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# CHAPTER 5

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## SYSTEMIC RISK, AMPLIFICATION AND CONTAGION

Strategic Complementarities, Amplification, Multiplicity

Systemic Risks in Irish Banking Sector in the 2000s

Emerging Markets' Storm of 1997-98

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**a crash course  
on crises:**

**macroeconomic**

**concepts for**

**run-ups,**

**collapses, and**

**recoveries**

**markus k. brunnermeier  
and ricardo reis**

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# STRATEGIC COMPLEMENTARITIES, AMPLIFICATION, MULTIPLICITY, AND PECUNIARY EXTERNALITIES

- Modern financial markets depend critically on how each individual market participant reacts to the behavior of others
    - Unlike traditional banks, modern banks want to mimic the actions of others as the result of change in structure of liabilities and assets held by banks
  - The combination of capital misallocation, reliance on wholesale funding has led to a financial system that hugely depends on market sentiment and is prone to instability
  - **Adverse feedback loops** amplify initial exogenous shocks, so seemingly small events can have large changes in credit and asset prices
  - If these amplification forces are sufficiently strong, there may be multiple equilibria, so that even just a switch to more pessimism by financial institutions can trigger a crisis
    - The system self-generates **systemic risk**
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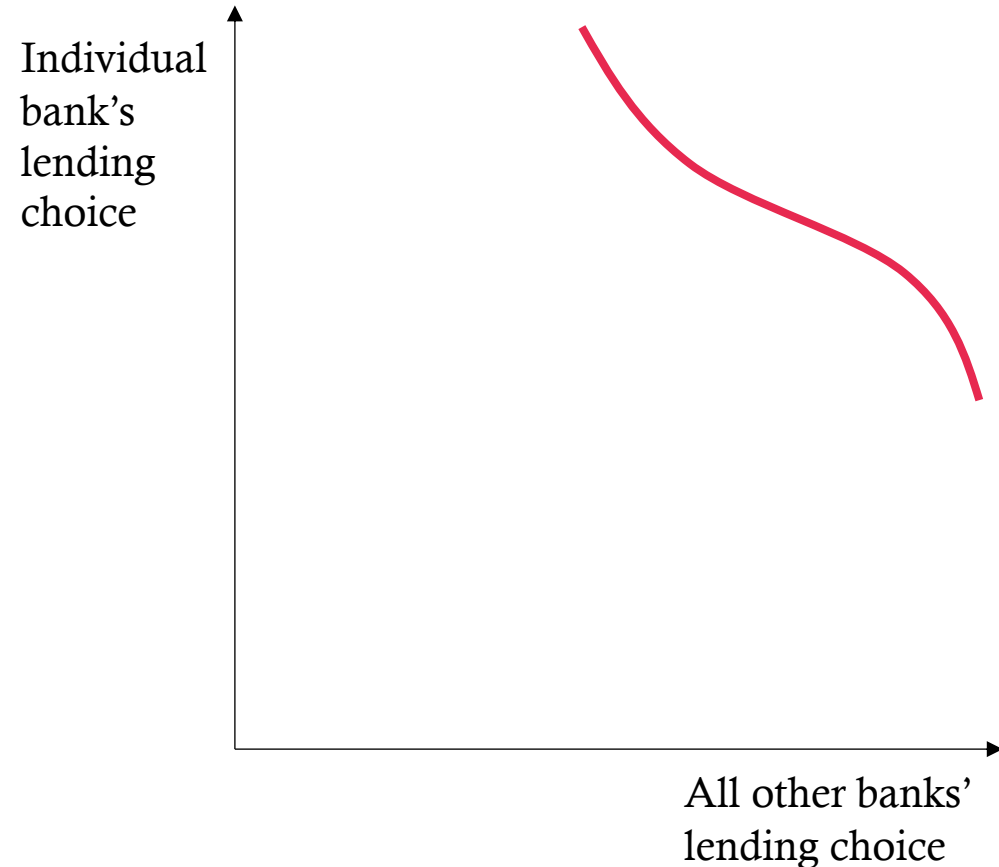
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# A MODEL OF STRATEGIC INTERACTIONS

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# TRADITIONAL BANKS: MODEL SETUP

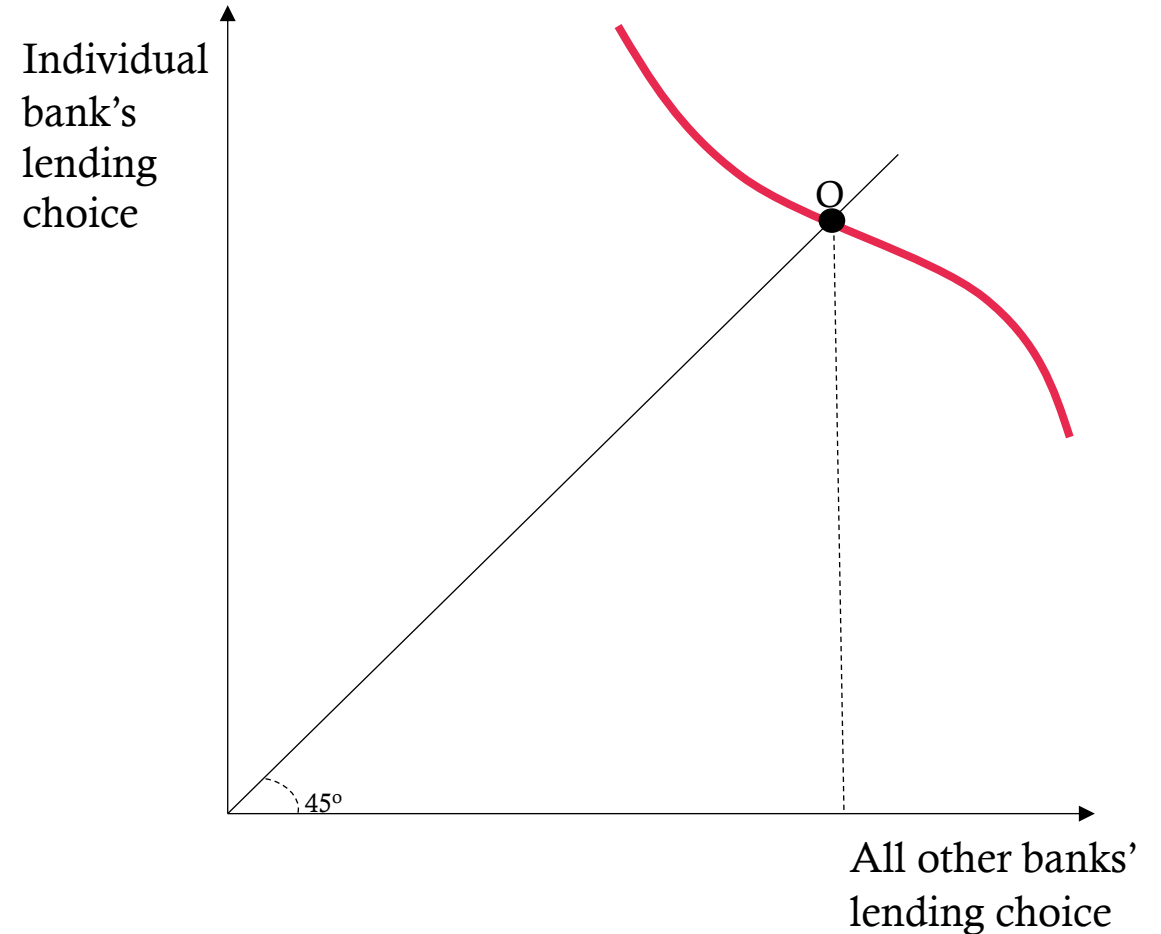
- **Best Response** (BR) functions show the best response of one bank given others' choices in the financial market
- Determines how much it will lend given the others' behavior
- Traditional bank decreases lending whenever others increase their average lending
- The good projects with higher returns are already invested
- BR curve is **downward sloping**
- Actions are **strategic substitutes**



