Climate Change and Financial Complexity

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January 18th 2016

Public lecture at the University of Zurich

Climate change poses not just a challenge to the planet, but for and to the financial system

- **Retroffitting** the global economy to respond to climate change (reducing emissions) will require large investments
- Changes in asset prices associated with climate change will have large and complex **repercussions** for **financial system**
  - There will eventually be a **price of carbon**
  - Price of carbon will be reflected in prices of **various sources of energy**
  - These changes will lead to **large change in asset prices**
  - These asset prices will lead to large changes in **prices of corporations**
  - **Rapid** adjustments could pose **systemic risks**

I. A Missed Opportunity

- The central problem facing the global economy today is lack of **aggregate demand**
- Lack of demand is causing weak growth in the US, near-stagnation in Europe, slowdown in Asia
- **Retrofitting** the global economy to face the challenges of **climate change** would have **stimulated** the economy, improving **growth and employment**
- And in doing so would have helped address one of the other major challenges of our time—increasing **inequality**

But even were there a carbon price, how can these "climate investments" be financed?

- Bernanke (Chairman of the Federal Reserve) blamed the crisis on *a **savings glut***
  - Excessive savings in Asia
- But there is not a savings glut or a dearth of good investments
  - There is a huge need for climate investments
  - As well as infrastructure investments
- The failure is in our private financial markets to bring savings and these investment opportunities together
  - This is *supposed* to be one of their central **social functions**
  - They failed in this, as they failed in so many other dimensions
  - This failure has long run consequences

Intermediation

- Investment needs are long term
- Many of the sources of savings are long term
  - Sovereign Wealth Funds
  - Pension Funds
- Intermediating between long term investment needs and long term savers are financial institutions, many of which have a very **short term focus**
  - Central policy question is how to change their focus from quarterly returns to long term
  - Major issue in US Presidential Debate

The Good News: New Institutions

- The creation of new development banks (The Brics Banks and the Asian Infrastructure Bank)
- Discussions about creating new facilities in the World Bank and a Global Infrastructure Investment Platform
- These institutions and facilities can help recycle surpluses
  - Not only from reserves
  - But from the trillions of dollars in Sovereign Wealth Funds
  - Some of which have a longer run focus than the short run focus of private markets and have more sensitivity to the social importance of climate investing

II. Climate financial risk

- If we are successful in limiting increase in temperature to 2C degrees
- Then we will not be able to use all of the “reserves” of oil and gas that have already been discovered (let alone coal)
- **Stranded assets**
  - “Zero value”
  - But market does not currently value them at zero
- When the market discovers that they are worthless, there will be large changes in values of companies that own these assets
  - Markets are often short sighted—have not yet fully taken on board the implications of climate change
  - The **adjustment** could occur slowly
  - But it could also happen **suddenly**—”herding behavior”

Some evidence that market is beginning to realize "clima risk"

- By some accounts, value of reserves (overvalued as they are) exceeds the market value of the corporations that own them
  - Consistent with "agency" perspective
    - Managers of oil companies will dissipate value as they continue to explore for additional oil
    - Marginal value of discoveries likely to be considerably less than the cost of exploration
  - Explains the negative "residual" value of corporation
  - Market value maximization would entail stripping out reserves from corporations

Real challenge: highly interdependent financial ma

- Banks lend to corporations
- Corporations own shares in other corporations
- Banks and corporations have a wide range of interdependencies with producers of fossil fuels
- Decrease in value of fossil fuel companies—with many bankruptcies—will have *systemic* effects
- Analyzing systemic effects is important

Broader research agenda

- Importance of similar systemic effects exposed by financial crisis
- Where bankruptcy of Lehman Brothers turned out to have systemic effects
- Had they conducted "network analysis" this would have been discovered
- Fed failed to do this, even though some research had highlighted risk
  - Allen and Gale (2001), Greenwald and Stiglitz (2003)
- Inconsistency of models used by Fed, IMF
  - Emphasized importance of diversification before a crisis
  - But emphasized contagion after crisis
  - Contagion exacerbated by greater linkages
  - Needed a coherent approach taking both sets of effects into account
    - Optimal degree, form of diversification
- Since then there has been considerable progress in analyzing impacts of "network architecture," the effects of networks on systemic stability, the role of contracts (CDSs, derivatives)
  - Privately profitable contracts may not be socially desirable
  - Excessive diversification may lead to increased systemic risk

Main insights from network analysis

- Systemic risk can be measured and monitored with network-based indicators
- To contain systemic risk it may be desirable
  - to limit **interconnectedness, complexity** (of structure and instruments), and **correlations**[1]
  - to construct a **richer ecology** of financial institutions (not just universal banks).
- **Architecture** matters[2]
  - Some architectures better able to absorb small shocks
  - Some architectures more resilient to large and correlated shocks
  - Some architectures more likely to give rise to bankruptcy cascades
  - Circuit breakers can help prevent cascades
    - Capital controls can be thought of in an analogous way

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[1] Battiston, Caldarelli, Georg, May, Stiglitz *Nature Physics* 2013.
[2] Battiston, Delli Gatti, Gallegati, Greenwald, Stiglitz JEDC 2012; JFS 2012

General Principles

Systemic Risk

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

Extent of systemic risk *endogenous*

- There is an **international** network of TBTF institutions that are too interconnected to fail. But we have national authorities.
- Moral hazard in a network context.

The financial system as a network

- The financial system can be seen as a **multi-level network**[1]
  - It is a collections of actors (market players) and relations (contracts)

  Note: financial networks not only entail **direct linkages** (contracts); they encompass **bank-asset** and **bank-firms** linkages
- We argue that thinking the financial system as a (multi-level) network
  - improves our understanding of how it functions both within countries and at a macro-economic level
  - provides insights into long-standing issues
    - Role of capital controls
    - Role of clearing houses
  - allows us to better design policies that make the financial system better serves its social function

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[1] The Price of Complexity in Financial Networks,
S. Battiston, G. Caldarelli, R. May, T. Roukny, J.E. Stiglitz *SSRN:2594028*

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)

Climate change represents new arena where network analy will be essential

- Calculations are complex
- Systemic effects are likely to be larger than impact effects
- Fiduciary responsibility
- Managers of funds, realizing that there is likely to be large adjustments in asset prices in coming years, need to take precautionary measures now in adjusting portfolios
  - Divestment from carbon assets
  - But also asking, what *other* assets are likely to be affected indirectly as the price of carbon and other prices adjust

Concluding comments I

- Seldom has there been an instance in which the world has been put on notice that prices are markedly wrong
  - Carbon price is now zero or near zero
  - But in not too distant future, carbon price is likely to be large
- The sooner that this is recognized, the more quickly the world will move to a **carbon-neutral** economy
- But the more discrete the change in carbon price and the recognition of the fact that there will be a high carbon price in the future, the **more likely that we might face a financial crisis**
  - In principle, the economy should be able to easily absorb the adjustment
  - But **systemic risk analysis** suggests that this may not be the case

Concluding comments II

- Putting a price on carbon provides the best opportunity for the world economy to return to full employment quickly
- In principle, there should be no problem funding the necessary **“climate investments”**
- But institutional innovations may facilitate the transition
- The transition does pose systemic risks
- **Only through network analysis** can we understand the **nature of these systemic risks**
- And take appropriate preventive measures