Crises, Contagion, and the Need for a New Paradigm

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Failures of modern macroeconomics

- Didn't predict the financial crisis
  - Standard models assert that bubbles can't happen
    - Based on simplistic models making strong economic and mathematical assumptions
    - Rational individuals with rational expectations,
    - Typically "representative agent models," which meant that there were no problems of information asymmetries, no problems of externalities
    - Strong concavity assumption (important for consequences of risk diversification)
    - Standard models assert that shocks are exogenous
      - Key "disturbance" to the economy was endogenous
- Assumptions and conclusions inconsistent with historical experiences and micro-evidence

Policies based on flawed models were badly flawed

- Policy frameworks suggested that (a) keeping inflation low was necessary, and almost sufficient, for stability and growth; (b) government didn't have instruments to prevent bubbles; (c) cheaper to clean up mess after bubble broke
- Even after bubble burst, economists claimed effects "contained"
  - because of **diversification**
    - **Diversification had spread risks, in effect dissipating them**
  - because markets have good "buffers"
    - Financial frictions actually amplified risks

Failures (cont.)

- Responses to crises (based on advice from economists) have clearly been inadequate
  - High unemployment years after beginning of recession
- Standard models didn't focus on **credit**—and therefore didn't have much to say on repairing credit system
  - Credit entails *differences* in individuals (some are borrowers, some are lenders) and *asymmetries of information* (key problem—lenders don't know who are good borrowers)
  - Theory of banking provided micro-foundations (including incentives of banks and bankers)
    - Remarkable that models used by Central Banks often had little to say about banking
  - Policies ignored lessons of this literature (Greenwald-Stiglitz, 2003)

- Even less to say on *inherent deficiencies* in securitization
  - Viewed to be one of key advances in financial markets
  - Questionable improvements in risk diversification
  - Unambiguous attenuation of incentives (selection, monitoring, enforcement)
  - Some market participants took advantage of information asymmetries
  - But clear evidence that most market participants didn't even understand pervasive information asymmetries
  - Many had beliefs and took actions that can not be reconciled with any reasonable model of rationality and rational expectations
  - Remarkable testimony to inefficiency, irrationality of markets that market participants did not recognize these (and other) problems
    - Including risk of increased leverage
    - Market didn't seem to learn lesson of Modigliani-Miller

Failures (cont.)

- Moreover, countries that have had highest persistent unemployment include those with allegedly most flexible labor markets (e.g. US), in contradiction to "standard" theory
  - But consistent with earlier studies of volatility
    - Easterly, W., R. Islam, and Joseph E. Stiglitz, 2001a, "Shaken and Stirred: Explaining Growth Volatility," in *Annual Bank Conference on Development Economics 2000*, Washington: World Bank, pp. 191-212.
    - —— , ——, and —— , 2001b, "Shaken and Stirred: Volatility and Macroeconomic Paradigms for Rich and Poor Countries,", in *Advances in Macroeconomic Theory*, Jacques Drèze (ed.), IEA Conference Volume, 133, Palgrave, 2001, pp. 353-372.

Failures (cont.)

- There were large losses associated with misallocation of capital before the bubble broke.
- But most of the losses occur *after* the bubble breaks, in the persistent gap between actual and potential output
  - Standard theory predicts a relatively quick recovery, as the economy adjusts to new "reality"
    - New equilibrium associated with new state variables (treating expectations as a state variable)
    - And sometimes that is the case (V-shaped recovery)
  - But sometimes the recovery is very slow
    - Persistence of effects of shocks
    - Explained by slow recovery of balance sheets (Greenwald-Stiglitz, 1993, 2003)
    - But current persistence is greater than can be explained by these models

Understanding what has happened

- There have been large (and often adverse) changes in the economy's risk properties, in spite of supposed improvements in markets
  - Moving from "banks" to "markets" predictably led to deterioration in quality of information
  - Increased **interdependence** has led to more financial fragility

- The global economy is undergoing a major structural transformation
  - structural transformations may be associated with extended periods of underutilization of resources
    - Associated with deep market failures
    - Important role for government to facilitate transformation

- See J.E. Stiglitz, 2011, "Rethinking Macroeconomics: What Failed and How to Repair It," Journal of the European Economic Association, 9(4), pp. 591-645.