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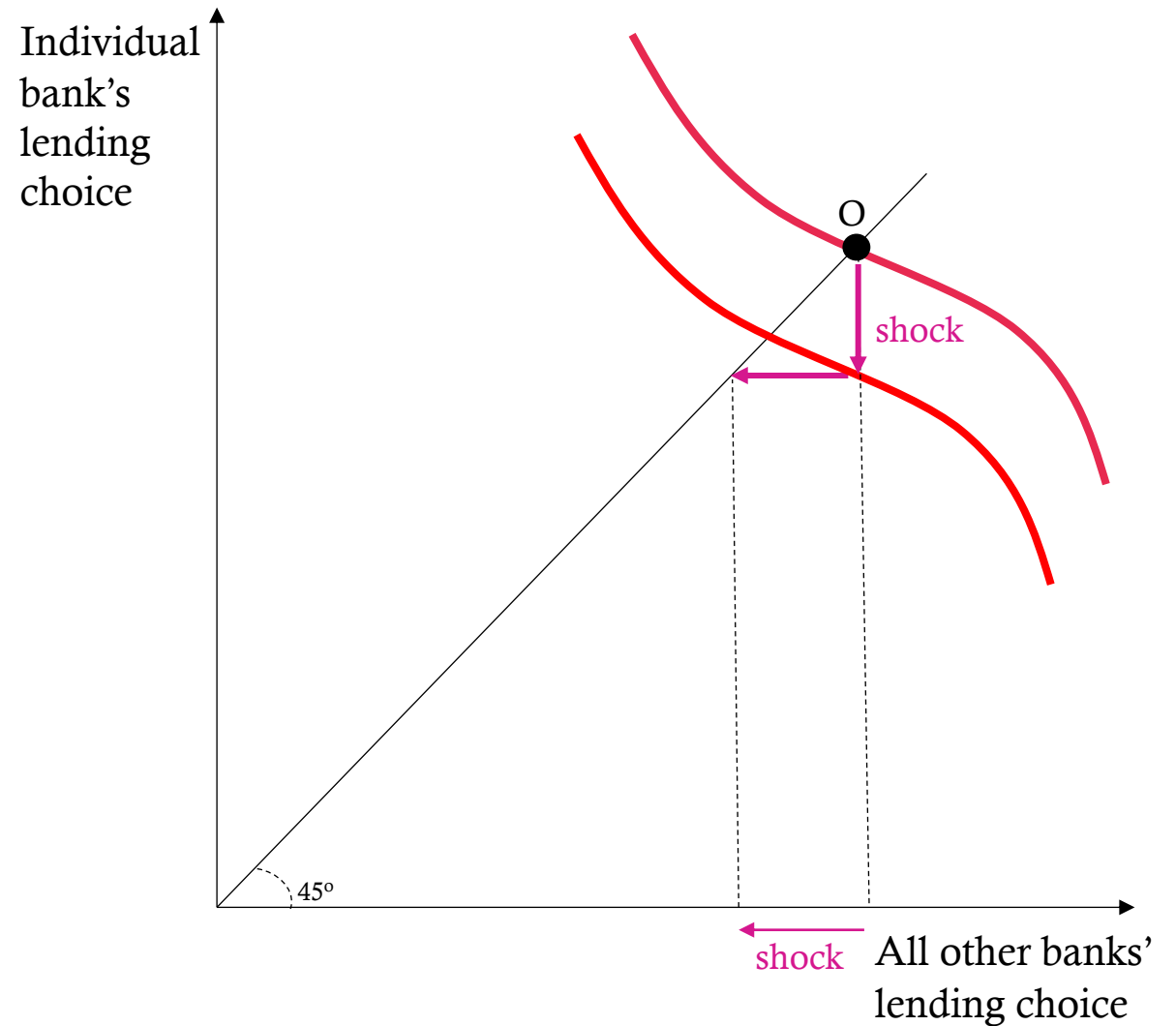
# TRADITIONAL BANKS: EQUILIBRIUM

- For simplicity, assume all other banks' lending choice is identical
- There is a **symmetric equilibrium** in that every single participants choses to do what the group is also doing
- The system is **stable** in two senses:
  1. A **unique equilibrium** at O, the individual bank's BR coincides with the market BR at  $45^\circ$  line, as all are identical
  2. Shift in the BR lead to **moderate changes** in equilibrium



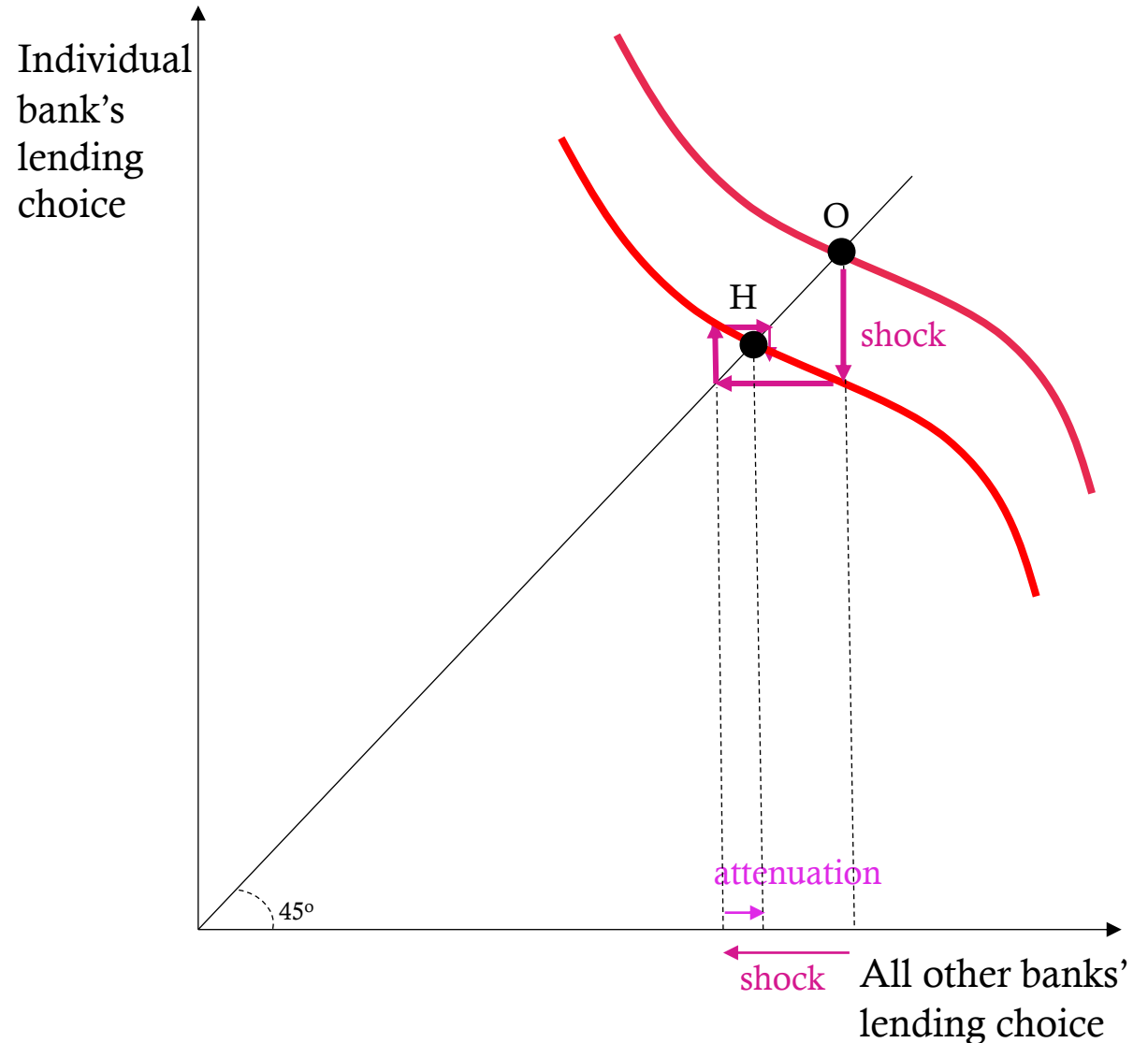
# AFTER A SHOCK

- Shock: banks become better aware of risks or investors give less funding.
- Individual banks want to cut lending.
- Shift the BR curve **downwards**
- As all banks are identical that they react to the shock in the same ways, others cut lending (from 45° line)



# AFTER A SHOCK

- But now individual bank wants to respond by lending more
- Cobweb: then want to lower, then want to raise it, and so on...
- **Attenuation** of the initial shock: The final reduction in credit is smaller than the initial fall by the shock
- Equilibrium moves from O to H
- Both O and H are stable equilibriums and shocks only lead to moderate changes due to attenuation



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# MODERN BANKS: UPWARD-SLOPING BR CURVE

- Due to rapid growth, modern banks are under-capitalized, they have little equity capital relative to their large credit funding
  - **Leverage ratio** (equity capital: credit funding) is at regulatory limit
  - Cannot take advantage of low asset price to buy assets
- Funding depends on tradable assets such as securitized mortgages etc.
  - Fall in tradable asset prices increase the leverage ratio, so banks must shrink their balance sheets by shedding assets.

