

Centre for Risk Studies Research Showcase 13 January 2015
Session 3: Financial Catastrophe Risk

Contagion Modelling of Financial Catastrophes

Centre for
Risk Studies



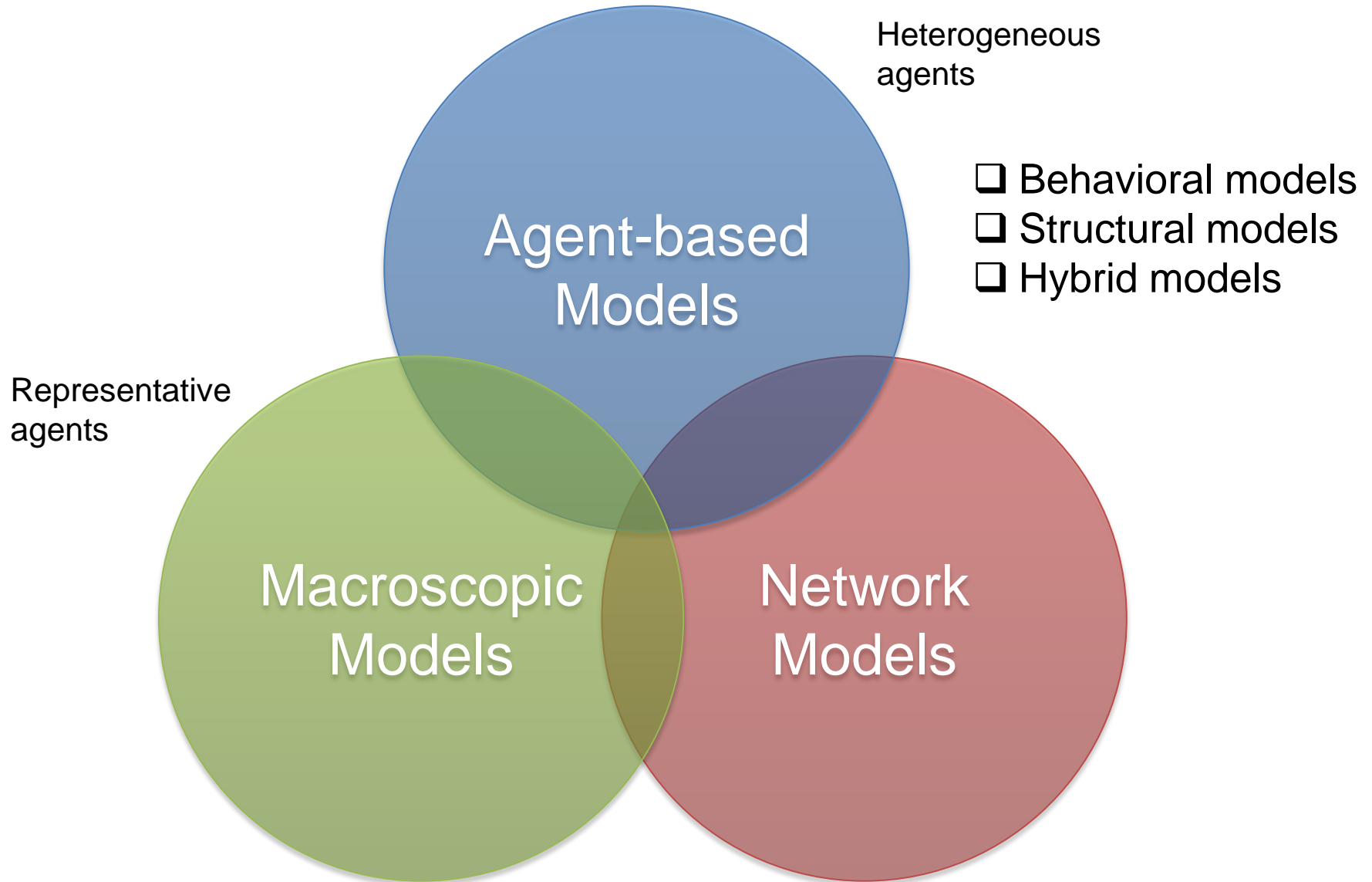
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Outline

- Classes of Models
- CRISIS ABM
- Contagion
- Systemic Risk
- DebtRank

Classes of Financial / Economic Models



Representative Agents vs. Heterogeneous Agents

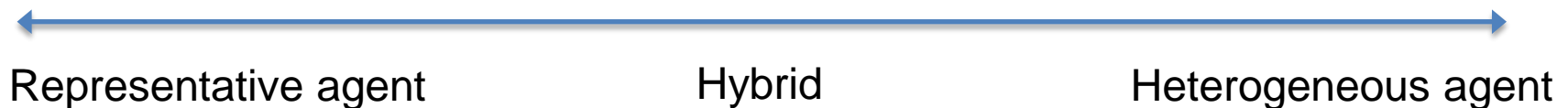
■ Problem:

Under which conditions heterogeneous agents behave similarly and can be described by a representative agent?