Does interconnectivity lead to more or less systemic risk?

- Key question in understanding this crisis:
  - Failures in one financial institution led to failures in others—to the point where the system was at risk
  - Problems in one country (US) led to problems in others
    - Phenomenon that economists call "contagion"
- Standard answer: spreading of risk, with concavity, leads to better outcomes
- But economic systems are rife with non-convexities—e.g. bankruptcy, natural non-convexities associated with information, incentive constraints
  - Standard model had ignored these
- **Interlinked systems are more prone to system wide failures, with huge costs**

Origins of interest

- East Asia crisis 1997-1998
  - 70% of firms in Indonesia went into default, more than 50% in Korea, almost 50% in Thailand
  - Hard to establish value of any firm—depended on what they received from those who owed them money; and that depended on how much their debtors received from those who owed them money
  - Complex general equilibrium problem

Severe Consequences

- Paralysis
- Costly delay in restructuring
- Proposals: Super-chapter 11 (Miller-Stiglitz

After East Asia crisis

- Work developing general equilibrium theory of credit (Greenwald-Stiglitz, Allen-Gale)
  - Bankruptcy cascades
  - Multiple equilibrium
  - Architecture mattered
    - Limited data available at time on credit interlinkages (Japan)
    - Some architectures better able to absorb small shocks
    - Some architectures more resilient to large and correlated shocks

2008 Crisis highlighted importance of financial networks

- Collapse of one financial institution could lead to collapse of others (bankruptcy cascade)
  - Fear that bankruptcy cascade could embrace entire financial system
- Belief had been that diversification enables risk to be spread
  - But diversification had create financial interlinkages, that facilitated breakdown

Key economic insight

- Privately profitable transactions may not by socially desirable
  - May lead to **systemic risk**
  - **Systemic risk** involves behavior of the system as a whole
  - There are important **externalities**
    - Excessive borrowing or interconnectivity can make the *system* more volatile
    - More vulnerable to shocks, whether endogenous or exogenous
    - Each market participant ignores these effects
      - *Greenwald-Stiglitz, "Externalities in Economies with Imperfect Information and Incomplete Markets," The Quarterly Journal of Economics, 101(2), pp. 229-64. 1986)*

Incoherence in standard macro-frameworks

- Argue for benefits of diversification (capital market liberalization) before crisis
- Worry about contagion (worsened by excessive integration) after crisis
- Optimal system design balances benefits and costs
  - *"Contagion, Liberalization, and the Optimal Structure of Globalization," Journal of Globalization and Development, 1(2),*
  - *"Risk and Global Economic Architecture: Why Full Financial Integration May be Undesirable," American Economic Review, 100(2), May 2010, pp. 388-392.*

“Contagion”

- Concept borrowed from epidemiology
- Response to the spread of diseases is not “diversification” but “isolation,” quarantine
- The spread of disease is a multiplicative process

An Analogous Problem

- With an integrated electric grid the excess capacity required to prevent a blackout can be reduced
  - alternatively, for any given capacity, the probability of a blackout can be reduced.
- But a failure in one part of the system can lead to system-wide failure
  - in the absence of integration, the failure would have been geographically constrained
- Well-designed networks have circuit breakers, to prevent the “contagion” of the failure of one part of the system to others.

Some general results

- Circuit breakers can help prevent cascades
  - Can capital controls be thought of in an analogous way
- Full integration never pays if there are enough countries
- Optimal sized clubs

Some general principles

- Nature of impacts depends on conservation of losses vs. amplification, on convexity or concavity of relevant functions
  - In epidemiology, “Contagion” entails amplification
  - Real bankruptcy costs imply system is not conservative
  - Processes with trend reinforcement exhibit similar properties
    - Negative balance sheet shock forces borrower to pay higher interest rates
  - In conservative systems with concave loss functions, spreading risks typically is welfare enhancing
  - In non-conservative system (and most systems are not conservative), it may well not be

Systemic Risk

Systemic Risk

- Not just a matter of too big to fail
- Too “central” to fail
- Too interlinked to fail
- To correlated to fail

What can we say about good architecture design?

