An Agency Perspective to Cloud Computing

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In Brief
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What are the hindrances currently constraining a broader adoption of cloud computing?

How can these be understood on an abstract, theory-founded level?

What can we learn from this in matters of fostering a broader cloud adoption?
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A Usual Case

Cloud Provider | Considers Employing | Cloud User (e.g. SME)

IaaS, complex PaaS-Services (Redshift, Dynamo, Payment, ...)

(e.g. SME)
A Usual Case

Law enforcement obligations

Squeeze out customers

Optimized resource allocation

Exploit customer data

SLA-exceptions

Limit security efforts

Considers Employing IaaS, complex PaaS-Services (Redshift, Dynamo, Payment, ...)

Cloud Provider

Cloud User (e.g. SME)

Functional requirements

Risk of data exploitation

Data protection law

Availability needs

Isolation from competitors

Promises toward customers

Performance needs

SLAs enforceable?

Must be highly „secure“

...
We would find dozens of possible reasons speaking against cloud computing
And for each, we would immediately find possible countermeasures employing technological, legal, ... instruments.
„Pragmatic engineering“

Concrete situation / hindrances / conflicts  Pragmatic engineering / management  Concrete measures / approaches
Metodological Approach: Positive/Normative Economics

Abstract / theory-founded representation  \[\rightarrow\]  Deductive application of theory  \[\rightarrow\]  Abstract approaches suggested by theory

Concrete situation / hindrances / conflicts  \[\uparrow\]  Concrete measures / approaches
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„America has no permanent friends or enemies, only interests“

H. Kissinger
A Usual Case

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Squeeze out customers
Optimized allocation
Exploit customer data
SLA-exceptions

Limit security efforts

Cloud Provider

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(Redshift, Dynamo, Payment, ...)

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Conflicts of Interests

Law enforcement obligations

Functional requirements

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SLAs enforceable?

Must be highly „secure“

...
Agency Theory
Agency Theory

Two parties: Principal and agent

Both are „opportunistic utility maximizers“
→ Primarily serve own individual goals
Agency Theory

The „principal engages the agent to perform some service on his behalf, and to facilitate the achievement of the activity, he delegates some decision-making authority to the agent”

Information is „asymmetric in the sense that
(1) the agent’s action is not directly observable by the principal [...] or
(2) the agent has made some observation that the principal has not made“

Furubotn/Richter (2005, p. 162)
Cloud Computing as Agency Relation

Conflicts of Interests

Information asymmetries

Agent (Provider)

Principal (User)
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Agency Theory

Three main challenges in agency relations:

Adverse Selection
Moral Hazard
Hold-Up
Agency Theory

Second-order problem:
Optimizing achieved loss reductions against newly incurred cost

Loss from orig. problem

Costs of countermeasure
Agency Theory

Three main challenges in agency relations:

- Adverse Selection
- Moral Hazard
- Hold-Up
Adverse Selection

General Problem:
- Principal must choose appropriate agent
- Principal does not know the quality of a single agent
  - Assumes “medium quality“ for each agent
  - Medium „willingness to pay“
- Downward spiral for quality and prices → „Lemons market“ (Akerlof 1970)

General Approaches:
- Screening (inspections, assessment centers in job market)
- Signalling (certificates, university degrees, …)
  → Signals must be less expensive to emit for „high quality“ agents
- Self-Selection (insurance contracts → Agent reveals priv. knowledge)
Adverse Selection in Cloud Computing

How do you evaluate the „quality“
(e.g. security / reliability / ... capabilities)
of a given cloud provider?
Screening in Cloud Computing

E.g. **CloudHarmony**

- Can be valuable for certain, easily measurable quality properties (e.g. abilities to provide high performance / availability)

- Hardly efficient (screening effort vs. contract volume) for others (e.g. security-related abilities)
Signalling in Cloud Computing

“ISO 27001:2013 certified”

Agent (Provider) → Quality signals → Principal (User)

→ Can efficiently provide choice support if sufficiently expensive to achieve for qualitatively bad providers („lemons“)

→ Does, however, say nothing about actual provider conduct, only about provider capabilities!
Self-Selection in Cloud Computing

„Offer several contract options to the agent, stimulating the agent to reveal knowledge about own capabilities“

a) Base price: X€, malus for outage / data breach: Y€
b) Base price: >X€, malus for outage / data breach: >Y€

