Approaching Real-World Interdependence and Complexity

“[…] Reducing transaction costs is the main argument for financial deregulation, which is the root of the current financial crisis.”

Ping Chen

“There trend to be a lack of communication and co-operation in the supply chain, and the process is not marked by a great deal of trust.”

Oliver Loebel
Readings for this lecture

- Mandatory reading this time:
  

- The lecture and the slides are complements, not substitutes

- An additional reading list can be found at the companion website
Aims of this lecture

- Characterize real world economic phenomena
- Apply the tools acquired so far to study these phenomena
- Identifying needs for further analyses and related tools, to be developed in the forthcoming parts of the lecture.
Topics

- The complexity of the real world economy and its implications
  - How do economics deal with their complex environment?
  - How should policy makers deal with complex economies?
- Fragmentation of value added chains (VAC)
- The increasing role of network-based technologies
- Spatial clusters and networks as dominating organizational structures
Outsourcing, the delegation of parts of a company’s production process (and potentially also employees or assets) to a third party, typically the less productive elements of the VAC, leading to:
- Functional fragmentation
- Spatial fragmentation along VACs

Inappropriability of information:
- Inevitable information and knowledge outflow
  - Thus impossibility to maintain a long-term monopoly on technological knowledge or to appropriate potential rents
- Stimulating in cooperative environments
- Continuous exchange of positive externalities
- Harmful in defective environments
- Free riding and exploitation
Two firms, A and B, in the same VAC

What does this mean for their technology choices?
- The technologies must be *interoperable*
- Coordination problem

Continuous exchange of information through product parts
- Collective good characteristics of information

What does this mean for the firm’s decisions to invest into R&D?
- There is an incentive to free-ride on the other’s expense
- Dilemma Problem
Tacit Knowledge

- Inappropriability of information in business processes affects
  - Formal technological knowledge, including current research, trade secrets etc. (to a lesser degree)
  - Knowledge on the organizational structure, etc.
  - Procedural knowledge on implementation of technologies, work experience, etc. (tacit knowledge)
    - Tacit knowledge cannot (or hardly) be formally taught or catalogued
    - It is part of the firm’s employees human capital, the firm will lose it when laying off the employees (typically when closing the firm’s presence in the region)
    - It will spread as employees collaborate with others from other parts of the VAC.
Outsourcing may lead to the division of
- Manufacturing processes and
- Service provision

Direct interdependence
- between the two resulting units
- with other units in the VAC and potential costumers

Coordination and Cooperation is required to the ends of
- Developing tacit knowledge
- Joint development
- Building trust (including but not only on the management level)

Implicit assumption: No power difference among the firms
- What if there are some big firms, and many small ones?

Example: Service Providers and Customers
Network Technologies

- Different agents in an interconnected system
  - VAC, Joint Venture, Communication network
- Compatibility and interoperability required
  - Software, supplier parts
- The users the network has, the bigger its usefulness for the users
  - New users generate positive external effects for the incumbent users
  - New users generate negative external effects for the users of competing networks
- Choice as a path-dependent process involving many actors
- Individualistic maximization becomes nearly irrelevant
Network Technologies

- Technologies that gain their value to the user predominantly from their user base, e.g. telephones, communication equipment, technological and social standards'
  - New users generate positive external effects for the incumbent users
  - Technology choice as a path-dependent process involving many actors
  - Multiple Equilibria; Individualistic maximization has low predictive power as to which equilibrium the system will converge.

- In the context of modern businesses:
  - Different agents in an interconnected system that requires compatibility and interoperability, e.g. VAC, Joint Venture, Communication network
  - E.g. software, communication infrastructure, supplier parts
A Game Theory Example

- Three agents: A, B, C
- Choice among two non-interoperable technologies, $T_1$ and $T_2$ with numbers of users $n(T_1)$ and $n(T_2)$ and expected individual payoffs per user $\Pi_1$ and $\Pi_2$
- At the beginning, agents do not know which technology is superior
- Suppose, in fact, $T_1$ is superior to $T_2$

<table>
<thead>
<tr>
<th>Technology</th>
<th>$T_1$</th>
<th>$T_2$</th>
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<tbody>
<tr>
<td>Agent</td>
<td>A</td>
<td>B</td>
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- Coordination problem
- If a player makes her choice, she produces positive externalities for the other players
Consider

\[ \Pi_1 = n(T_1) + 1 \] and \[ \Pi_2 = n(T_2) \]

- Coordinated situation at the inferior technology is superior to all non-coordinated (isolated) situations
- Path dependent process
- The underlying mechanism may easily lead to latent collective blockage of action
Incentive to wait vs. first mover advantage

- To make the first move in the technological choice model is risky
  - One might bet on the wrong technology
  - One might set the standard and receive increased profits
    - Minimum critical mass required

- To wait can be profitable as well
  - Exploitation of the information revealed by prior movers
Fragmented VACs imply a certain distribution of information

The single firm receives less profit from their R&D expenses...
- The information inherent to the project cannot be privatized entirely

...but it might also receive benefits from the products of others

Potential for mutual exchange of information

But individualistic incentive to just exploit the others

Need for an institutional structure solving the underlying dilemma
The development of an economic system depends on past events and is time-dependent.