Underlying Question: **Why networks, and network analysis, matters—** including for macro-economic analysis

The presence of externalities provides one of the important reasons that understanding the micro-structure of the financial sector—in presence of externalities, system behaves differently than it would if there were a single „agent“

- Financial market spillovers—bankruptcy cascades, contagion
- Broader macro-economic externalities--Balance sheet effects interact with collateral effects to give rise to costly macro-economic fluctuations

Levels of analysis

1. Describing different patterns of credit interlinkages, the architectures

Observing changes in these structures, differences among structures in different countries

2. Analyzing each (observed or potential) architecture in terms of how it responds to different kinds of shocks, *given a set of contracts and portfolio*
   - analyzing how we can quantitatively assess systemic risk
   - analyzing particular architectures—clearing houses vs. Bilateral contracts
   - analyzing equilibrium valuations
   - analyzing probabilities of bankruptcy

Levels of analysis

3. Analyzing each architecture in terms of how it responds to different kinds of shocks *taking contracts and investments (loans) as endogenous,* given a particular set of rules of the game

- Need a theory of behavior of financial agents (banks)
  - How they form expectations
  - Agency issues

Levels of analysis

4. Analyzing the consequences of different rules of the game
   - The behavior of banks or other financial institutions, and therefore of the system as a whole, is dependent on the rules of the game (the regulations, the bail out policy, etc)
   - viewing the architecture itself as endogenous
   - Incentives to be too big to fail, to correlated to fail, to interconnected to fail
   - Effects of different restrictions (e.g. On naked cds‘s, on universal banking, on trading through clearing houses)
   - There needs to be an underlying theory of the behavior of financial agents

Levels of analysis

5. Normative questions: optimal design and the instruments by which that can be achieved

- Analysis of alternative objectives
- Analysis of exposure to shocks
- Given objectives and shocks, what rules, regulations, restraints, taxes are desirable

Levels of analysis

6. Interactions between financial sector and real sector
   - Trade and production networks
   - When do shocks get dampened, when do they get amplified?

7. Political economy

analysis of the political forces determining the rules of the game

- We now know that understanding the functioning of the financial system is crucial for understanding **macro-economic** behavior
- A better understand of the functioning of the financial system requires using a **network approach**
- Especially relevant for understanding critical issues of **systemic risk**
  - Which is at the heart of efforts to prevent another major financial and economic crisis

A simple example

$$(1) Q_i = F(S_i), \quad F' > 0, \quad F'' \leq 0$$

In autarky,

$$(2) \quad S_i = S + \varepsilon_i$$

where $E(\varepsilon)=0$ and $\mathrm{Var}(\varepsilon)=\sigma_i^2$. We normalize by choosing our units so that $S = 1$.

Simple example (cont.)

- Polar case where there is no value of risk diversification—production is linear in S, provided S is greater than some critical number S^*, at which point system failure occurs, and a loss of $-C$ occurs. The main concern then is to minimize the losses from system failure.

Simple example (cont.)

- Assume that $Si = -\alpha 1$ with probability p, $\alpha 2$ with probability $1 - p$, such that

$$p\alpha 1 = (1 - p)\alpha 2,$$

  i.e. expected output without bankruptcy is zero, but if $S \leq 0$, the country goes bankrupt, with output $-C$, where $C < \alpha 1$.

- Prior to liberalization, expected output is

$$-pC + (1 - p)\alpha 2 = p(\alpha 1 - C)$$

- Assume $N = 2$, and there is full liberalization

  $\alpha 2 < \alpha 1$, i.e. $p < .5$

  - We focus on this case—small probabilities of "disaster"

Liberalization is unambiguously welfare decreasing

- With liberalization,

$$p(\sum\nolimits^{\uparrow}{}_{i} S\downarrow i /2 < 0) = 1-(1-p)\uparrow 2$$

i.e. *both* countries go bankrupt if only one country has a bad outcome, and expected output (per country) is

$$(1-p)2\,\alpha 2 - C\,(1-(1-p)2) < -pC + (1-p)\alpha 2$$

- Basic insight: even with mean preserving reductions in risk associated with risk pooling, the probability of any particular country falling below the bankruptcy threshold may increase with economic integration