## Traditional bank

<i>Assets</i>	<i>Liabilities</i>
Government bonds	Deposits
Loans mortgages	
Traded assets	Equity

## Modern bank

<i>Assets</i>	<i>Liabilities</i>
Government bonds	Deposits
Loans	Wholesale funds, repos
Tradable assets	Equity

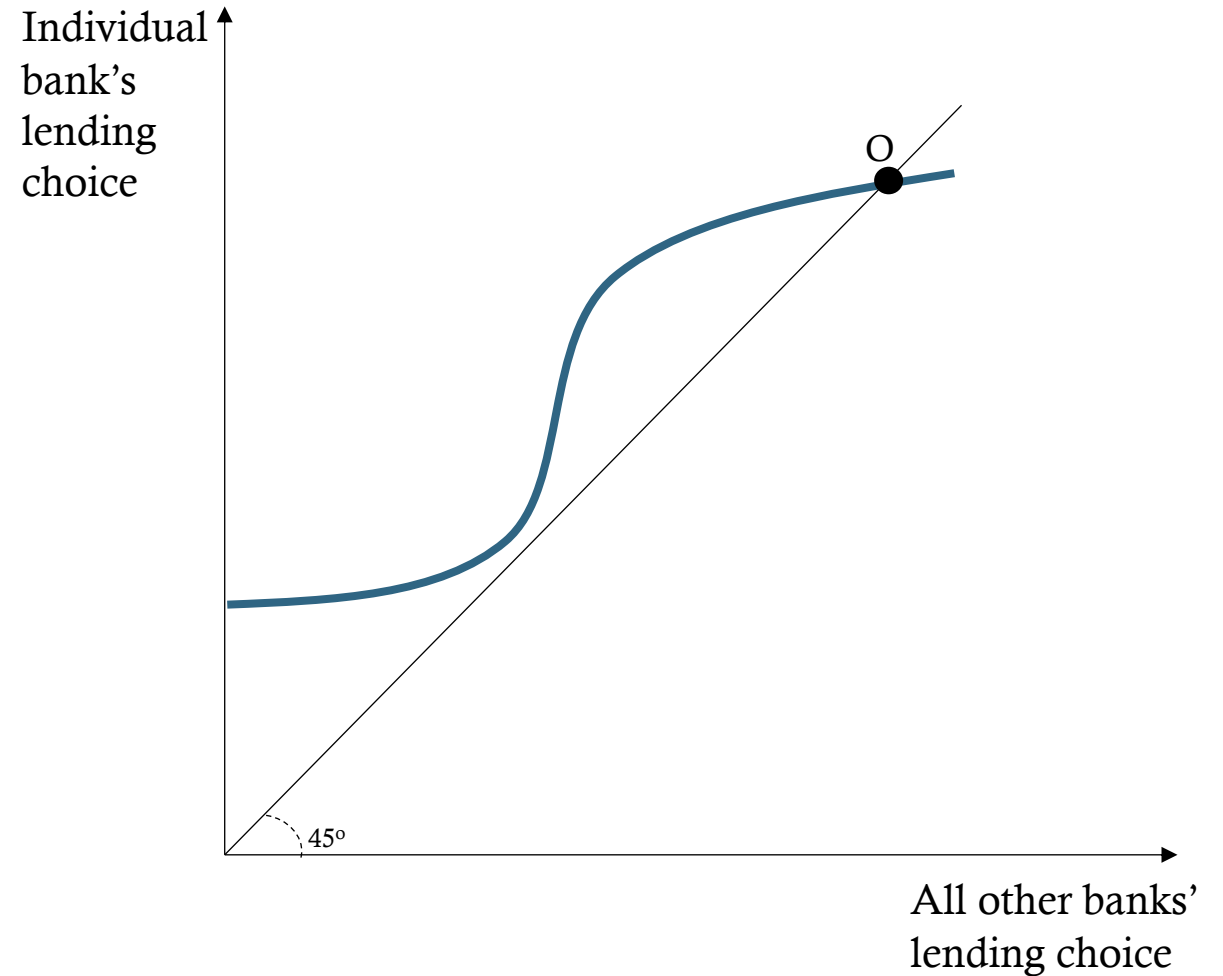
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# MODERN BANKS: UPWARD-SLOPING BR CURVE

- Why is the BR upward sloping?
- The entire financial sector is trying to sell asset at the same time.
- Since each bank anticipate all other banks will be shedding their assets, each have an incentive to be the first one to sell, causing **fast drop** in asset prices.
- Market liquidity: Low asset prices cause a **losses spiral**, where decreases in collateral value lead to cuts in funding and loans, for a fixed margin, as the funding of banks depend on market value of tradable assets



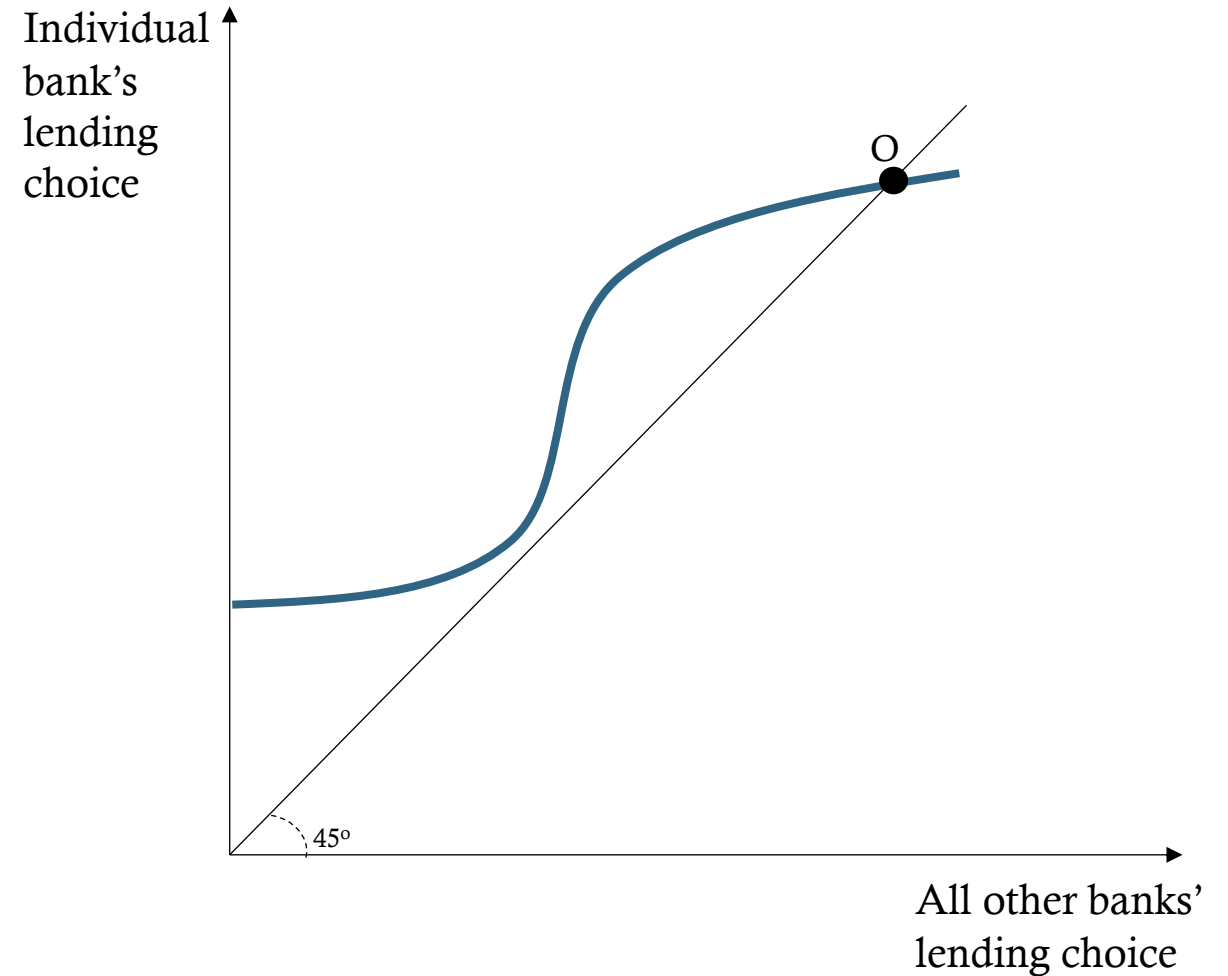
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# MODERN BANKS: UPWARD-SLOPING BR CURVE

- Why is the BR upward sloping?