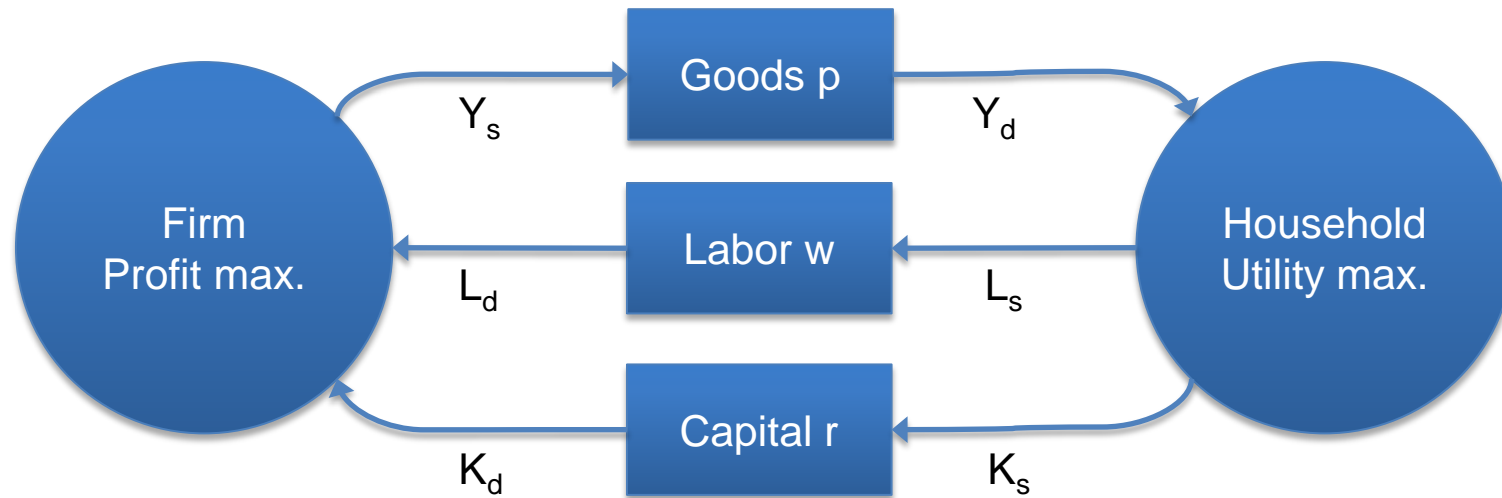
■ Motivation:

In physics, disordered systems often display multiple quasi-equilibria. These are responsible for complex dynamical behavior: slow dynamics, aging, strongly non-linear response, cracks....

■ Is this possible/natural in economic models?



The “representative agent” model

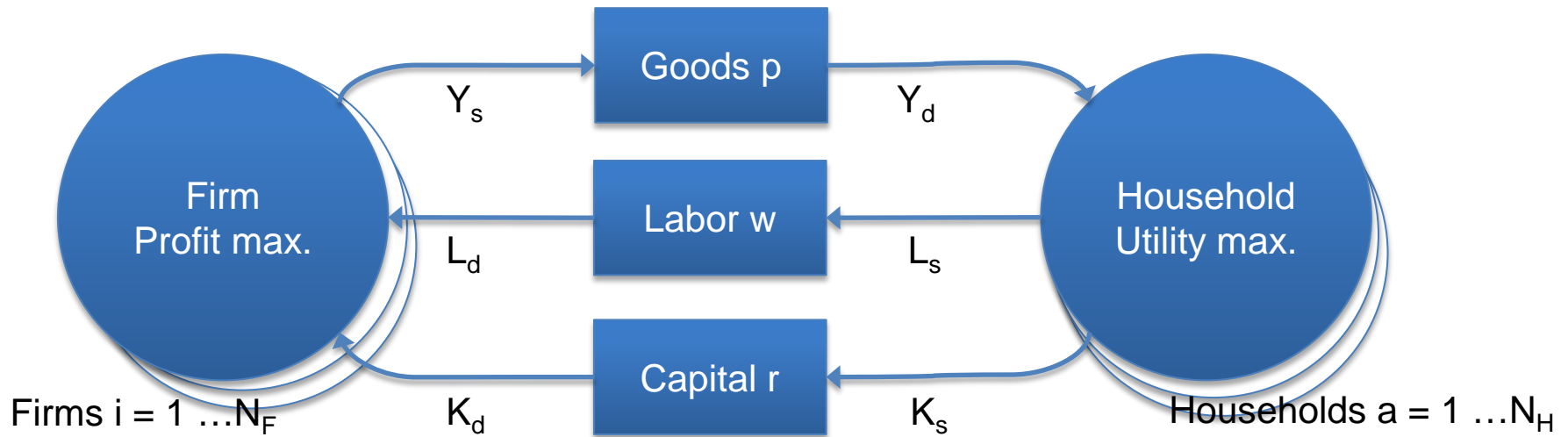


The “simplest possible” economic model:

- Markets obey the law of supply and demand
- The representative firm decides labor and capital demand based on profit maximization
- The representative household decides labor and capital supply based on utility maximization