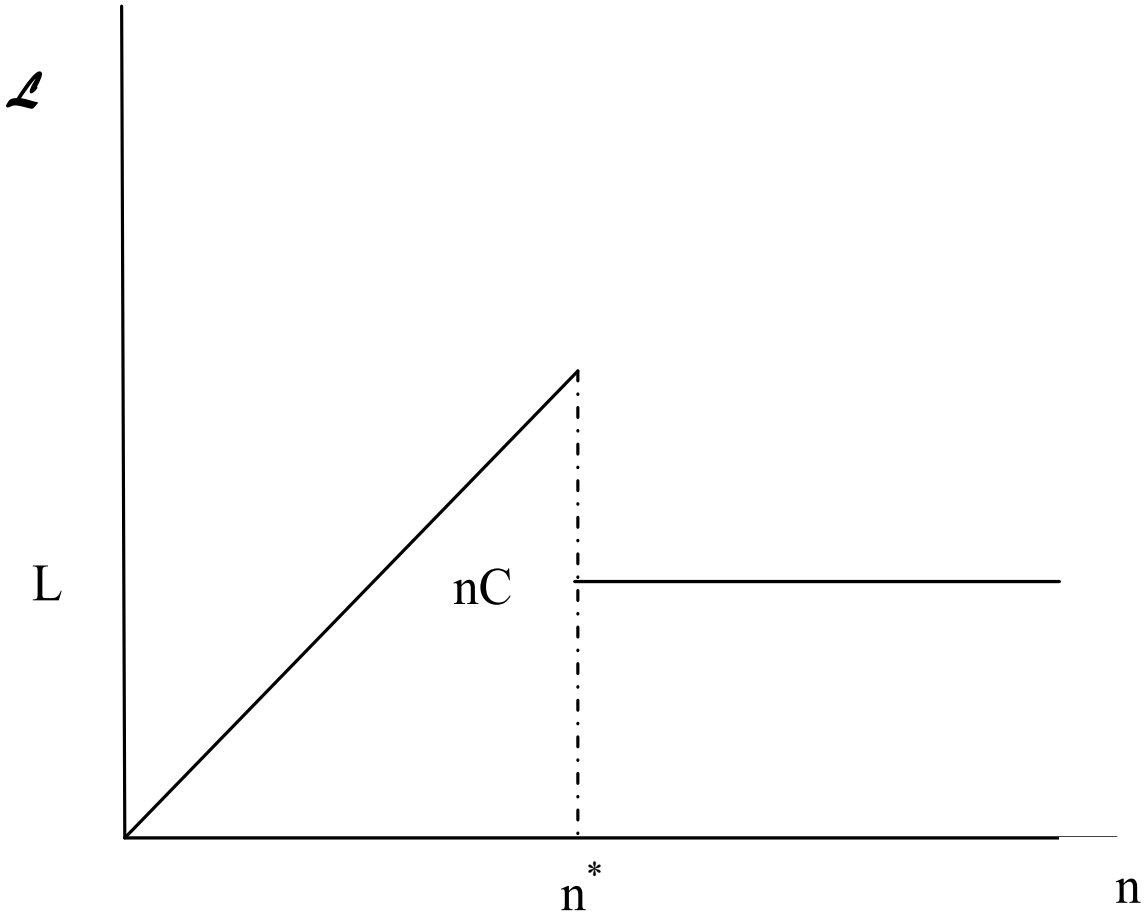
Simple intuition: Limited risk sharing may increase losses

- Assume that country has a loss of L, and that is has contracts that share that loss with n other countries $\Sigma L_i = L$, .
- Assume the cost to each is linear in L_i, the loss it absorbs, provided $L_i < L^*$, but is C for $L_i > L^*$, where we assume C is large, and > L.
- Total LOSS = -nC for $n < n^*$

  L for $n > n^*$

where $n^* \equiv L/L^*$

$$\mathcal{L} = \begin{matrix} -nC \text{ for } n < n^* \\ L^* \text{ for } n > n^* \end{matrix}$$