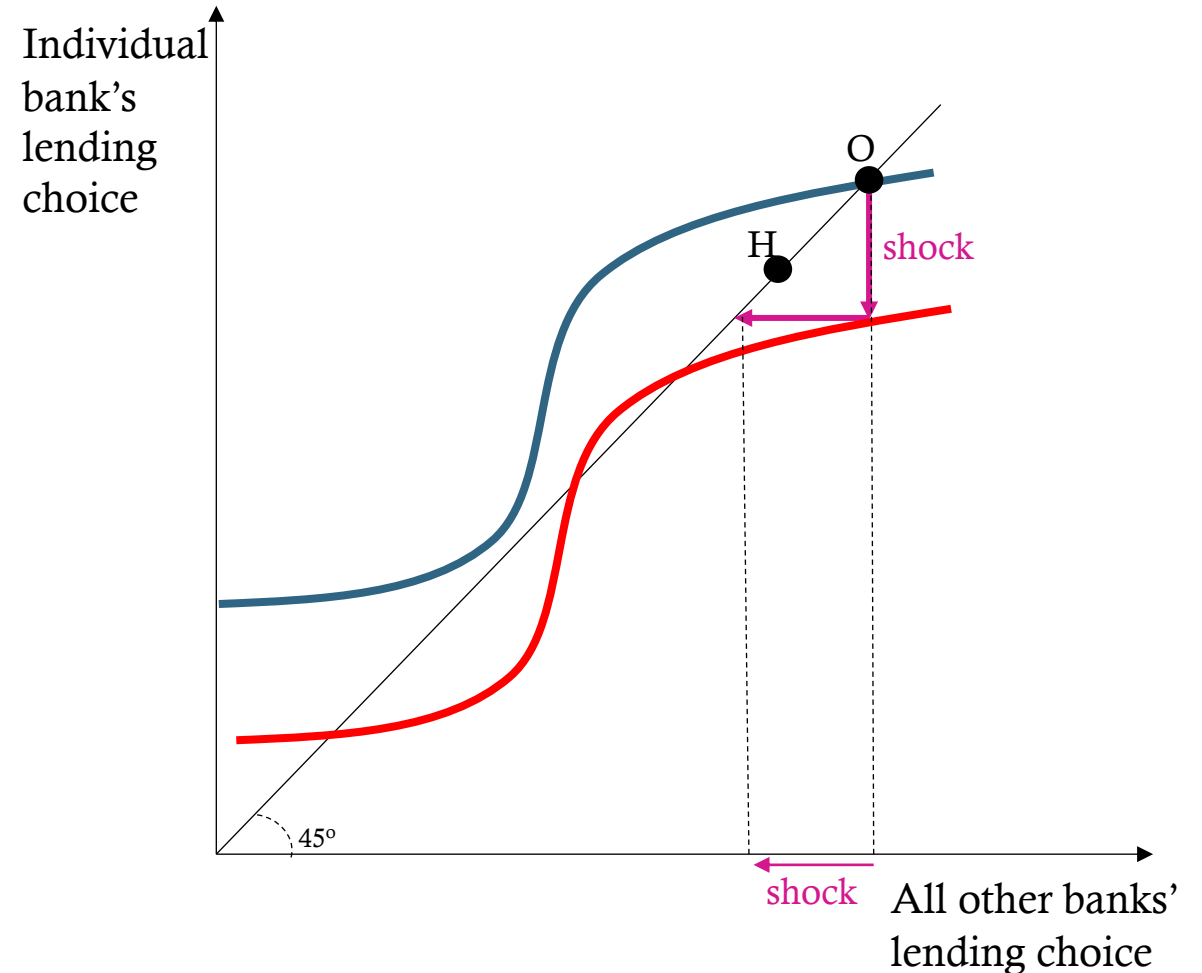
## Funding liquidity

- Low asset prices cause a **margins spiral**, where a fall in collateral value causes lenders to raise margins in anticipation of a fire sale drop in price
- The margin and loss spirals mean that when average actions increase, the participant chooses a more aggressive action
- **Upward sloping** best response function, or **strategic complements**



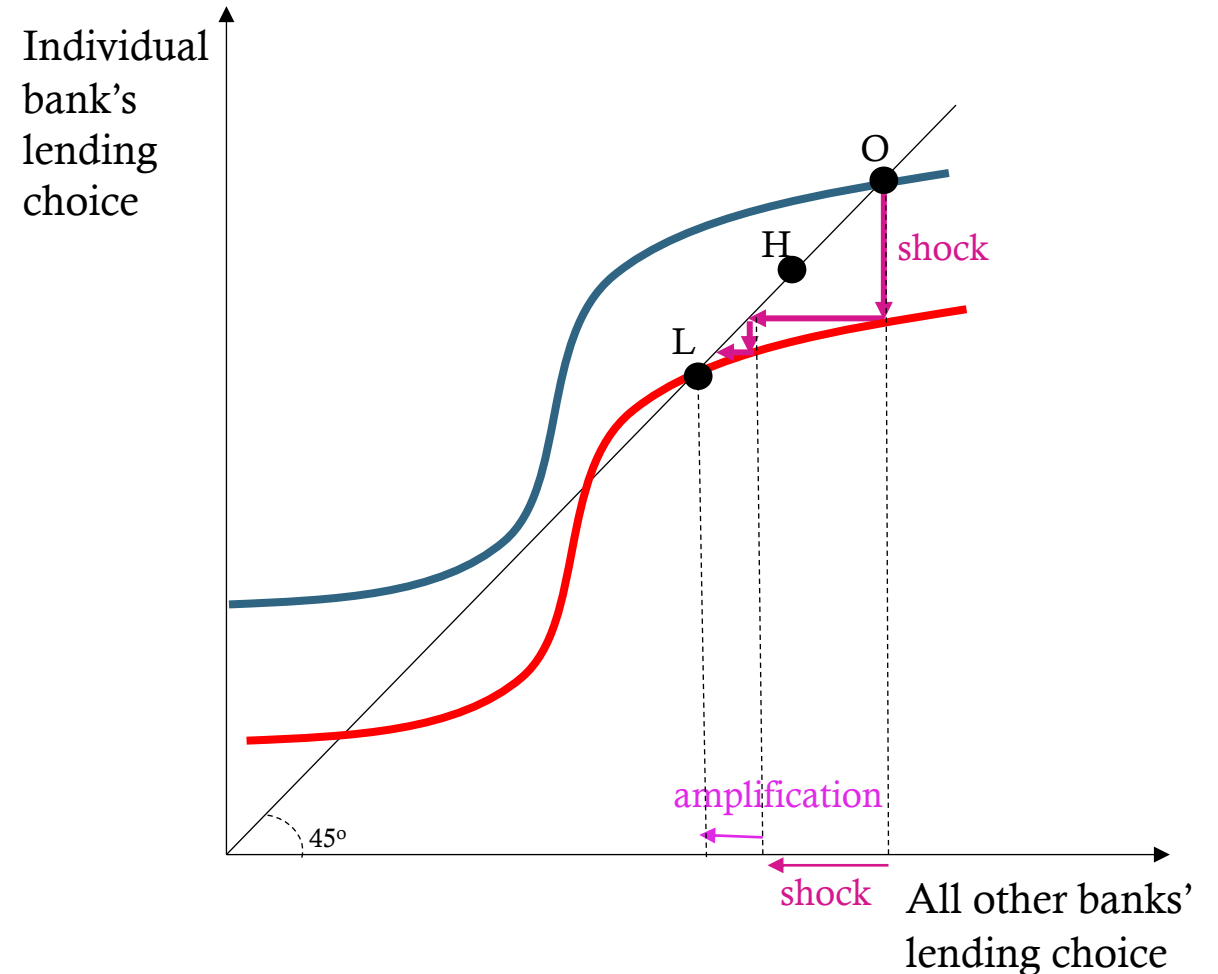
# MODERN BANKS: AFTER A SHOCK

- At equilibrium  $O$ , the difference between a downward and upward sloping BR curve is not **immediately apparent**
  - Traditional banks and modern banks are both on a unique, stable equilibrium  $O$
- Same shock hits: banks become better aware of risks or investors give less funding.
- Still shifts BR down by the same vertical distance as with traditional banks