This model has a unique equilibrium that is reached exponentially fast

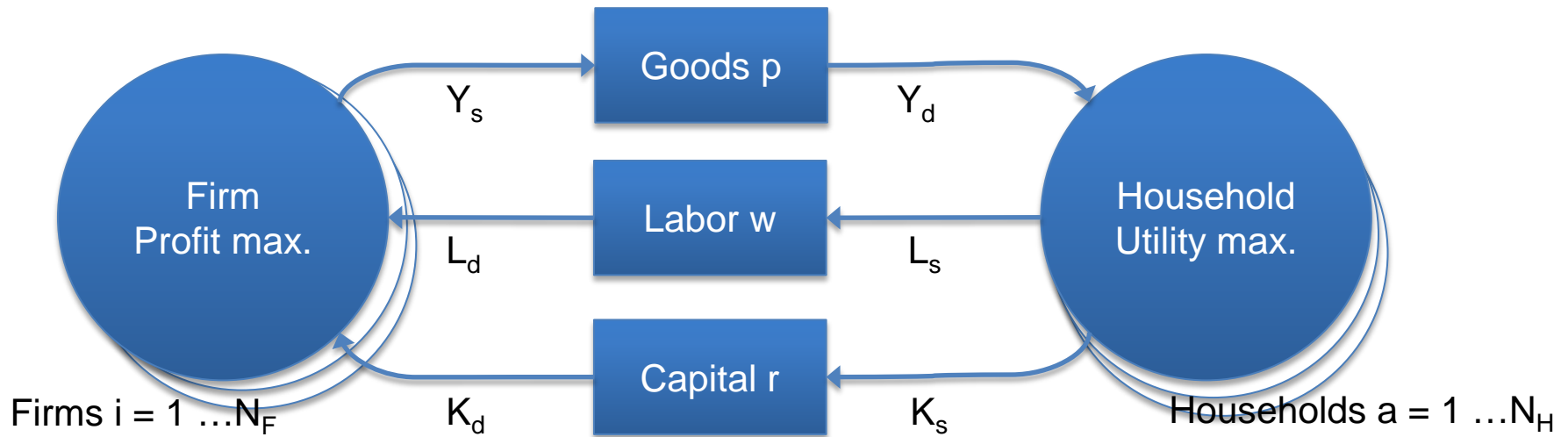
“Agentifying” the model



Same model, but with heterogeneous agents:

- Random network of connections, one for each market
- Markets obey the law of supply and demand for each product
- Heterogeneous firm decides labor and capital demand based on profit maximization
- Heterogeneous households decide total labor and capital supply based on utility maximization
- Households distribute good demand and labor/capital supply with an intensity of choice model

“Agentifying” the model



Very preliminary result [Bouchaud et al 2013]:

- This model always has an equilibrium, but in some regions of parameters there are many others.
- The simplest “greedy” dynamics is not always able to find the equilibrium!

CRISIS model

- Comprehensive framework for agent-based models of economy (Financial and Macro)

Agents:

- Firms
- Banks
- Households
- Funds
- Central Bank
- Government

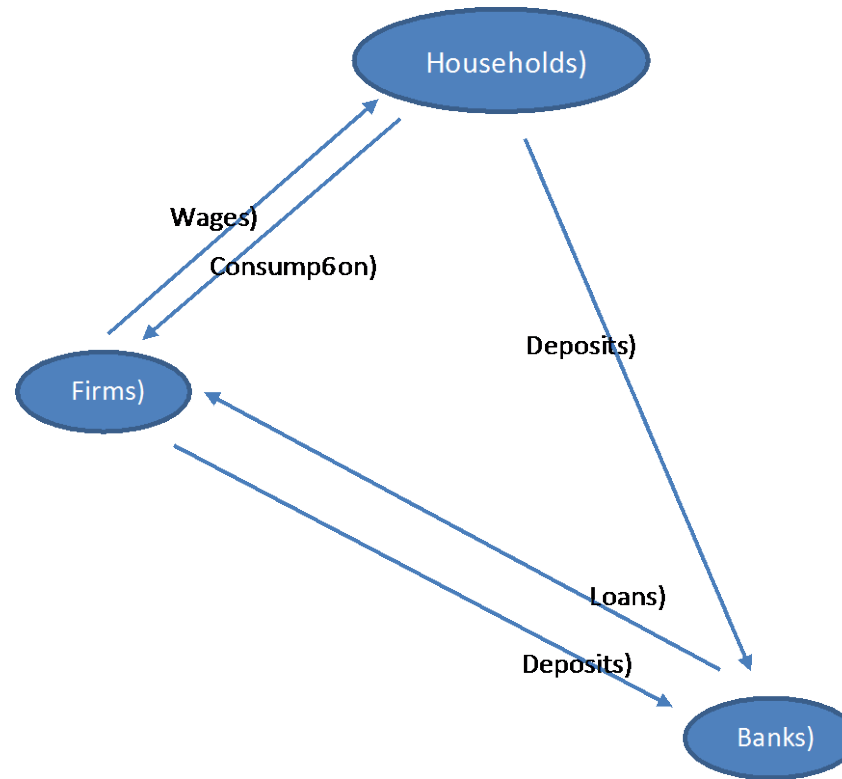
Markets:

