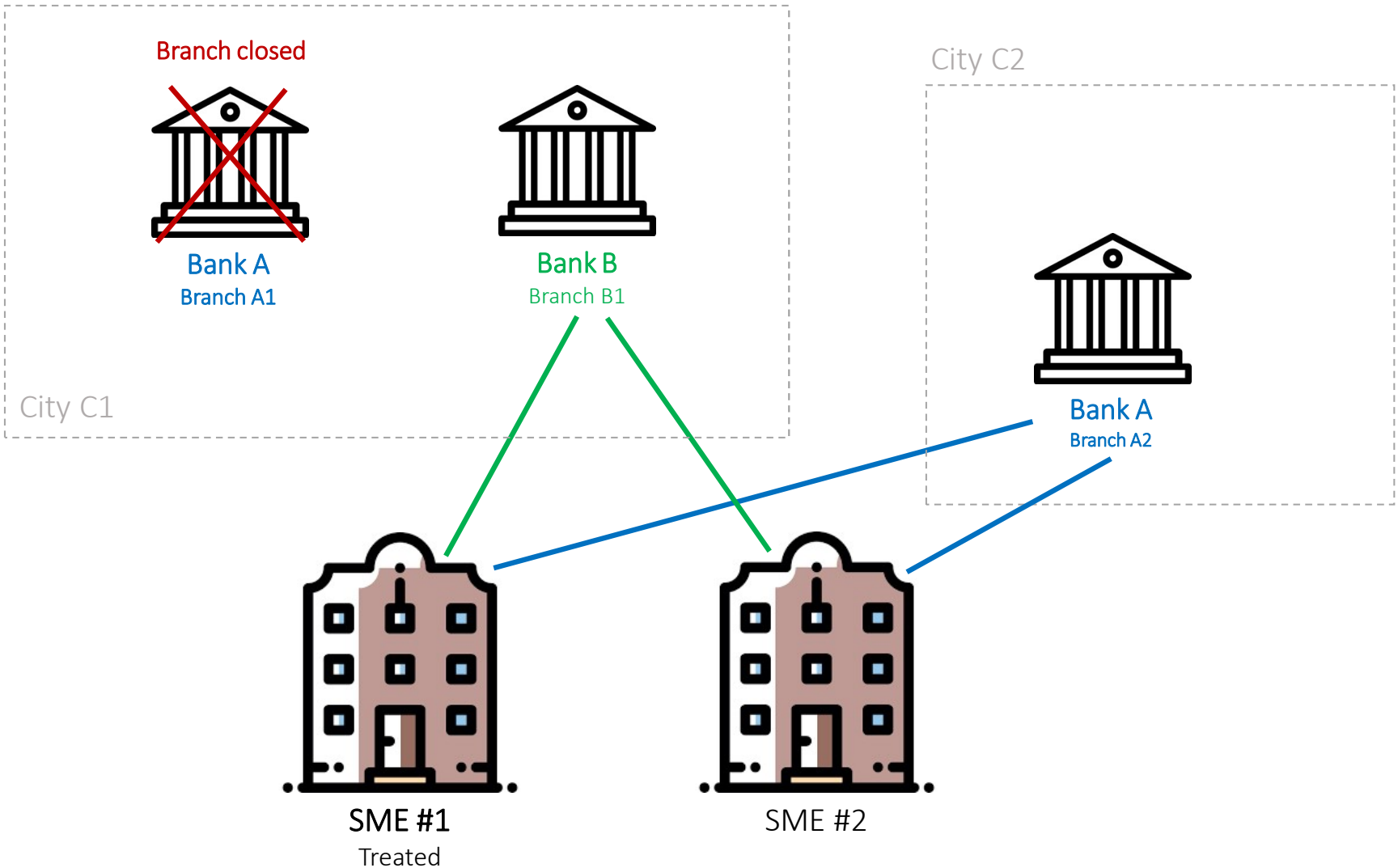
# Relationship banking: specialization matters