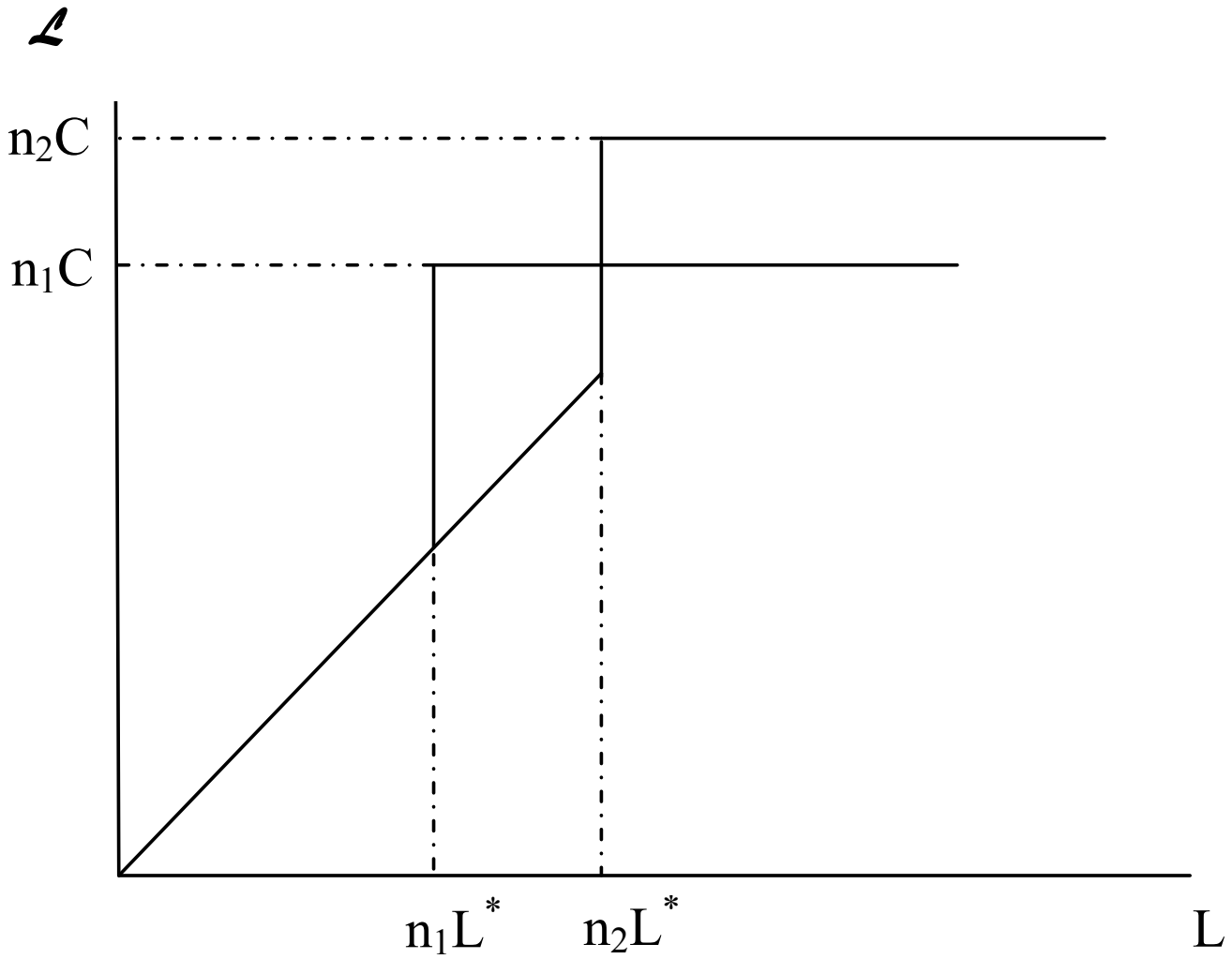


Simple intuition: Large losses may lead to systemic crises

- Assume L is a random variable. (n is fixed)
- So long as L is small enough, diversification pays.
- But if L is large, there are large losses from the contagion, as many countries (banks) go into bankruptcy.
- If n is increased (a higher degree of diversification), diversification can handle a larger L.
- But when L is large, total societal costs are increased.
- There is a trade off—diversification helps with small L, hurts with large L
- (The ability to absorb small shocks is enhanced, effects of large shocks is increased.)
- There is an optimal degree of diversification