- Goods
- Labor
- Housing
- Stocks
- Deposits
- Bonds
- Loan
- Interbank

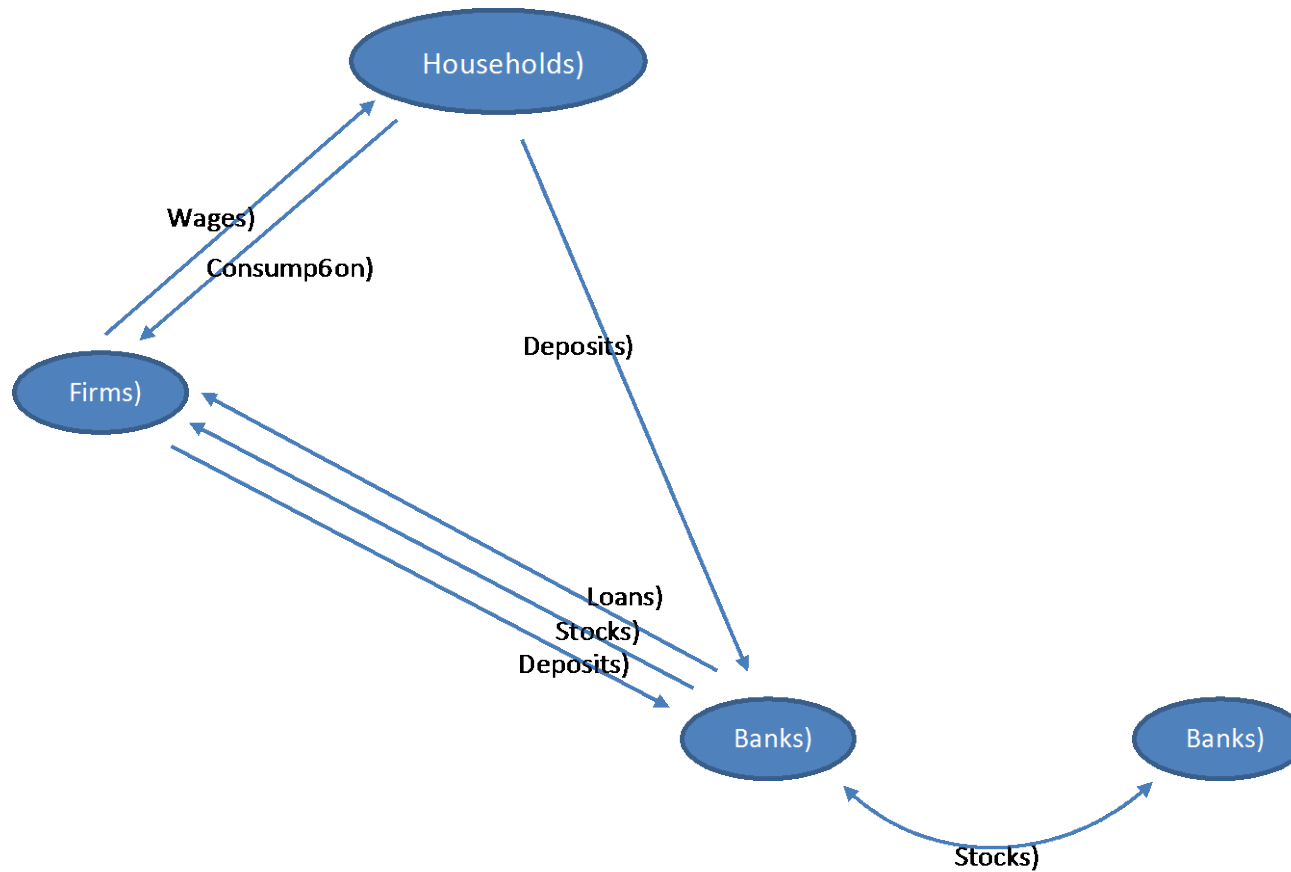
Infrastructure:

- Payment system
- Contracts: Loan, Repo, Bond, Stock, ...
- Bankruptcy resolution
- Dashboard

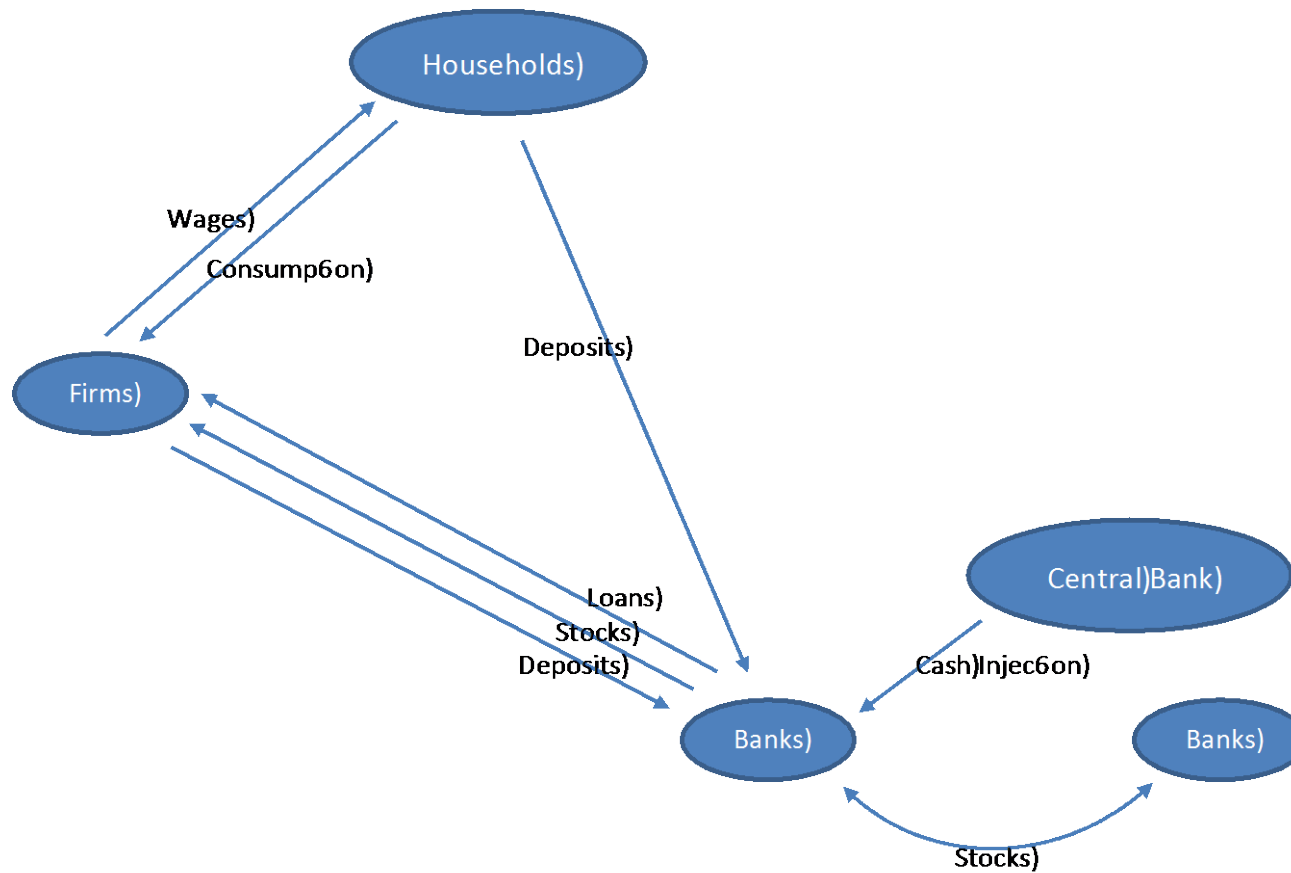
CRISIS model (structure)