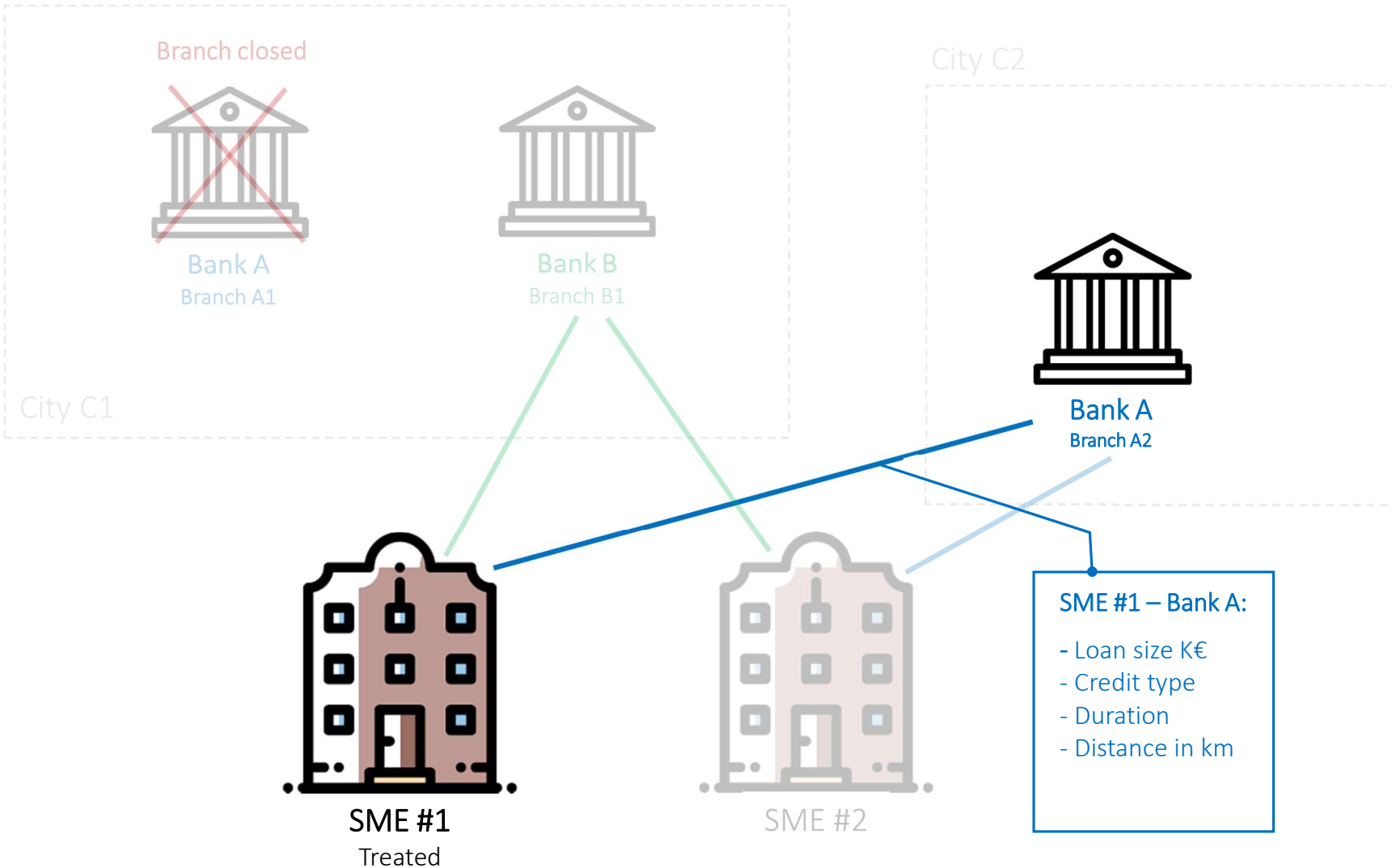
# Relationship banking: specialization matters



# Relationship banking: specialization matters



# Relationship banking: specialization matters



# Relationship banking: specialization matters

| | Total credit | | | | |
|---|---|---|---|---|---|
| | (1) | **(2)** | (3) | (4) | (5) |
| Announcement x Post | -0.072*** | -0.072*** | -0.071*** | -0.071*** | -0.071*** |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) |
| Closing x Post | -0.124*** | -0.119*** | -0.121*** | -0.117*** | -0.112*** |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) |
| **Closing x Post x $\Delta$ specialization** | | **-0.145*** ** | | -0.115** | |
| | | **(0.046)** | | (0.046) | |
| Closing x Post x Specialization loss | | | | | -0.143** |
| | | | | | (0.057) |
| Closing x Post x Specialization gain | | | | | 0.068 |
| | | | | | (0.070) |
| Branch specialization | | | 0.062*** | 0.061*** | 0.061*** |
| | | | (0.006) | (0.006) | (0.006) |
| Firm x Bank FE | Yes | Yes | Yes | Yes | Yes |
| Firm x Quarter FE | Yes | Yes | Yes | Yes | Yes |
| GEA x Quarter FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 3931733 | 3931733 | 3931733 | 3931733 | 3931733 |
| R-Square | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |

**Robust standard errors (clustered at the urban unit x year level) are in parentheses.**

# Informed lending and IT adoption

- Low-Tech screening : 1-on-1 meetings with borrowers, manual financial analysis
- Today: ML algorithm and balance-sheet / income statement data. See Hurley and Adebayo (2016) and Fahner (2018) $\rightarrow$ See this week's optional PC Lab!
- According to you, does distance still mater?

# Informed lending in a digital world

- Facebook, Google and other techs know much more about us than all banks combined. Banks' information advantage has eroded!
- FinTech lenders have been using people's digital footprint in Facebook and other social media for quite some time to evaluate the creditworthiness of applicants who have no official credit score.
- Are such data any good ?