- External/environmental random events
- Internal random effects
- Systemic structural changes
- Indirect reactions of the system to both exogenous and internal stochastic effects
- Transitions in the behavior of the system as result of any of the above

For optimizing individuals it is impossible to take all these aspects into account.
- IBM planned to enter the market for personal computer systems and
- Microsoft was hired to develop a suitable operation system.
- Microsoft bought Q-DOS, made some minor changes, called it MS-DOS and sold it to IBM
- The rights on the “new” operation system stayed with Microsoft
- The program became in spite of a poor performance quite successful.
- Microsoft went on to dominate the PC sector ever since
IT startups at the time faced strong uncertainty and had several options to deal with it, the most important being:

- **Radical innovation:**
  - Developing a new generation of programs/operating systems/etc.
  - First-mover advantage
  - Long-term monopoly revenues
  - Very risky

- **Incremental innovation**
  - Developing applied solutions
  - “Wait” for dominating system to emerge
  - Less risky

- **Sell company to major competitor**
  - Opportunity of becoming part of the new mother company
  - Without bearing much risk

What would be the right choice for a maximizing individual?
Microsoft for instance did not choose a single path and to be prepared for the development of the sector.
- Acquiring (and investment in) in DOS
- Joint venture with IBM
- Negotiations with companies working with UNIX
- Collaboration with Apple
- Development of a next generation operating system (what would become Windows)

Microsoft realized a mixture of the three alternatives presented earlier

They benefited heavily from the tacit knowledge then available to them

After becoming the standard setter, Microsoft turned to more individualistic strategies
- Ending collaboration with some major partners (those who were also competitors) removing compatibility from their products
- Aggressively pursuing a strategy of gaining first-mover advantages at the cost of e.g. quality and also revenue (tolerating piracy)
The complexity challenge

- The economic environment of most economic agents is characterized by
  - Strong dependence
  - Uncertainty about the actions of others
  - Need for cooperation and coordination

- How do agents react to this complexity challenge?
  - Individualistic strategies
  - Collective strategies
Network effects favor the growth of big firms

The individual form or agent cannot change the systemic properties of the economy

Big firms often rely on hierarchy to solve the problem of coordination and cooperation under complexity
- Helps them to sustain their position
- Not favorable for the rest of the economy, i.e. an individualistic response
- But it is a system of institutionalized behavior
- Includes barriers of entry, mergers and acquisitions, standard setting, lobbying and the use of hub & spoke networks
Hub & Spoke Networks

- Hub cooperation controls layered sourcing systems
- Main suppliers as spokes
- Less profitable steps get outsourced
  - Hub retains processes with highest value-added, i.e. the most profitable
- Cheap labor can be exploited
- Hub retains control over the network
  - Standard setting
Hub & Spoke Cluster

- Hub & spoke structures established as
  - global sourcing/supplier networks (often with system suppliers supplying several assembler hubs);
  - regional forms of organization in spatial (regional, local) clusters of firms (i.e. firm agglomerations consisting of competitors/ cooperators on a horizontal level and suppliers, customers, service suppliers, infrastructure providers, …).

- Highly fragile structures:
  - High dependency of firms, employees, and regions worldwide from the central hub and its development; risky and precarious.
Industrial Clusters

- Local and regional clustering as alternatives to the individualistic responses
- A cooperation- and qualification-oriented system of independent and even-based small and medium-sized enterprises benefiting from
  - Spatial proximity (countermeasure against too much fragmentation)
  - Regional open information flows (tacit knowledge)
- Characteristics
  - Interaction density of stakeholders
  - Proximity of stakeholders
- Silicon-Valley or Third-Italy type systems
Industrial Clusters

- Quasi reintegration of parts of the VAC
- Spatial institutional re-embedding
- Mixtures of the two reactions are common
  - Firms may be clustered around Silicon Valley and still outsource parts of their VAC to other parts of the world
- Determinants for the choice
  - Recognized interdependence
  - Degree of uncertainty
  - ...

...
Emergence of regional clusters

Spontaneous market action

Complex Environment

Spatial proximity

Stable relation

Resistance against conventional market signals

Stable expectations

Long term reciprocity

Relation outgrows the market

Initial interaction

Stable institutional setting
Industrial clusters and firm networks

- The emergence of industrial clusters often proceeds without formal central planning
- Inside an industrial clusters, more intense relations may be built consciously among a subset of firms
  - Strategic networks
  - Special case: Open-Source Networks
Summary

- Modern Information Economies are characterized by
  - Fragmented VAC
  - Network technologies

- This leads to
  - Need for technological interoperability
  - Direct interdependence among actors
  - Ubiquitous coordination problems and underlying dilemmas

- As a result: A complexity challenge
Preliminary conclusions

- There are different reactions for the agents to cope with the complexity of their environment

- Big corporations favor to preserve existing power differentials
  - Individualistic reactions (Hub&Spoke networks, ...)

- From a societal viewpoint, low power differentials and a cooperative institutional setting would be preferable
  - Industrial and strategic clusters
Preliminary conclusions for policy

- Critical time windows for intervention in technological development (standardization and monopolization processes) should be identified.

- Policy should foster non-individualistic reactions to complexity.

- To elaborate the exact functioning and to design adequate policies more concretely, more advanced tools are required.

- Mere deregulation is not sufficient or even harmful.

- Therefore: Understand the theories underlying deregulation and elaborate better alternatives.
Readings for the next lecture

- Compulsory reading:


- For further readings visit the [companion website](#)