Uncertainty and amplification

- Assume that there is risk about how the loss is divided.
  - the risk is divided among n countries, $n < n^*$
  - but it is not known which countries.
  - Hence, each country now faces a risk of a loss of –C with probability n/N, where N is the total number of banks.
  - With risk neutrality, the market value of each will be decreased by nC/N
  - With risk aversion, reduction in market value is greater
  - each will find it more difficult to raise capital.
- This in turn will have its own amplification effect: uncertainty can amplify the amplifications


n_2C
n_1C
n_1L^*
n_2L^*
L

Summary

- Impact of shocks depends on size of shocks, the correlation among the shocks, how the shocks are distributed
- And the architecture of the “network”
- Banking systems evolved into a few concentrated nodes; big nodes interlinked
  - Good for absorbing small shocks
  - Bad for systemic risk in the face of large and correlated shocks

Incentives make matters worse

- Large "**too-big-to-fail**" institutions have an **incentive** to engage in **risk taking**
  - Heads I win, Tails you lose
  - But system **evolves** in towards too-big instituions. Because they are implicitly guaranteed, they can get access to capital at lower rates.
  - In many cases they can become so large that they have market power
  - And even worse, political power—incentive and means to shape regulations
  - Can even become "too big to be held accountable," to be subject to effective judicial disciplines

- But so also in financial systems with too correlated to fail and too interlinked to fail institutions there are incentives for excessive risk taking
  - There are incentives to be **“too interlinked to fail,” “too correlated to fail”**
  - Hence market structure that evolves on its own is likely to entail **excessive systemic risk**

Incentives and information asymmetries make matters worse

- Markets make money out of complexity
  - Create information asymmetries
  - Lack of transparency enhances profits, but erodes systemic performance
- Securitization forced reliance on others to monitor and assess risk
  - And reduced the incentives for originators to monitor risk
  - Created a public good out of information associated with lending
  - But credit rating agencies and investment banks putting together securitization packages had flawed incentives
  - And exploited ignorance/flawed incentive structures of managers of pension and other funds.
    - Who had to maximize returns given the ratings of the rating agencies
- Structured financial products made matters even worse

Further analysis systemic risk

- TREND REINFORCEMENT
- BASCRUPTCY CASCADES

Trend Reinforcement

Negative shocks move us down further (equity depletion)

- Modeling using stochastic differential equations, with probability that at any given time an agent goes bankrupt modeled as problem in first passage time

- With trend reinforcement, there is an optimal degree of diversification
  - Battiston, Stefano, Domenico Delli Gatti, Mauro Gallegati, Bruce Greenwald, and Joseph E. Stiglitz, "Liaisons Dangereuses: Increasing Connectivity, Risk Sharing, and Systemic Risk," paper presented to the Eastern Economic Association Meetings, February 27, 2009, New York, NBER Paper No.

Financial interlinkages and bankruptcy cascades

- Bankruptcy cascades (Greenwald and Stiglitz, 2003; Gale and Allen, 2001)
  - The bankruptcy of one firm affects the likelihood of the bankruptcy of those to whom it owes money, its suppliers and those who might depend upon it for supplies; and so actions affecting its likelihood of bankruptcy have adverse effects on others.
- The "architecture" of the credit market can affect the risk that one bankruptcy leads to a sequence of others.
  - If A lends to B, B lends to C and C lends to D, then a default in D can lead to a bankruptcy cascade.
  - On the other hand, if lending all goes through a sufficiently well capitalized clearing house (a bank), then a default by one borrower is not as likely to lead to a cascade
  - But a very large shock which leads to the bankruptcy of the "clearing house" can have severe systemic effects

- Further externalities are generated as a result of *information costs and imperfections*.
  - If unit i doesn't fully know other units' characteristics—including the relationships (contracts) of those with whom it engages in a relationship, including all the relationships with whom those are engaged, *ad infinitum*—it cannot know the risks of their honoring their contract.
  - Explains some of adverse effects of non-transparent over the counter credit default swaps

Asymmetric Patterns

- Our canonical model also assumed symmetric relationships in which all ties/contracts were identical.
- In the presence of convexities, such symmetric arrangements often characterize optimal designs.
- But that is not so in the presence of non-convexities, and there are many alternative architectures.
  - For instance, a set of countries (banks) can be tightly linked (a "common financial market") to each other, but the links among financial markets may be looser. The former is designed to exploit the advantages of risk diversification, the latter to prevent the dangers of contagion.
  - Circuit breakers might be absent in the former but play a large role in the relations among the "common markets."
- Different architectures may lead to greater ability to absorb small shocks but less resilience to large shocks