# Informed lending in a digital world

- Facebook, Google and other techs know much more about us than all banks combined. Banks' information advantage has eroded!
- FinTech lenders have been using people's digital footprint in Facebook and other social media for quite some time to evaluate the creditworthiness of applicants who have no official credit score.
- Are such data any good ?
- It seems so: Berg, Burg, Gombovi and Puri (2018) have shown in a dataset of 250,000 registrations at a German e-commerce website that the digital traces that we are leaving while shopping online are more precise predictors of our creditworthiness than the credit scores of credit bureaus.

# Informed lending in a digital world

| Company & Product | Example Data Inputs |
|---|---|
| **LexisNexis – RiskView** | Residential stability, asset ownership, life-stage analysis, property deeds and mortgages, tax records, criminal history, employment and address history, liens and judgments, ID verification, and professional licensure. |
| **FICO – Expansion Score** | Purchase payment plans, checking accounts, property data, public records, demand deposit account records, cell and landline utility bill information, bankruptcy, liens, judgments, membership club records, debit data, and property asset information. |
| **Experian – Income Insight** | Rental payment data, public record data. |
| **Equifax – Decision 360** | Telco utility payments, verified employment, modeled income, verified income, spending capacity, property/asset information, scheduled monthly payments, current debt payments, debt-to-income ratio, bankruptcy scores. |
| **TransUnion – CreditVision** | Address history, balances on trade lines, credit limit, amounts past due, actual payment amount. |
| **ZestFinance** | Major bureau credit reports and thousands of other variables" including financial information, technology usage, and how quickly a user scrolls through terms of service. |
| **LendUp** | Major bureau credit reports, social network data, how quickly a user scrolls through its site. |
| **Kreditech (Not available in U.S.)** | Location data (e.g., GPS), social graphing (likes, friends, locations, posts), behavioral analytics (movement and duration on a webpage), e-commerce shopping behavior, device data (apps installed, operating systems). |
| **Earnest** | Current job, salary, education history, balances in savings or retirement accounts, online profile data (e.g., LinkedIn), and credit card information. |
| **Demyst Data** | Credit scores, occupation verification, fraud checks, employment stability, work history, and online social footprint. |

- More on this next week !


Liquidity
Transformation

# Illiquid bank assets

- In acquiring information, banks reduce the information gap between lenders and borrowers
- Side effect: the better the bank knows its borrowers, the greater becomes the bank's information advantage over anyone else in the economy

Could it be a problem ?

# Illiquid bank assets

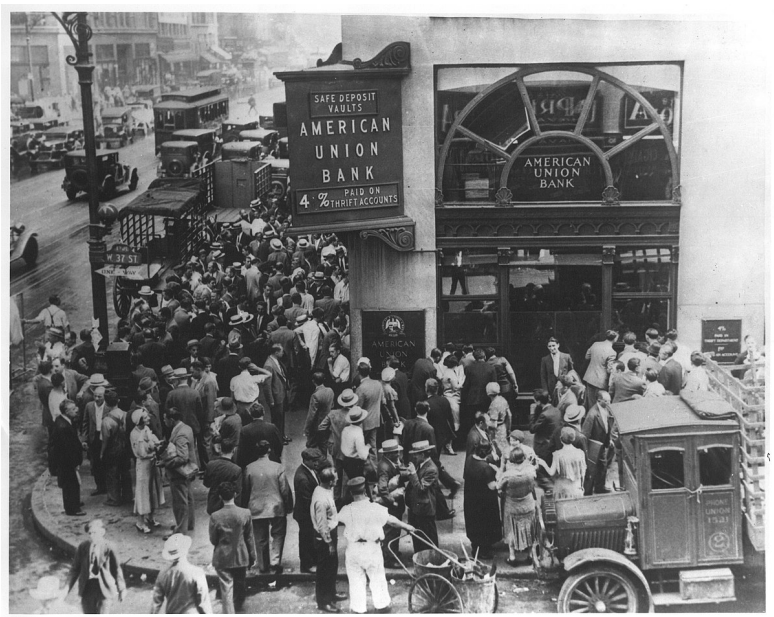
- In acquiring information, banks reduce the information gap between lenders and borrowers
- Side effect: the better the bank knows its borrowers, the greater becomes the bank's information advantage over anyone else in the economy

Could it be a problem ?