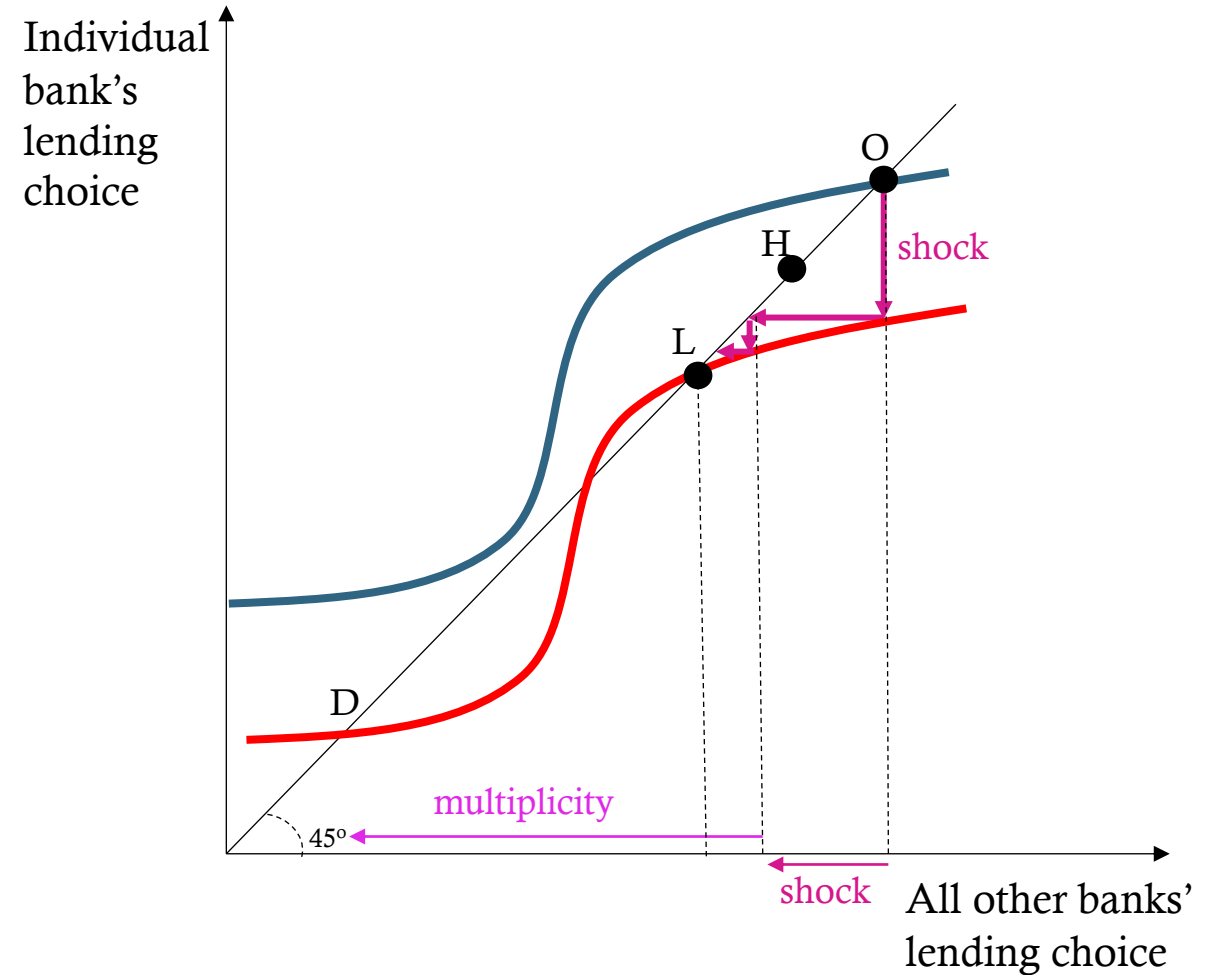
# AMPLIFICATIONS AND LIQUIDITY SPIRALS

- Equilibrium move from O to L, after initial cut of individuals, the others want to cut as well, where the former cuts more and so on
- Equilibrium is now lower at L
- Compare to the equilibrium H where traditional banks ends)
- **Amplification** of initial shock, even less credit now than immediately after the shock



# MULTIPLE EQUILIBRIA

- **Shifts in beliefs** can lead to a new (stable) equilibrium D
- **If people believe that all other will lend less, this is sufficient to lead to an outcome with even less lending**
- If each bank anticipate that others will cut lending and resulting losses and margin spirals, then it will cut lending beforehand, triggering the **depressed-lending equilibrium**



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# PECUNIARY EXTERNALITIES AND SYSTEMIC RISK

- When banks sell assets, it pushes down the market price, and affects the value of assets of other banks, the collateral constraint for other banks will become tighter
    - The action of one bank causes loss of other banks — **pecuniary externality**
  - While strategic complementarities lead to **amplification and multiplicity**, which enlarges all effects, including externalities, and externalities lead to **systemic risk**
  - Systemic crisis and losses of some financial institutions can spread across the whole financial system through a **general-equilibrium propagation** of the initial shock
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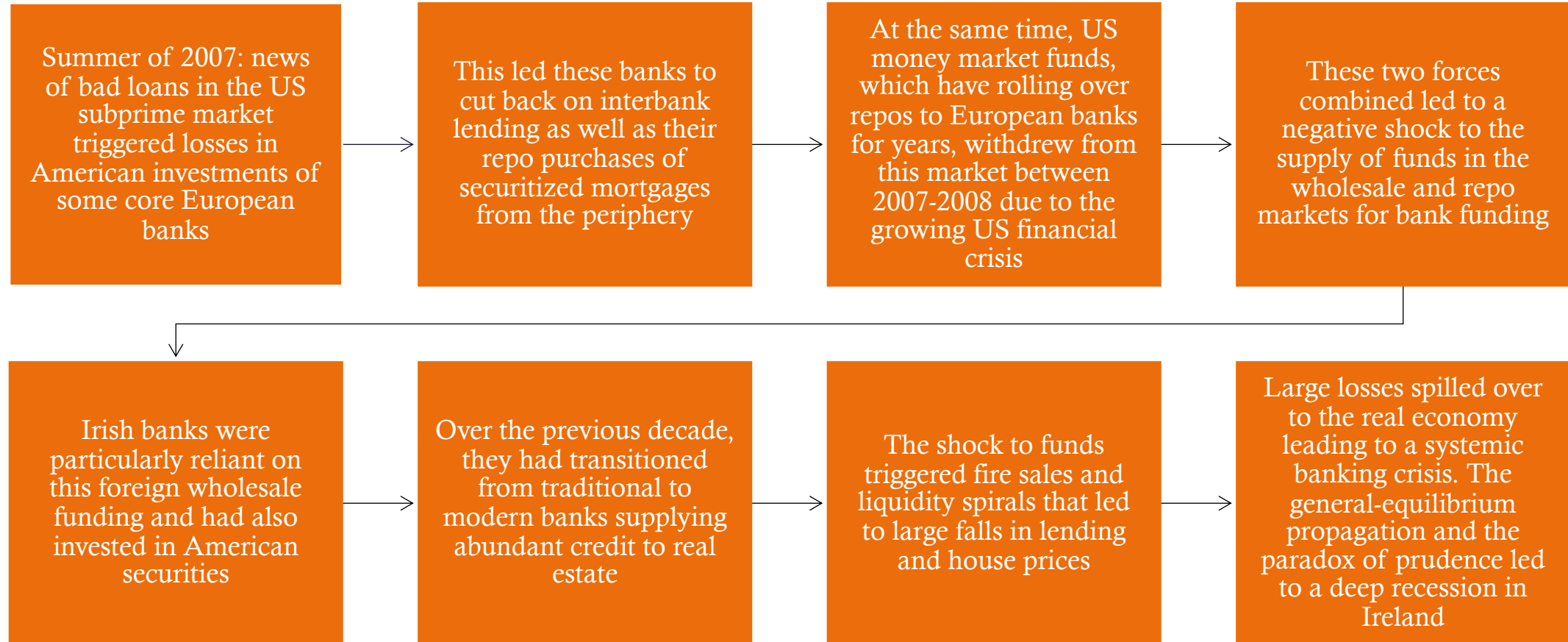
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# SYSTEMIC RISK IN THE IRISH BANKING SECTOR IN THE 2000S

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# SEQUENCE OF EVENTS





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# INDIVIDUAL RISK AND SYSTEMATIC RISK