- Reducing the set of admissible relationships and behaviors can have benefits
  - Reducing the scope for these uncertainties,
  - Reducing the potential for information asymmetries,
  - Reducing the burden on information gathering.
- In large non-linear systems with complex interactions, even small perturbations can have large consequences
  - Understanding these interactions major research agenda
- **Broader research agenda: Design of optimal networks, circuit breakers: optimal degree and form of financial integration**
- Beginning of large literature

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Structural Transformation

- Great depression was structural transformation from agricultural to manufacturing—this is a structural transformation from manufacturing to services
  - Productivity growth well in excess of growth in demand
  - Implying decrease in demand
  - If labor gets “trapped” in declining sector, then income will decline

- Technical change always can induce large distributive consequences
  - Standard models ignore these
  - With perfect markets, winners can compensate losers — but they seldom do
  - With imperfect markets, decrease in welfare of those in “trapped sector” has spill over effects on others
  - And especially if there are efficiency wage effects, there can be adverse macro-economic consequences

Basic model

- Two sectors (industry, agriculture)

(1) $\beta\alpha=\beta D\uparrow AA\ (p, p\alpha)+ED\uparrow MA\ (p,w\uparrow *\ )$

(2) $H(E)=\beta D\uparrow AM\ (p,p\alpha)+ED\uparrow MM\ (p,w\uparrow *\ )+I$

- β is the labor force in agriculture, $(1-\beta)$ is the labor force in industry;
- α is productivity in agriculture;
- $D\uparrow ij$ is demand from those in sector i for goods from sector j;
- $w\uparrow *$ is the (fixed) efficiency wage in the urban sector;
- I is the level of investment (assumed to be industrial goods);
- p is the price of agricultural goods in terms of manufactured goods, which is chosen as the numeraire; and
- E is the level of employment $(E \leq 1-\beta)$; and
- where we have normalized the labor force at unity.

Basic results

Theorem 1: If

1) the steady state is stable

2) the income elasticity of the demand for food by rural workers is small enough,

3) c^A (the marginal propensity to consume manufactures by agricultural households) is sufficiently greater than c^M (the comparable marginal propensity to consume of manufacturing households)

then an increase in agricultural productivity unambiguously yields a reduction in the relative price p and in employment in manufacturing.

Results

- The result of mobility-constrained agricultural sector productivity growth is an extended economy-wide slump.
- *Theorem 2:* Under the stability condition, an increase in government expenditure increases urban employment and raises agricultural prices and incomes
- *Theorem 3:* Under the stability condition an decrease in urban real product wages increases urban unemployment and lowers agricultural prices and incomes

Note irrelevance of standard model

- Since such structural transformations occur very seldom, rational expectation models are not of much help
- Since the central issue is structural, aggregate model with single sector not of much help
- Since among major effects are those arising from redistribution, a representative agent model is not of much help
- Since central issue entails frictions in mobility, assuming perfect markets is not of much help
- Problems exacerbated by efficiency wage effects

Policy implications

- There should be structural policies to facilitate the movement of labor that is "trapped" in a dying sector
- Even though structural policies are ***part*** of the solution, traditional Keynesian policies play a role
  - Contrast to those who are now claiming that most of the remaining unemployment is structural – there is a new "normal" to which we must now accommodate ourselves – and therefore policies designed to stimulate the economy may not only be useless, they may be counterproductive.
- Such policies were at the center of recovery from Great Depression

Reference

Domenico Delli Gatti; Mauro Gallegati; Bruce C. Greenwald; Alberto Russo; Joseph E. Stiglitz, “Sectoral Imbalances and Long Run Crises,” presented to IEA meeting, Beijing, July, 2011.

Concluding Comments

- Old paradigm was “wrong” and policies based on it contributed to Financial Crisis and to the inadequate recovery
- Diversification may make an economy more unstable
- Financial architecture matters
- An economic downturn related to a structural transformation is different from “normal” economic fluctuations

Models matters

- Strong assumptions follow from strong conclusions
- Mathematical assumptions, like convexity, matter
- Networks and frictions matter
- Old analysis was intellectually incoherent—focusing on benefits of interdependency at times, on costs of contagion at others
- Tried to outline a set of models that provide a coherent and better description of what happened
- And that provide the basis of policies that are more likely to lead to better economic performance