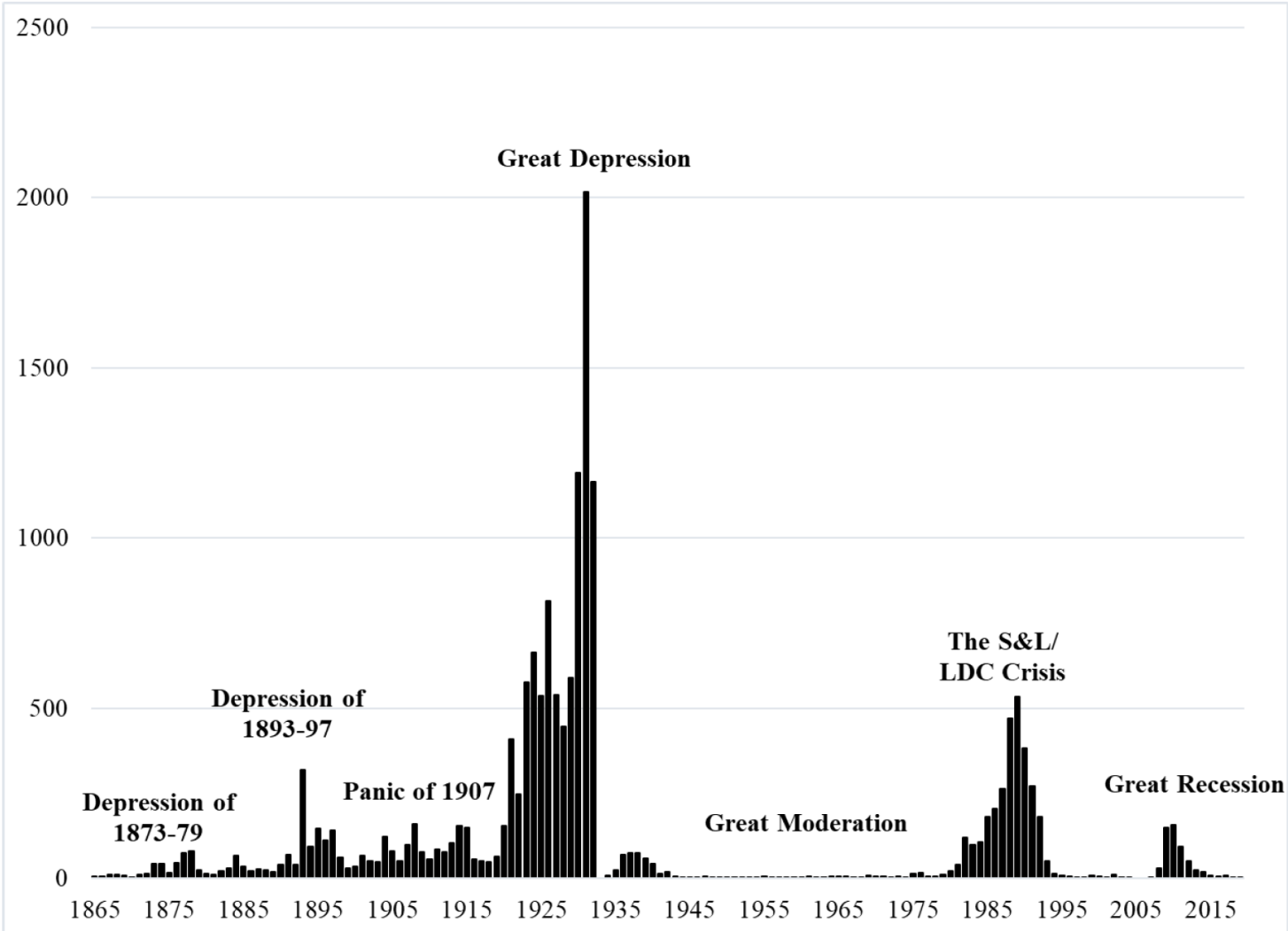
- Loans are very illiquid (hard to sell) because the bank's information advantage creates asymmetric information problems between the bank and the prospective buyers of the loans

# Illiquid bank assets

- As many loans have long maturities whilst most bank deposits can be withdrawn anytime, this is a potential problem $\rightarrow$ banks runs !