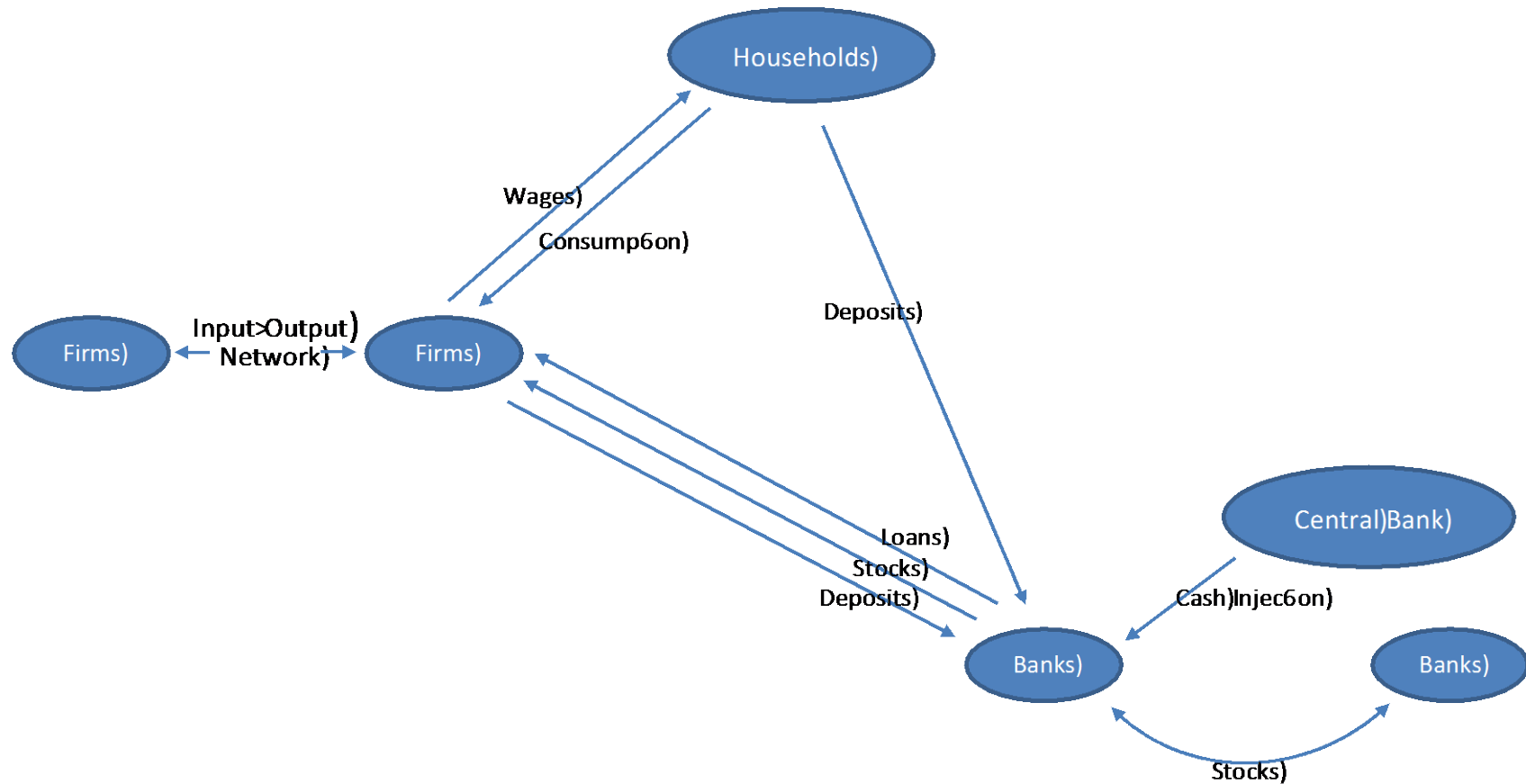
CRISIS model (structure)