## Value-at-risk (VaR)

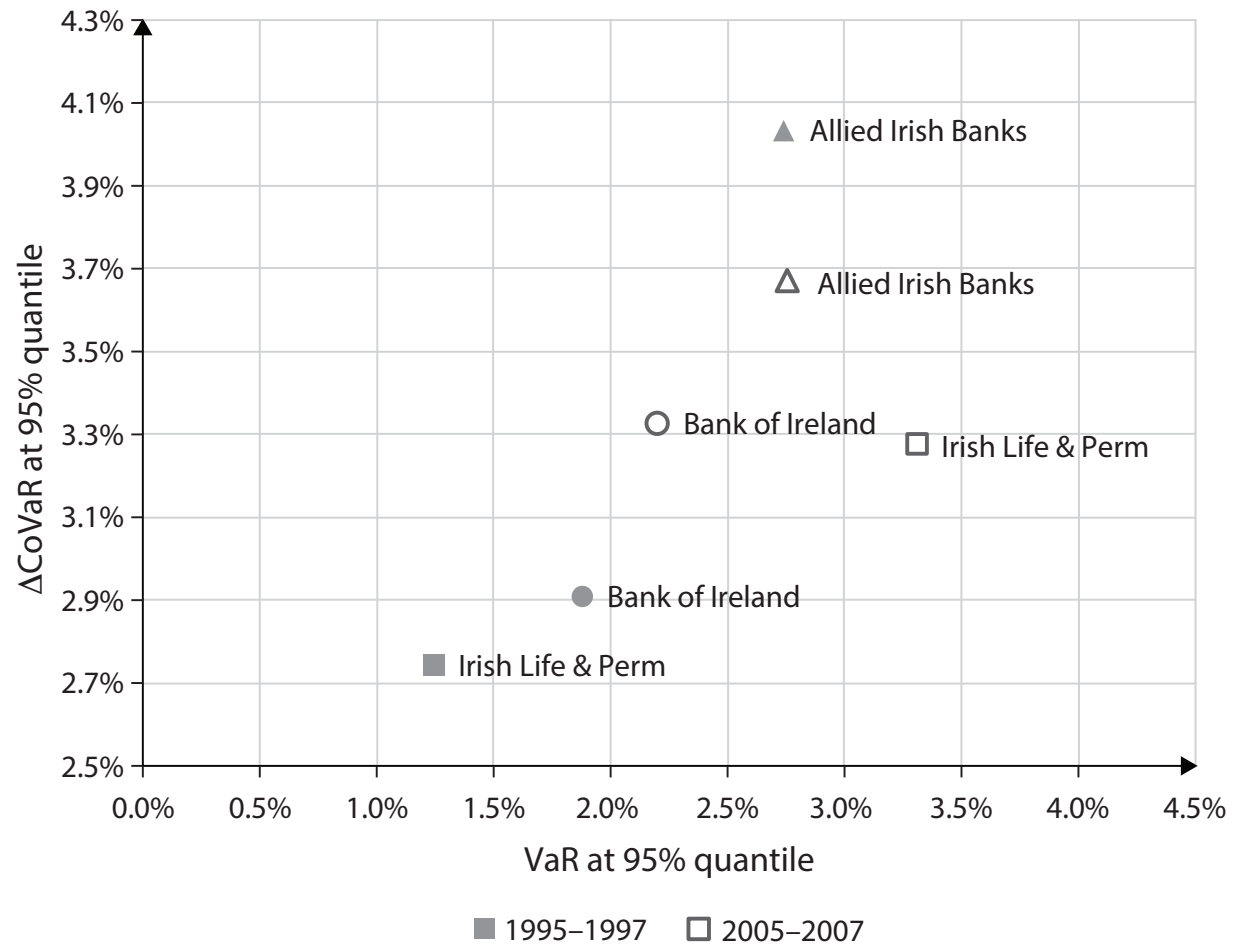
- Measures how **individually risky** a bank is
- Calculate the size of the losses in the value of its equity in the worst 5% of the weeks during a two-year period.
  - Measures the risk of particular bank in isolation, the focus of **micro-prudential regulation**

## $\Delta$ CoVaR

- Measures **systemic** risk of banking sector
  - Calculate by how much the value at risk of the banking sector changes when one particular bank is under distress.
    - Measures how much the distress of a particular bank spills over to the banking sector, the focus of **macro-prudential regulation**
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# FROM TRADITIONAL TO MODERN BANKING: HIGHER VAR AND HIGHER $\Delta\text{CoVaR}$



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# IRISH BANKS AND HOUSING

- Strategic complementarities amplified the financial shock from abroad, causing credit to construction and housing sectors to fall by 48% between 2008-2010
  - Propagation to the real economy led to a fall in residential property prices in Dublin of 35%
  - By the start of 2009 the private equity of all three banks had been almost entirely wiped out
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# WHAT CAN POLICY DO?

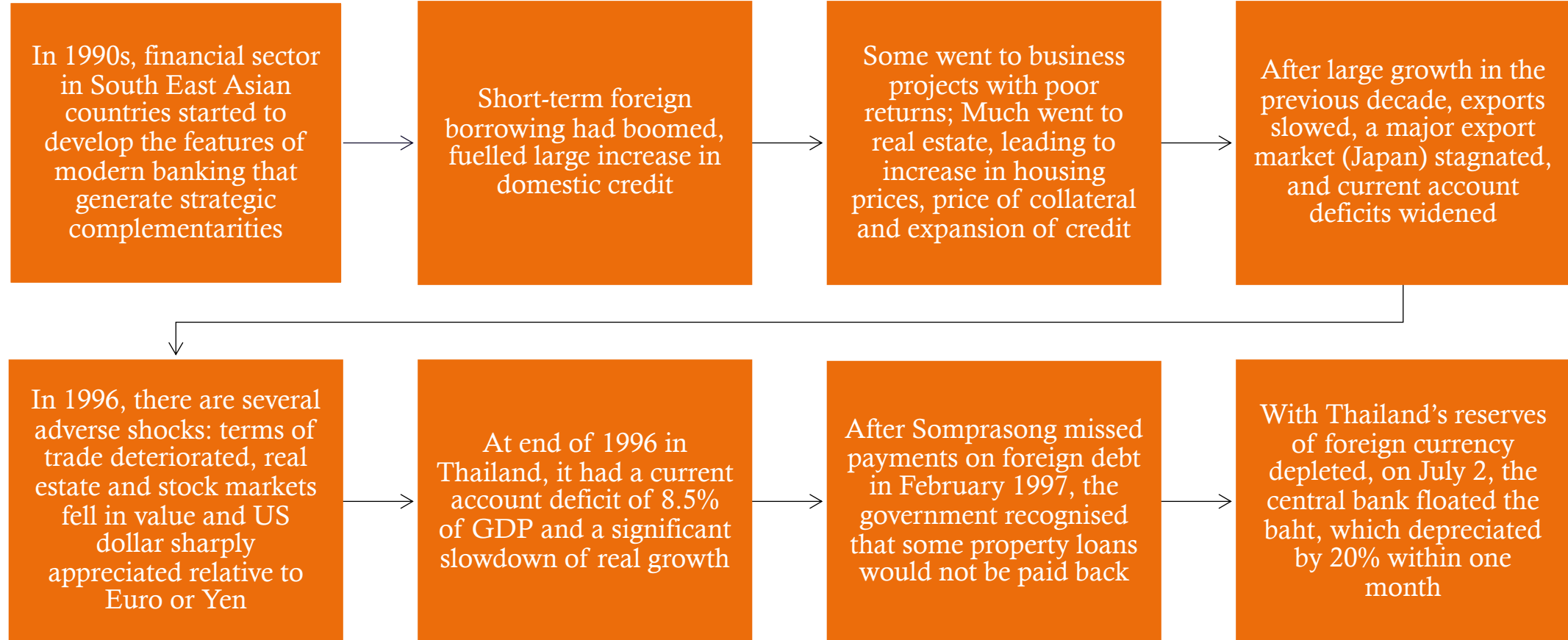
- Want to intervene to attenuate the amplification of the shocks, as well as because the externalities to the real economy are large
  - Approach 1: Stop funding spiral by central bank to lend to the bank
    - Yet, central bank lending requires collateral, typically government bonds
  - Approach 2: Governments bail out banks through loans or recapitalization that more or less explicitly nationalize the banks.
    - But recapitalization requires trusting that banks remain economically solvent
  - Approach 3: Conduct public stress test of banks' balance sheets to let banks know the others will not cut lending in the near future
    - Done in Europe, but with limited success
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# THE EMERGING MARKETS' STORM OF 1997-98