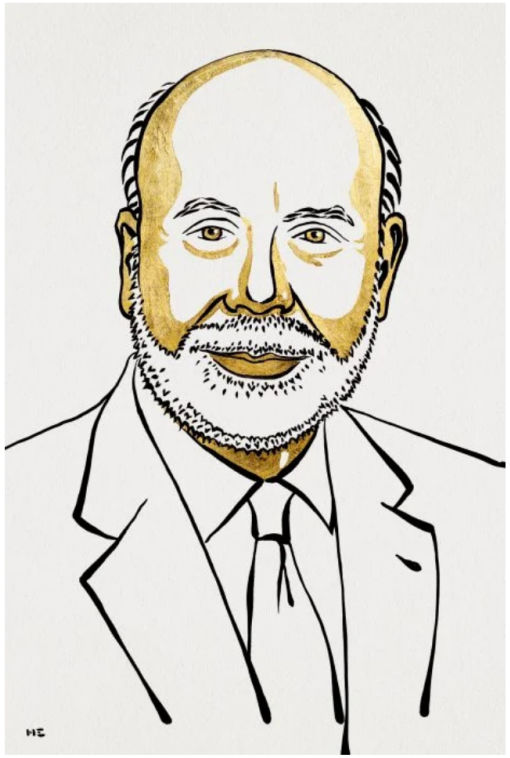



# Bank runs and bank failures



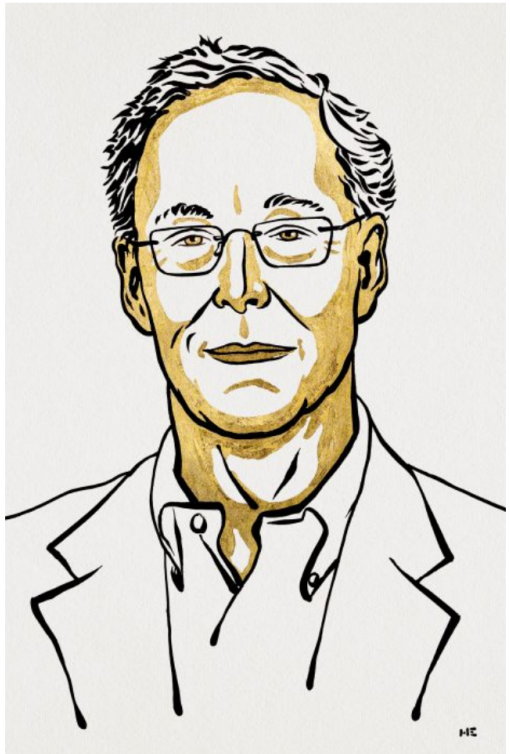

- We'll demonstrate the consequences of this liquidity transformation in the Diamond-Dybvig (1983) model.

# Diamond-Dybvig: two years ago!



Ill. Niklas Elmehed © Nobel Prize Outreach

Ben S. Bernanke



Ill. Niklas Elmehed © Nobel Prize Outreach

Douglas W. Diamond

Ill. Niklas Elmehed © Nobel Prize Outreach

Philip H. Dybvig

→ Nobel Prize 2022

# Diamond-Dybvig (1983)

## An illiquid asset

- There are two assets in the economy (liquid = cash and illiquid)
- Let's model an illiquid asset in a stylized way :

# Diamond-Dybvig (1983)

## An illiquid asset

- There are two assets in the economy (liquid = cash and illiquid)
- Let's model an illiquid asset in a stylized way :
  - There are three periods $t = 0, 1, 2$
  - The illiquid asset matures in period $t = 2$.
  - Every unit of the illiquid asset gives at $t = 2$ a payoff of $R > 1$. If liquidated early in $t = 1$, however, it can only be sold at a value $L < 1$.

# Diamond-Dybvig (1983)

## Consumers

- There is a continuum (i.e., a lot) of identical consumers

# Diamond-Dybvig (1983)

## Consumers

- There is a continuum (i.e., a lot) of identical consumers
- Each has an endowment of $1$ at $t = 0$, and can consume at either $t = 1$ or $t = 2$

# Diamond-Dybvig (1983)

## Consumers

- There is a continuum (i.e., a lot) of identical consumers
- Each has an endowment of $1$ at $t = 0$, and can consume at either $t = 1$ or $t = 2$
- At the beginning of the game in $t = 0$, consumers don't know (yet) when they will want to consume. They will learn at $t = 1$

# Diamond-Dybvig (1983)

## Liquidity preferences

- There is a probability $\pi_1$ that they need to consume early in $t = 1$. We will call those early consumers the impatient consumer types.
- With probability $\pi_2 = 1 - \pi_1$ they are patient and consume late in $t = 2$

# Diamond-Dybvig (1983)

## Liquidity preferences

- There is a probability $\pi_1$ that they need to consume early in $t = 1$. We will call those early consumers the impatient consumer types.
- With probability $\pi_2 = 1 - \pi_1$ they are patient and consume late in $t = 2$
- Assuming a concave utility function $u(.)$ with $u' > 0$, $u'' < 0$, their utility from consuming $c_1$ in period 1 and $c_2$ in period 2 is therefore given by :

$$u(c_1, c_2) = \begin{cases} u(c_1) \text{ w. prob.} \pi_1. \\ u(c_2) \text{ w. prob.} \pi_2 \end{cases}$$

– This assumption captures a pervasive pattern in financial markets : investors are hesitant to purchase illiquid financial assets because they don't know when they will need the money due to an unforeseen liquidity shock.

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 1: Autarky**

- If consumers are unable to trade with anyone, what would their allocation be? How much welfare would they enjoy?
- If they invest in $t = 0$ an amount of $I$ in the long asset and $1 - I$ in the short asset, then:
  - If they are impatient : $c_1 = L \times I + (1 - I)$ by liquidating the long asset early in $t = 1$ plus consuming all short asset payoffs.
  - If consumers are patient : $c_2 = R \times I + (1 - I)$ in period $t = 2$.
- How much can they consume if they choose $I$ optimally?

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 1: Autarky**

- How much can they consume if they choose $I$ optimally?
- Without solving this question, we can see that because of $L < 1$, any choice of $I$ implies that $c_1 \leq 1$ and $c_2 \leq R$, with one of these two inequalities holding strictly.

$\rightarrow$ It is not possible to attain a consumption of $c_1 = 1, c_2 = R$ in autarky.