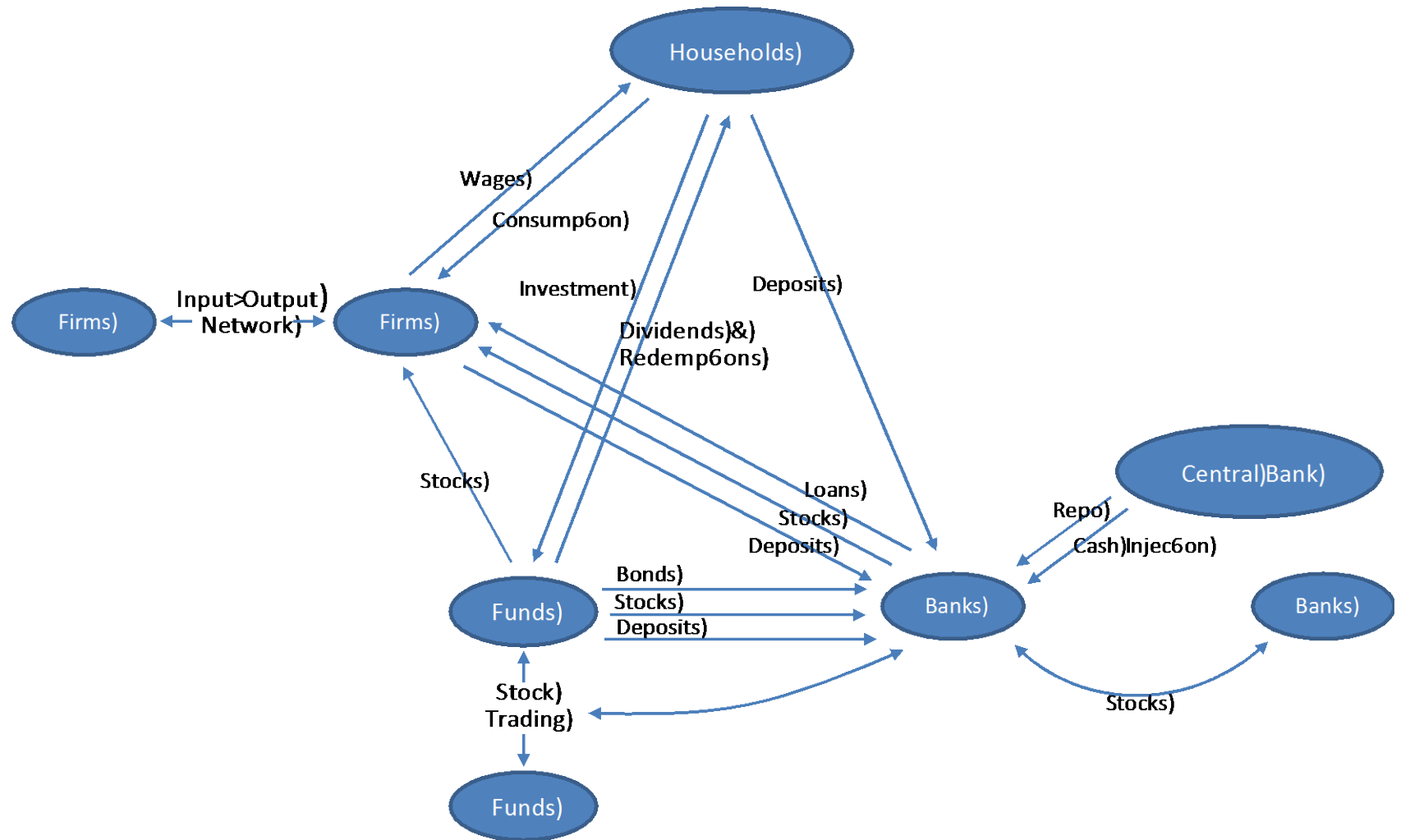
CRISIS model (structure)



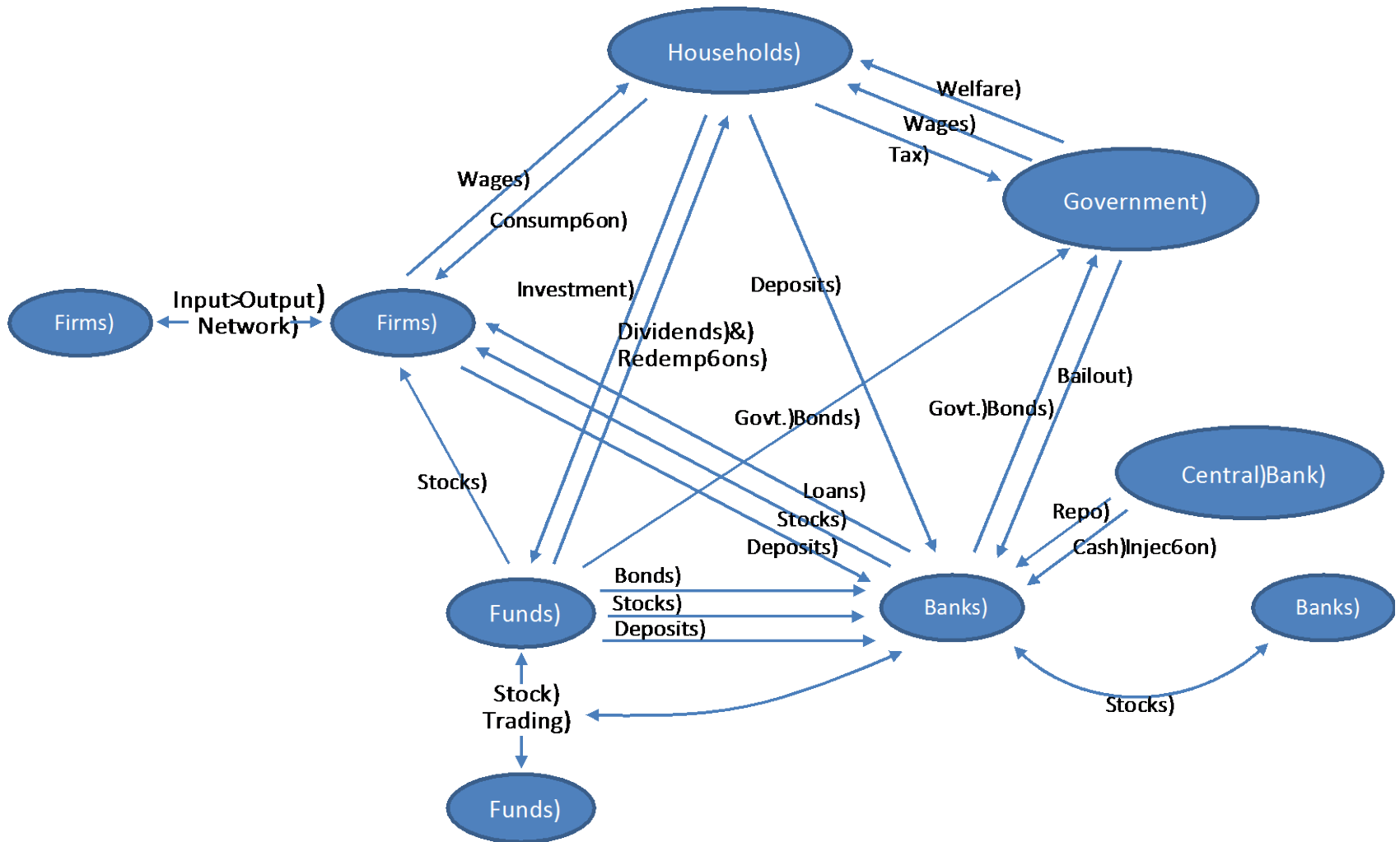
CRISIS model (structure)