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# SEQUENCE OF EVENTS



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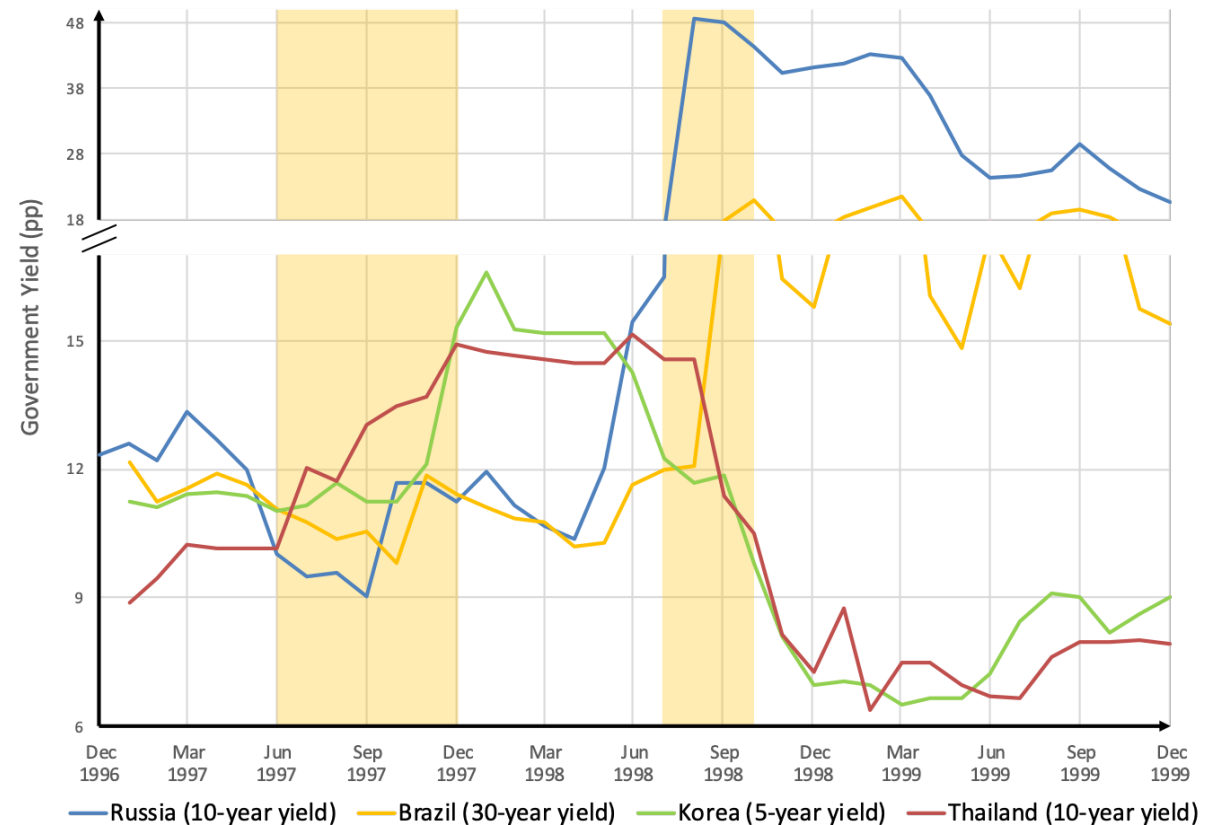
# CHANNELS OF PROPAGATION ACROSS BORDERS

**Strategic complementarities** not only amplify shocks within one financial system, but also propagate them across borders through multiple channels

- Banks are lending internationally, if one country has trouble to repay, the banks may need to cut credit for all other countries to cover the losses
  - Sharp fall in the value of currency will lead to large losses of investors that hold assets in their domestic currency
  - Depreciation implies that the terms of trade of its main trading partners worsen significantly
  - When one sovereign bonds abruptly lose value, it must sell-off their bond holdings in other countries to respond to margin calls
  - Upward sloping best response functions
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# THE EMERGING MARKETS' STORM OF 1997-98

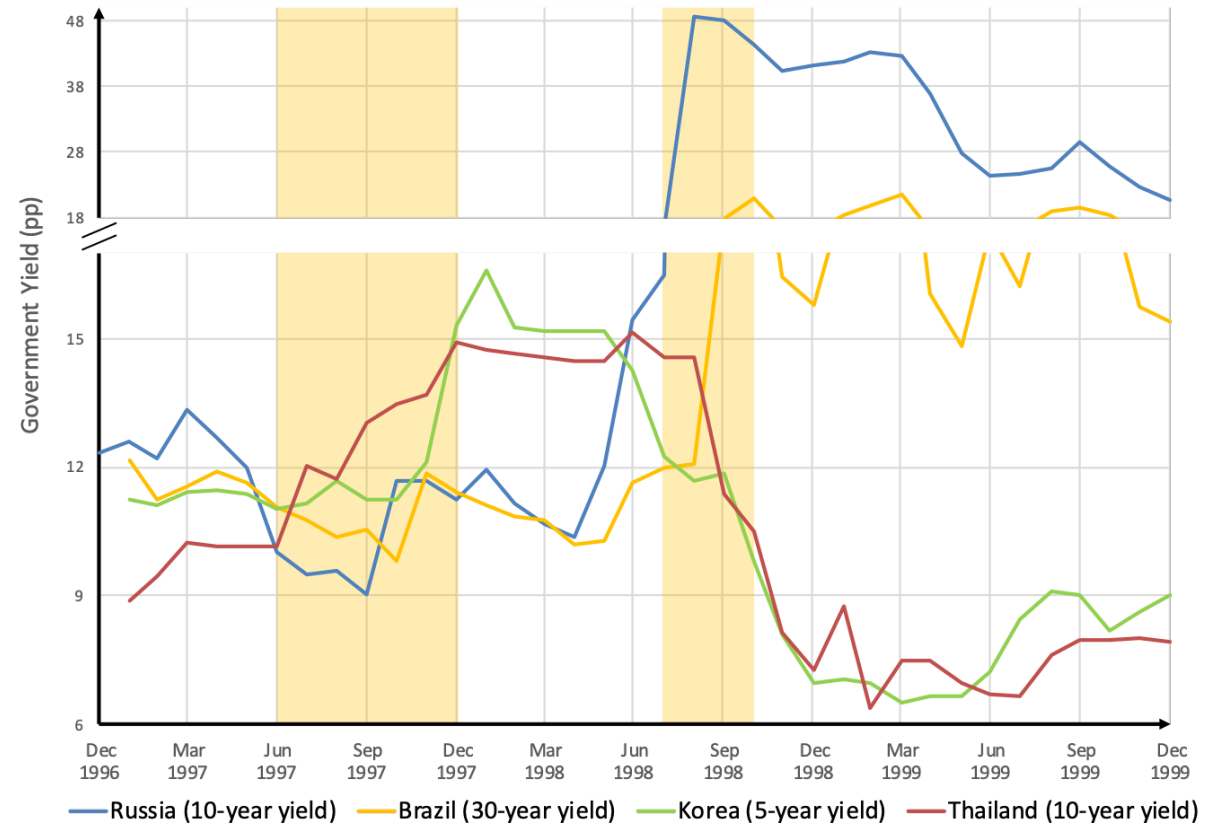
- Figure shows the interest rates on government bonds
- Started rising in 1997 for Thailand. Red line in figure spikes in second half of 1997
- Why? Investors expect further depreciation given the fragility state of the government finance
- As Baht depreciated, the currency of Malaysia, Indonesia, and the Philippines came under intense speculative attacks from investors