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 2: Allowing for trade**

- Impatient consumers can sell in $t = 1$ a bond to patient consumers
  - Instead of liquidating the long asset, they keep holding it, sell a bond to patient consumers that offers 1 at $t = 2$ for price $p$ at $t = 1$.
  - They use the money from selling the bond to consume early, and repay the bond with the payoff of the long asset in t=2.
- Patient consumers would use all their short asset holdings to purchase $(1 - I)/p$ bonds in $t = 1$ from impatient consumers
- Final consumption :

$$c_1 = p \times RI + (1 - I)$$

$$c_2 = RI + \frac{1 - I}{p}$$

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 2: Allowing for trade**

- Final consumption :

$$c_1 = p \times RI + (1 - I)$$
$$c_2 = RI + \frac{1 - I}{p}$$

- The utility of agents increases in $I$ if $pR > 1$, and decreases in $I$ if $pR < 1$. This means that the only price at which an interior optimum $I \in (0, 1)$ can exist must satisfy $pR = 1$, hence $p = 1/R$.

- Replacing in the previous equation gives $c_1^T = 1$ and $c_2^T = R$

- Strictly better than autarky

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 3: Social Planner**

- Let's ask a benevolent social planner to allocate resources at will as to maximize expected utility of all agents in the economy
- It will surely be optimal to pay for all $t = 1$ consumption with the short asset, and for $t = 2$ consumption with the long asset. The optimization problem becomes

$$\max_{c_1, c_2, I} \pi_1 u(c_1) + \pi_2 u(c_2)$$

- Subject to $\pi_1 c_1 = 1 - I$ and $\pi_2 c_2 = RI$

# Diamond-Dybvig (1983)

## Solving the model. **Benchmark 3: Social Planner**

- Substituting the constraints into the objective function, we have

$$U(I) = \pi_1 \, u(\frac{1-I}{\pi_1}) + \pi_2 \, u(\frac{RI}{\pi_2})$$

- which we can maximize by differentiating with respect to $I$. This yields the first-order condition

$$u'(c_1^*) - Ru'(c_2^*) = 0$$

- Our solution with trade, $c_1^T = 1$ and $c_2^T = R$ will satisfy this condition at best by coincidence : The market solution is not efficient here.

- In particular, if $u'(1) > R\,u'(R)$, there is more marginal benefit to first period consumption than what the (incomplete) market solution attains : $c_1^* > 1$.

- We need a social planner $\rightarrow$ Banks

# Diamond-Dybvig (1983)

## Banks as Social Planners

- A financial intermediary could receive deposits of 1 at $t = 0$ and promise withdrawal of $c_1^*, c_2^*$ in $t = 1$ and $t = 2$, respectively.
- By law of large numbers, the aggregate impatient and patient consumers withdrawals are deterministic, and by choosing $I$ accordingly, the planner's optimum can be reproduced

# Diamond-Dybvig (1983)

## Banks as Social Planners

- A financial intermediary could receive deposits of 1 at $t = 0$ and promise withdrawal of $c_1^*, c_2^*$ in $t = 1$ and $t = 2$, respectively.
- By law of large numbers, the aggregate impatient and patient consumers withdrawals are deterministic, and by choosing $I$ accordingly, the planner's optimum can be reproduced
- What banks essentially are in the Diamond-Dybvig model is liquidity intermediaries: they hold illiquid assets, yet they allow withdrawal of liquid deposits at any point in time, providing liquidity insurance for depositors.
- This is a great benefit + it's one of the core functions of banks.

# Deposit insurance and moral hazard

- But the same liquidity transformation is also the root of inherent instability:

# Deposit insurance and moral hazard

- But the same liquidity transformation is also the root of inherent instability: the bank can only meet the withdrawals of the impatient depositors from short asset liquidations.

- Imagine that some patient depositors come to believe that other patient depositors are withdrawing $c_1 > 1$ in $t = 1$. Then they must conclude that :

  - the bank must liquidate the long asset at a loss to meet those withdrawals, and not enough is left to pay them $c_2^*$ ;

  - if they believe that enough other patient depositors are withdrawing early, they will also want to withdraw immediately.

# Deposit insurance and moral hazard

- But the same liquidity transformation is also the root of inherent instability: the bank can only meet the withdrawals of the impatient depositors from short asset liquidations.

- Imagine that some patient depositors come to believe that other patient depositors are withdrawing $c_1 > 1$ in $t = 1$. Then they must conclude that :