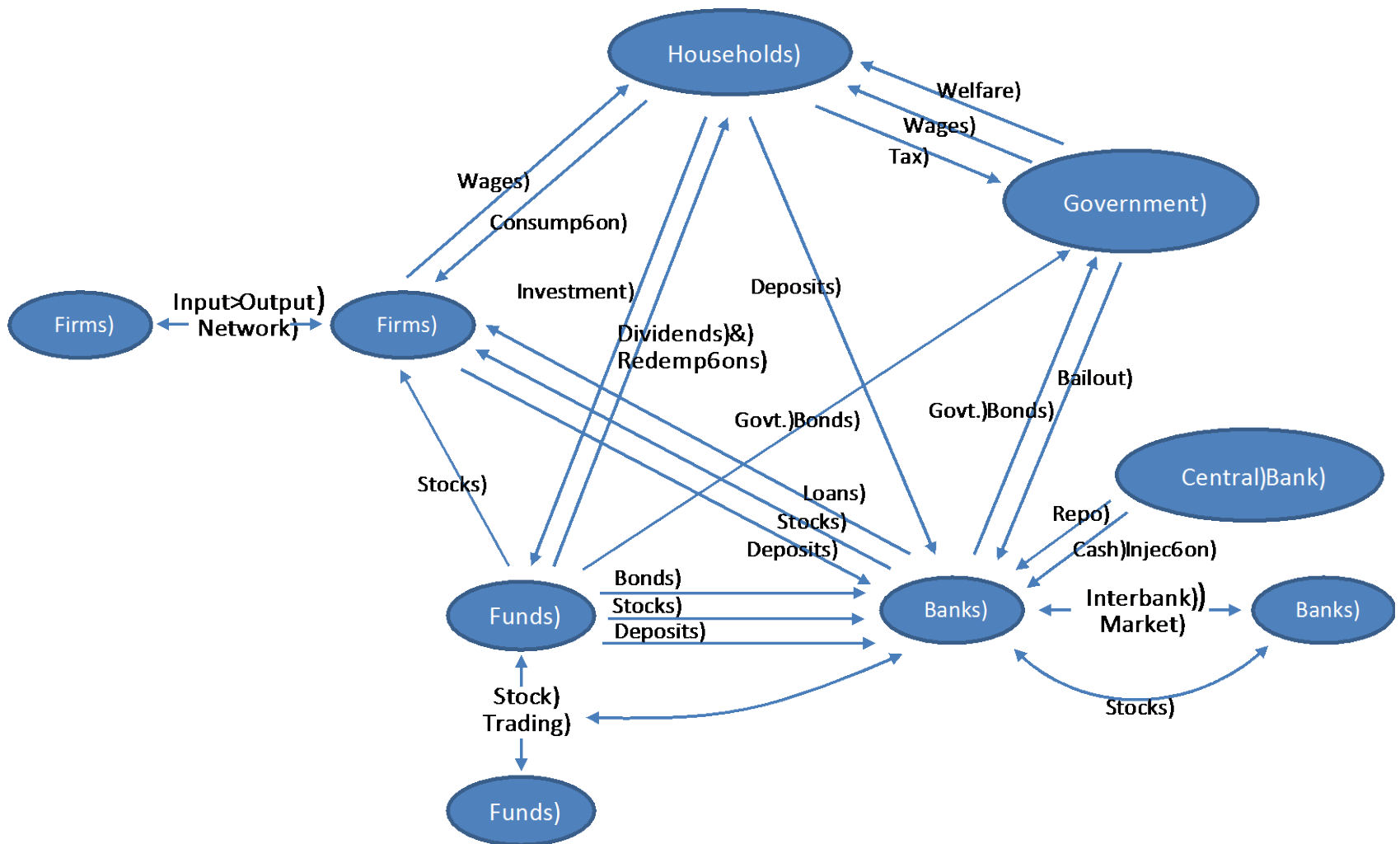
CRISIS model (structure)