→ „Good“ Providers will choose b) – „bad“ ones a)
→ No established scheme yet
  (But requires bargaining power for P and measurability)
Moral Hazard

General Problem:
- Principal is not aware of agent’s actual effort
- Agent is aware of information asymmetries → incentive to make low effort
- Principal can only evaluate agent based on observable outcome
- Agent will attribute good outcomes to own efforts, poor ones to adverse situational givens

General Approaches:
- Monitoring (behavior and external conditions → reduces inform. asym.)
- Bonding (guarantees, deposits → discourages „cheating“)
Moral Hazard in Cloud Computing

How do you ensure that the provider acts in your interest

(e.g. promptly installs security patches / adheres to country constraints / does not exploit data / spends effort on availability / ...)

instead of „cheating“ for own profit maximization?
Monitoring in Cloud Computing

→ „Random auditing“: hardly efficient in cloud context

→ „Trustworthy event logging“ / „provision of digital evidence“: highly promising (esp. if including external conditions)

→ **Fundamental conflict** with paradigm of maximum opacity
Bonding in Cloud Computing

➢ Scheme not established yet
➢ Requires sufficient probability of shirking to be recognized
   (➢ Monitoring)

TTP

Agent (Provider)

Principal (User)

Receives in case of agent caught „cheating“

deposits
Hold-Up

General Problem:
- One party (P or A) has to make specific investments
- Once investment is done, investing party is „locked in“
- Other party can exploit (e.g. through price in-/decrease)

General Approaches:
- Long-term contracts (anticipation → need to be sufficiently complete)
- Ensure availability of multiple, substitutable counterparties (avoid lock-in → costs for multiple specific investments)
- Non-contractual long-term relations (mutual trust, reputation, anticipated future rewards)
- Vertical integration (merge P+A → abandon benefits from delegation)
Hold-Up in Cloud Computing

How do you ensure that the provider does / will not exploit you

(e.g. increases prices / does not reduce prices / ...)

once you are „locked“ into his services / platform?
Long-Term Contracts in Cloud Computing

Ex-ante agreements on periodic future price reductions / performance increases?

→ Questionable with regard to other potential dimensions of hold-up (service quality, ... → completeness of contracts)

→ Conflict with concept of ad-hoc self-provisioning?
Multiple Counterparties in Cloud Computing

→ Multiple effort of adoption to specifics of several cloud providers
  (e.g. Amazon RedShift + xyz + abc)
Multiple Counterparties in Cloud Computing

→ Efficiently realizable for lower-level services, esp. IaaS („Cloud Federation“)

→ Increasingly inefficient with increasing service specificity (PaaS, SaaS)
Non-Contractual Long-Term Relations in Cloud Computing

Trust, reputation, anticipated future rewards?
Vertical Integration in Cloud Computing
Given the clear agency-relationship and the current status quo of existing countermeasures, it seems highly rational for many potential users not to employ cloud computing.
Measures Suggested by PA-Theory

- Audit certificates as credible signals, **not as statements about actual conduct**
- Novel **contract schemes** (self-selection, bonding, long-term)
- Self-conducted on-site audits
- Role of **trust mechanisms** for current usages of cloud computing needs further examination
- Technical mechanisms for achieving **interchangeability** of providers
- Technologies for providing **credible information** about actual **conduct** and **external conditions** („trustworthy event logging“ / „digital evidence“)

- **Policy** Implications?
Roundup

The relation between cloud provider and cloud user is clearly shaped by conflicts of interests and information asymmetries.

It can therefore be interpreted as principal-agent relation.

This allows for a better, theory-founded understanding of the factors currently hampering broader cloud adoption, ...

... helps discussing commonly suggested measures (e.g. certifications, ...) and forecasting their viability, ...

... and, finally, fosters the identification of auspicious starting points for developing novel instruments as suggested by economic theory.
Outlook

NIST Cloud Computing Reference Architecture
Outlook

Leimeister ea: The Business Perspective of Cloud Computing
Outlook

Service A
Service B
Service C
Service D
Service E
Service W
Service X
Service Y
Service Z

Shall provide property X
Agency theory as theoretical basis for analyzing relations between different stakeholders in cloud and service scenarios
Roundup

Conflicts of Interests

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Information asymmetries

Principal (User)
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