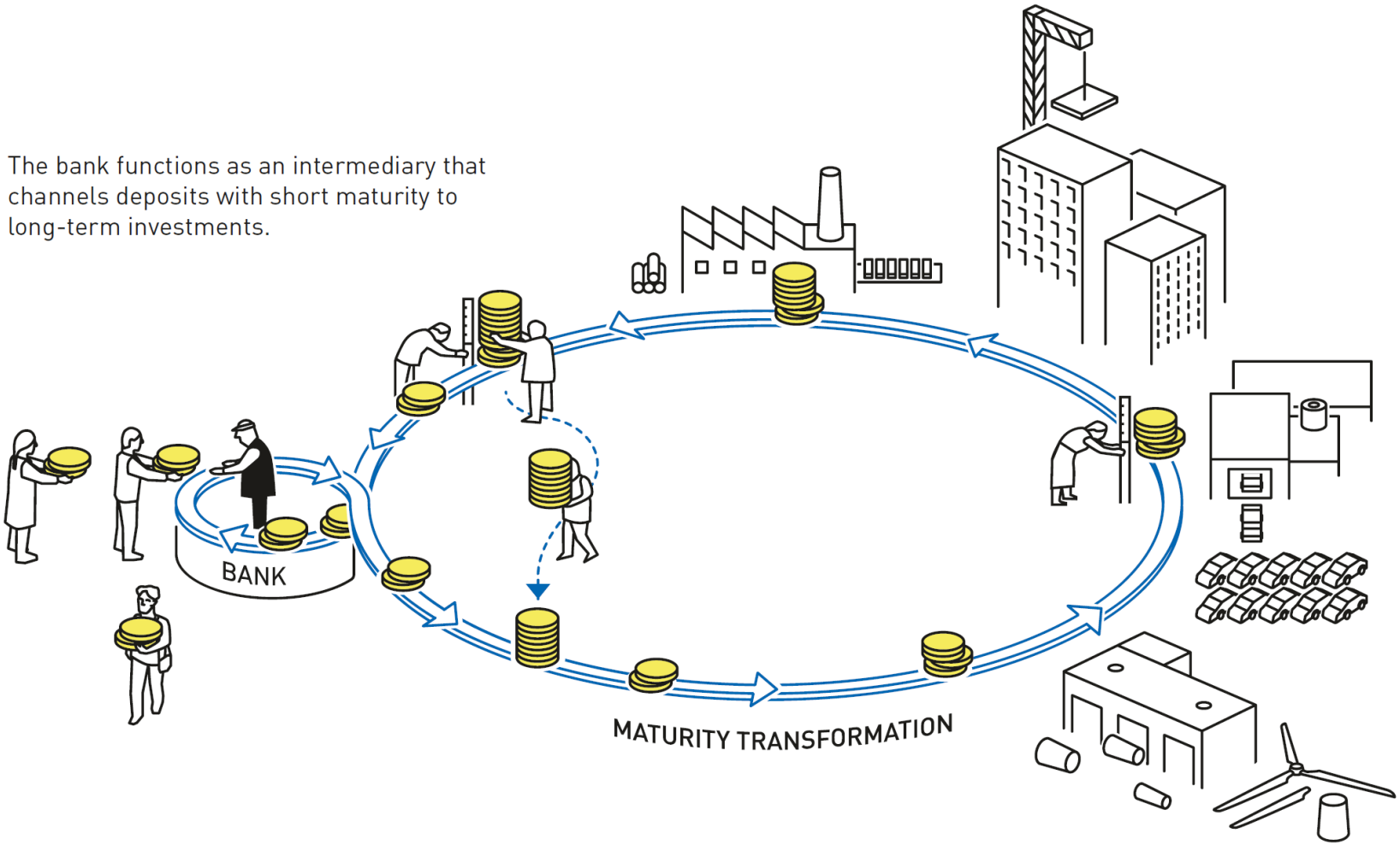
  - the bank must liquidate the long asset at a loss to meet those withdrawals, and not enough is left to pay them $c_2^*$ ;

  - if they believe that enough other patient depositors are withdrawing early, they will also want to withdraw immediately.

- The result is a **bank run:** both patient and impatient depositors attempt to withdraw at $t = 1$. Beliefs about others withdrawing early suffice to sustain a financial panic.

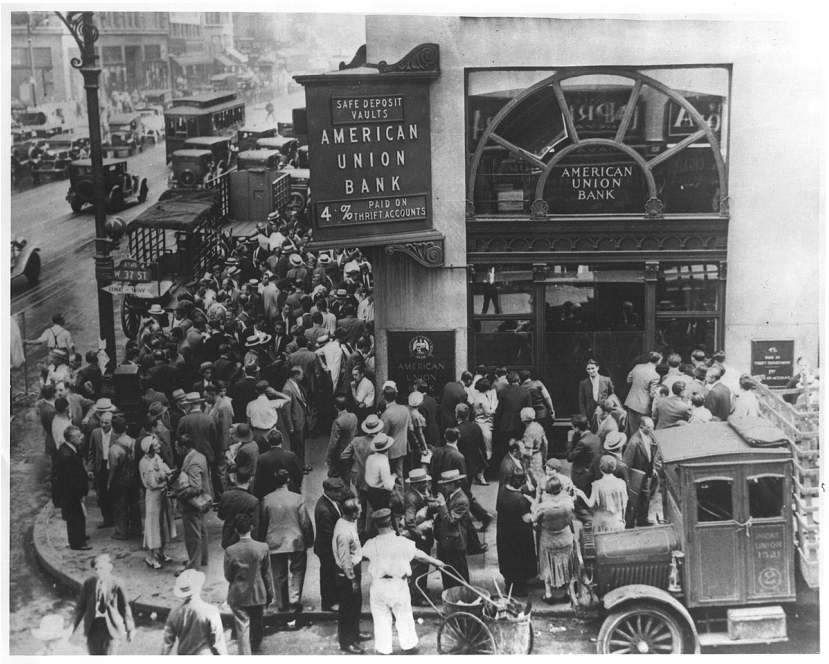
- Key policy implication: we need a lender of last resort + banking regulation