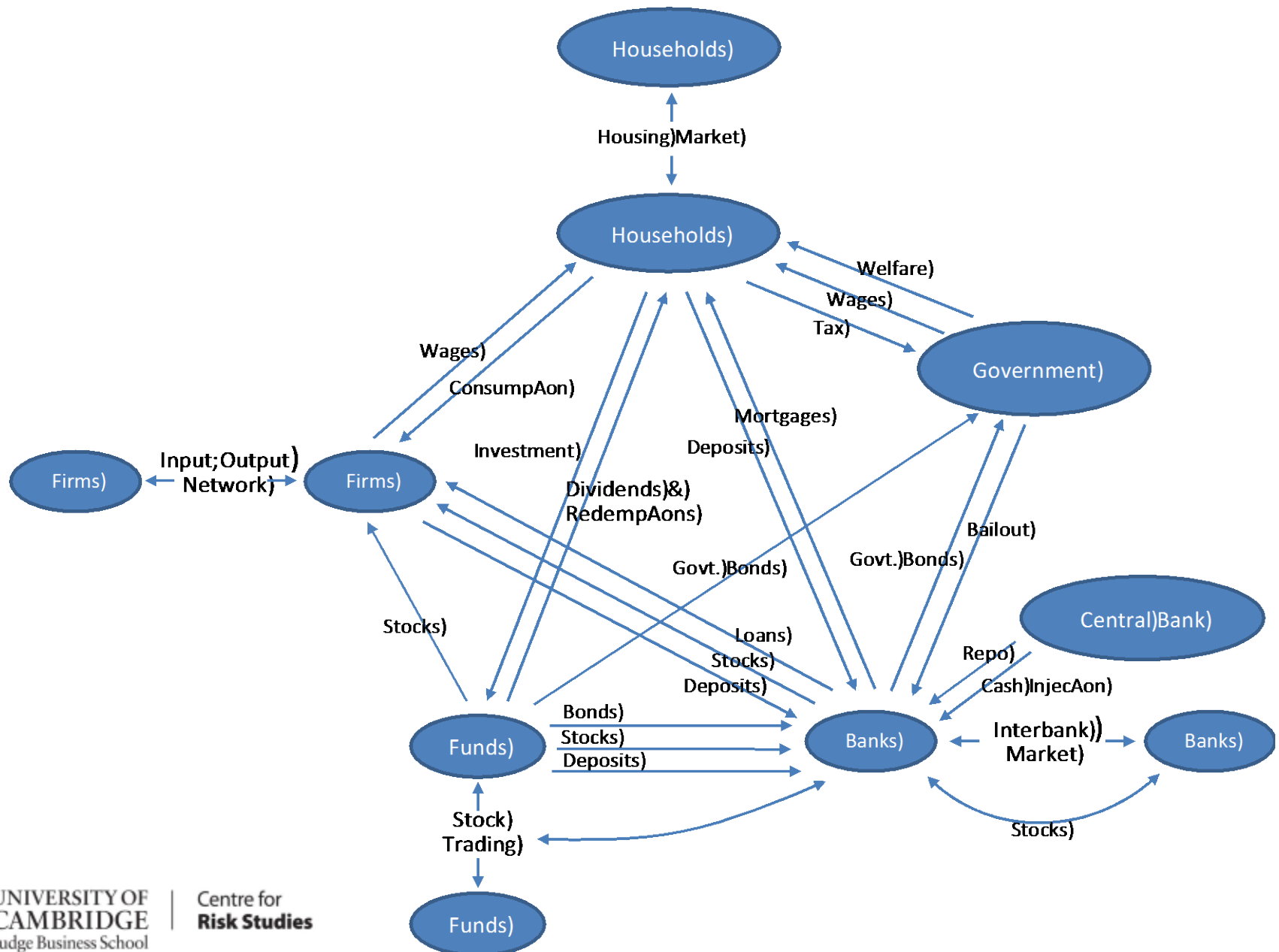
CRISIS model (structure)



CRISIS model (structure)



CRISIS model (structure)



Contagion in Networks of Financial Institutions

Mechanisms:

- contagion through the asset channel (counterparty loss)
- contagion through funding channel (rollover risk)
- depreciation of common assets

Causes:

- interconnectedness
- synchronization of behaviour (fire sales, margin calls, herding)

Stress test scenarios:

- presence of toxic assets
- failure of financial institutions

Systemic Risk (SR)

Definition:

- SR is the risk that the financial system as a whole or a large fraction of it can no longer perform its function as a credit provider and collapses.

Measure:

- DebtRank [Battiston] recursive method to quantify systemic relevance of institutions in the network.

Application:

- **financial regulation** should be designed to mitigate risk of the financial system as a whole and should specifically address systemic risk
- **risk management** of institutions?

Too-Big-to-Fail vs. Too-Central-to-Fail

- Too-big-to-fail: balance sheet size
- Too-connected-to-fail: number of financial inter-linkages
- Too-correlated-to-fail: similar portfolios and/or strategies
- Too-central-to-fail: impacting those who are important via network effects

DebtRank

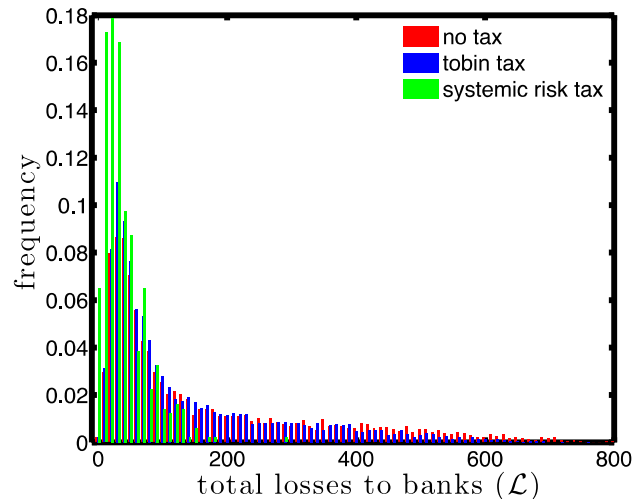
- DebtRank is a novel indicator to identify
 - SIFI (Systemically Important Financial Institutions)
 - groups of SIFI
- Propagation of distress from an institution to another is a key issue for the stability of financial systems.
- Propagation channels
 - direct: balance sheet interlock (unipartite graph)
 - indirect: common asset (bipartite graph)
- DebtRank overcomes some limitations in
 - standard stress-test techniques at central banks
 - standard complex network measures (e.g. betweenness, centrality etc.)

Application: Systemic Risk Tax (SRT)

SRT regulation is a proposal to apply a tax on every financial transaction proportional to the systemic risk introduced by this transaction (provides agents locally with an incentive to re-arrange their contracts).

Tobin Tax vs. SRT:

- ❑ Losses are frequent but small
- ❑ Cascades are frequent but small
- ❑ Transaction volume (efficiency) not affected



Poledna et al. 2014

Application: Basel III

proposes an indicator-based approach that includes

- size of institutions
- their interconnectedness
- other quantitative and qualitative aspects of systemic importance

Institutions get allocated to categories with increasing capital requirements based on indicator scores.

Basel III vs. SRT?

- To be published soon...

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