# THE EMERGING MARKETS' STORM OF 1997-98

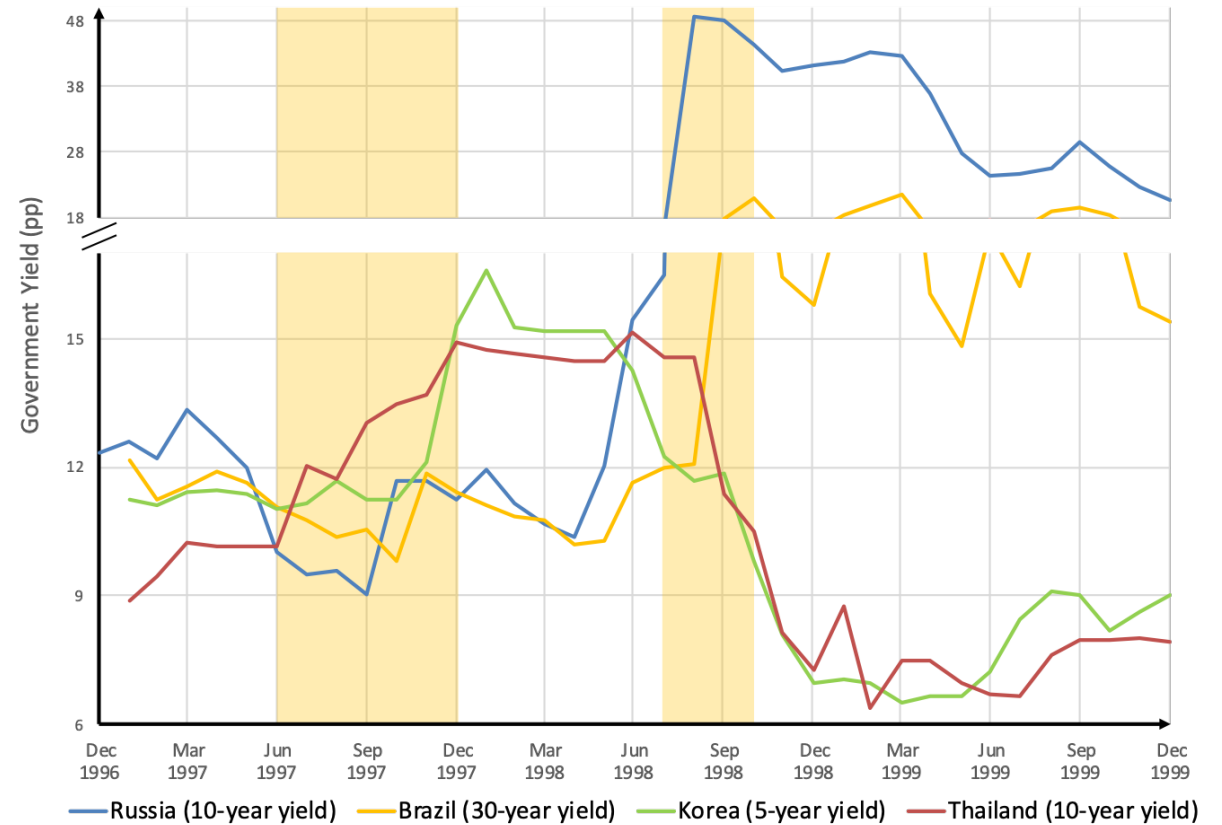
- Korea, which shared its main creditors, Japanese and European commercial banks, with country in crisis, came under attack in October 1997 where foreign investors ran to take capital out
- Won depreciated gradually with respect to dollars by 8%, asset prices fell by another 25% and by 4% in a single week in December
- There might have been a shift between multiple equilibria
- Similar events in Singapore and Hong Kong



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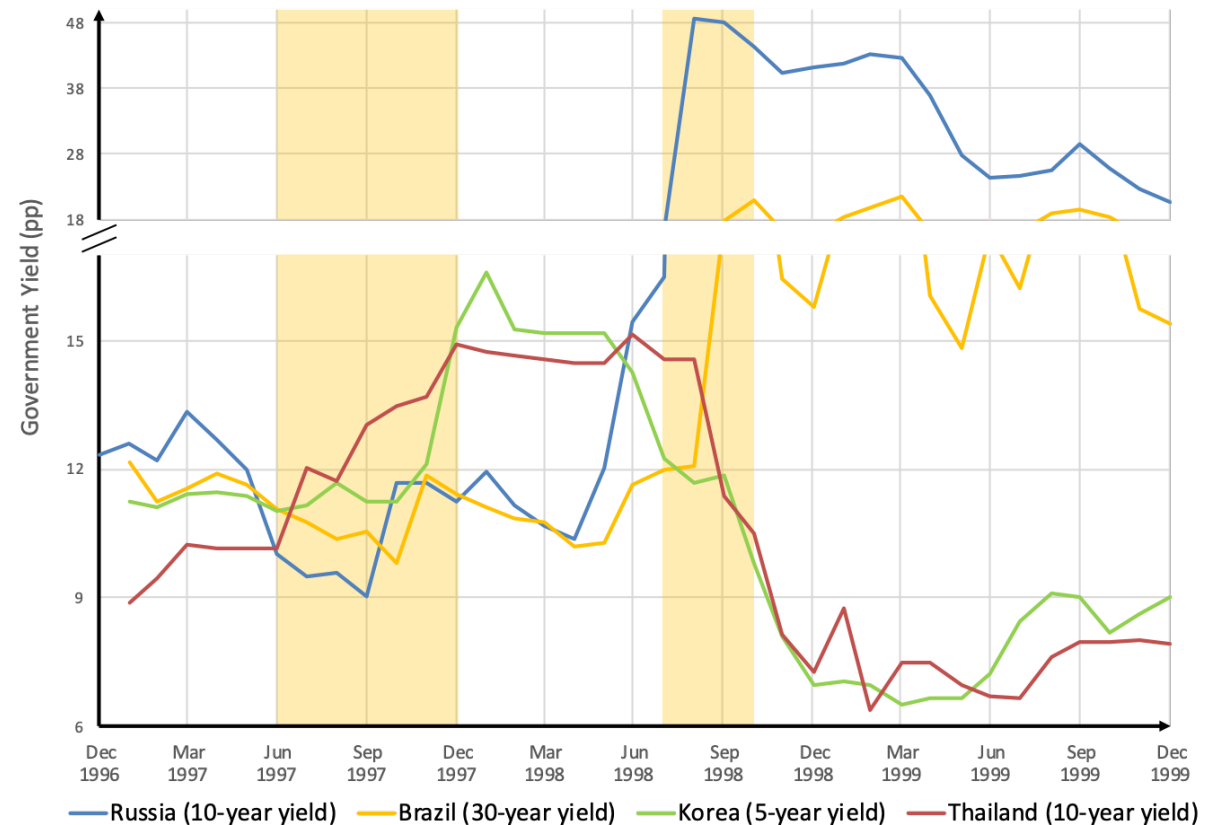
# THE EMERGING MARKETS' STORM OF 1997-98

- Propagation through common investors
- August 18, 1998, Russian government unexpectedly decided to impose capital controls and default on government debt
- Ruble depreciated by 262% between July 1998 and January 1999, interest rate reached almost 50%



# THE EMERGING MARKETS' STORM OF 1997-98

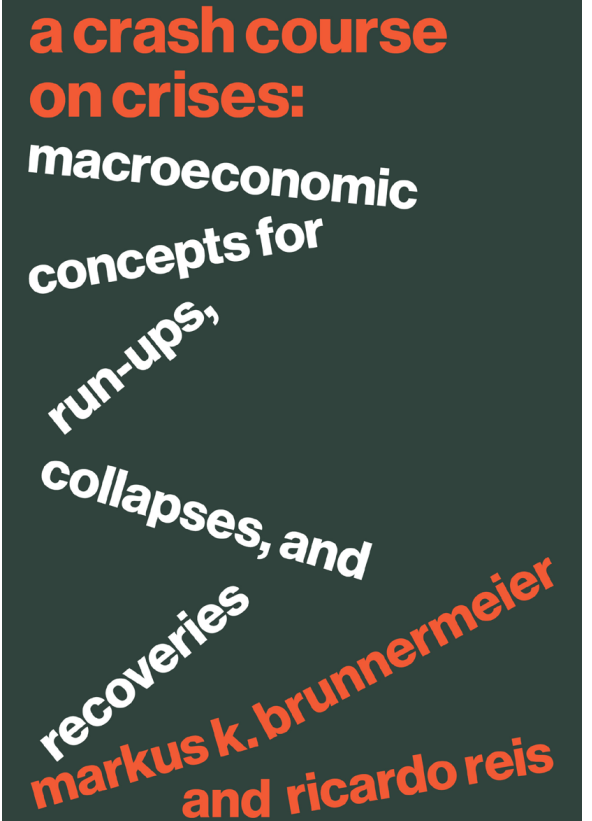
- Create large losses in US based hedge funds and mutual funds, that sold investments over the world
- Brazil saw large capital outflow, depreciation in exchange rates and spike in interest rates as result, even if its trade linkage to Russia is insignificant and have different economic fundamentals
- Similar event took place in Argentina, Chile, Colombia, Mexico, and Venezuela



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# SUMMARY

- The actions of **traditional banks** are **strategic substitutes**: downward sloping BR curve. There is **attenuation** after an initial shock to the system
- **Modern banks**, on the other hand, have upwards sloping BR curves. **Fire sales** and **liquidity spirals** cause their lending choices to be **strategic complements**
- **Multiplicity** can move the economy to a stable depressed-lending equilibrium
- The Irish banking sector is an example of systemic risk where the crisis spilled over into the real economy through a **general-equilibrium propagation** of the initial shock
- Crises in Asia and Russia demonstrate propagation of shocks across border through trade and common creditors around the world



**a crash course  
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macroeconomic  
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