# Key Take Away

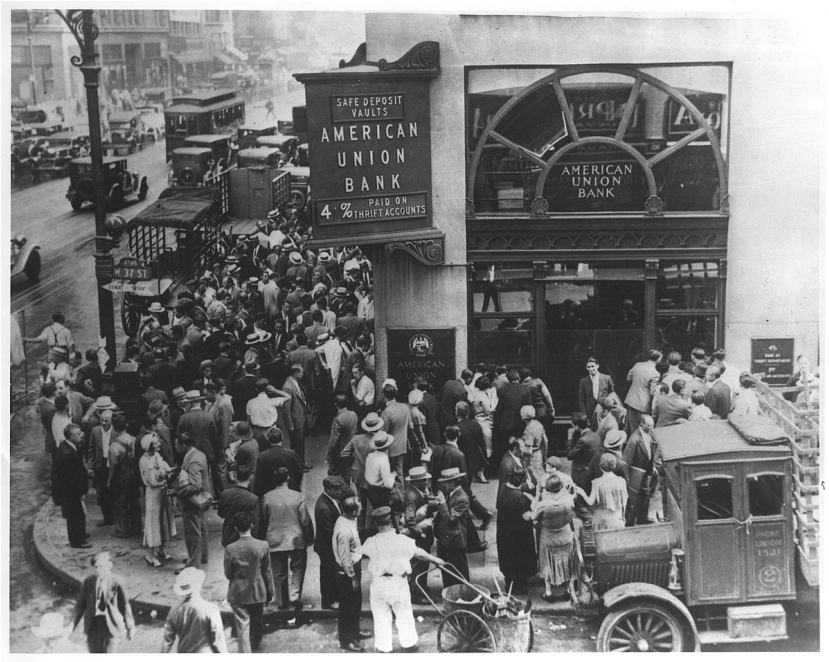



- Maturity transformation: transform securities with short duration (e.g. deposits) into long duration securities (e.g. home loans)
- Liquidity risk: depositors may withdraw their money before the long-duration loan is repaid

# Why should we care today?



# Why should we care today?




# Silicon Valley Bank (March 2023 )

- SVB specialized in Tech startups with tons of cash. These startups needed a bank to store their money, but they **didn't need any loan**
- Thus, contrary to traditional commercial banks, SVB invested **unsecured deposits money into bonds** (not in loans).
- Issue?

# Silicon Valley Bank (March 2023 )

- SVB specialized in Tech startups with tons of cash. These startups needed a bank to store their money, but they **didn't need any loan**
- Thus, contrary to traditional commercial banks, SVB invested **unsecured deposits money into bonds** (not in loans).
- Issue? If interest rates increase suddenly bond prices go down, and if the bank doesn't have a good hedging strategy = asset value collapses
- Finally, bad news about SVB assets triggers a startup run on uninsured deposits. We've all the ingredients for a bankruptcy!

# Silicon Valley Bank

| Bank | City | State | Year | Assets at time of failure (nominal) | Assets at time of failure (inflation-adjusted, 2021) | Ref. |
|---|---|---|---|---|---|---|
| Washington Mutual | Seattle | Washington | 2008 | $307 billion | $386 billion | [3] |
| Silicon Valley Bank | Santa Clara | California | 2023 | $209 billion | $209 billion | [4] |
| Signature Bank | New York | New York | 2023 | $118 billion | $118 billion | [5] |
| Continental Illinois National Bank and Trust | Chicago | Illinois | 1984 | $40.0 billion | $104 billion | [3][6] |
| First Republic Bank Corporation | Dallas | Texas | 1988 | $32.5 billion | $74 billion | [7] |
| IndyMac | Pasadena | California | 2008 | $32 billion | $40 billion | [8] |
| American Savings and Loan | Stockton | California | 1988 | $30.2 billion | $69 billion | |

# Beyond Silicon Valley Bank


Crédit Suisse stock market price, March 3-21, 2023

# Discussion I

Why do bank runs are more/less likely to happen today?

# Discussion II

Go to BlackBoard and read the 2022 Nobel Prize Press release


## The laureates explained the central role of banks in financial crises

*The Great Depression of the 1930s paralysed the world's economies for many years and had vast societal consequences. However, we have managed subsequent financial crises better thanks to research insights from this year's laureates in the Economic Sciences,* ***Ben Bernanke, Douglas Diamond*** *and* ***Philip Dybvig****. They have demonstrated the importance of preventing widespread bank collapses.*