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The analysis and measure of organisational transformations supported by ICTs and digital technologies

Nathalie Greenan
Cnam Lirsa CEET et TEPP

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Institutional & Organizational Economics Academy

Introduction

- ICTs in the different forms they take over time are a General Purpose Technology (GPT) (Bresnahan and Trajtenberg1995)
  - Pervasive
  - Improve over time
  - Generate complementary innovations
- Yet there are many concerns…
  - Productivity paradox
  - Employment threats
  - Increased inequalities
    - Skill bias
    - Job polarisation
- They have been widely discussed in the 1990s and they have come back to the forefront in the past decade

Introduction

- In the 1990s, no direct measurement of ICT investment or of ICT use at the company level
  - In France, a survey administered with the LFS where employees where asked whether they used a computer at work (enquête TOTTO)
    - Employees where also asked the name and address of their employer and a company identifier was coded from this information
    - It was possible to link this employee level survey with company level information
  - Idea to use this employee level information to measure a computer equipment rate at the employer level
    - "Computers and productivity in France: some evidence"
      - Greenan & Mairesse 2000
    - "Using employee level data in a firm level econometric study"
      - Mairesse & Greenan 1999

Introduction

- Need to design a new survey instrument to be able to analyse the consequences of the diffusion of ICTs
- Jacques Mairesse and Dominique Foray asked me to organise an interdisciplinary working group
  - mixing Economics, Sociology, Management sciences and statistics
  - With the objective to set up the foundation of a survey on "Computerization and organizational change"
- The fact that technology and organisation cannot be separated is indeed central in the debates
  - ➢ Investment in new technologies is a dimension of organisational change
  - ➢ The use of new technologies is crafted by the organisation at the same time as it crystallises it
  - ➢ ICTs are new technologies as well as management tools developed on new management concepts

Introduction

- **Linked employer-employee** survey carried out by the French national statistical system
  - Enquête Changement Organisationnels et Informatisation (COI)
  - Two editions
    - 1997
    - 2006
- MEADOW project
  - Measuring the dynamics of organisations and work
  - FP6 coordination action that ended in 2010
  - Aimed at setting out Guidelines for collecting and interpreting harmonised data at the European level on **organisational structures and changes** and their **economic and social impacts** in both the **public and private** sectors

Outline

- A framework for analysing and measuring the dynamics of organisations and work
  - Conceptual framework
  - Measurement
  - Linked employer/employee data collection device
- ICTs, decentralisation of organisations and empowerment of workers

A framework for analysing and measuring the dynamics of organisations and work

Conceptual framework

- An organisation is a **collective entity**
  - ➢ difficult to capture it through one unique response
    - what most company level surveys do
- Interview at least
  - ➢ an individual who is in a position to represent the point of view of the employer
    - Description of the **organisational level**
  - ➢ Employees
    - Description of their **work experience**
- some surveys also interview an employee representative (dual voice survey)
    - Another description of the organizational level with a focus on **work and employment relationships**

Conceptual framework

- Objectives of the questioning
  - identify **organisational forms**
  - identify **clusters of organisational changes**
  - collect the information allowing to analyse their consequences on
    - Performance, innovation and growth
    - Quantity and quality of employment
    - Worker outcomes
      - well being at work, skills development, work sustainability, health at work

Conceptual framework

- **Organisational level**
  - Organisational forms can be described through
    - Their structure
      - Governance
      - Hierarchical
      - Functional
      - External
    - Their systems of
      - Coordination
      - Control
    - Parameters of structure
      - Span of control
      - Height of the hierarchy
      - Number of direct reports to the CEO

Conceptual framework

- **Organisational change** can be approached through
  - The evolution of parameters of structure
  - The adoption of dropping of tools
    - Tools used by the organisation= **models of organised action**
    - Through the **adoption** or **dropping** of tools, **employers reveal their intentions of change**
    - Importance of **cumulative adoption**
      - reveals a strong intention of change
      - a new management concept
      - a new orientation in work practices

Conceptual framework

- **ICTs** are tools that equip the information system of organisations
  - Information and Communication Technologies
  - They allow to produce, manipulate, store, access, transmit and receive information electronically or in a digital form
  - They include hardware, software, physical or virtual networks, embedded systems, connected objects
- **Digitalisation or digital transformation**
  - Dematerialization, digitisation and interconnections
  - Diffusion of mobile tools and apps
  - Developments of transactions on networks and digital platforms
  - Data analytics and artificial intelligence

Measurement

- **Measure organisational change**
  - A challenge in a statistical survey !
- **Option chosen by most surveys**
  - Select a « new » management concept
  - List the associated management practices
  - Ask about their use
    - at the employee or employer level according to the survey instrument

Measurement

- **Example 1**: "How Common is Workplace Transformation and Who Adopts it?" Osterman, 1994
  - Notion of CORE job: "the largest group of non-supervisory, non-managerial workers who are directly involved in making the product or in providing the service at your location"
  - **Flexible Work Organisation**
    - Penetration of a mix of 4 Innovative work organisation practices in the CORE job
      - **self- directed work teams**
      - **job rotation**,
      - **employee problem-solving groups** (or quality circles),
      - **Total Quality Management**
  - **Use of High Performance Work System**
    - an organization is "transformed" if there are at least 2 practices in place with 50% or more of CORE employees involved in each.

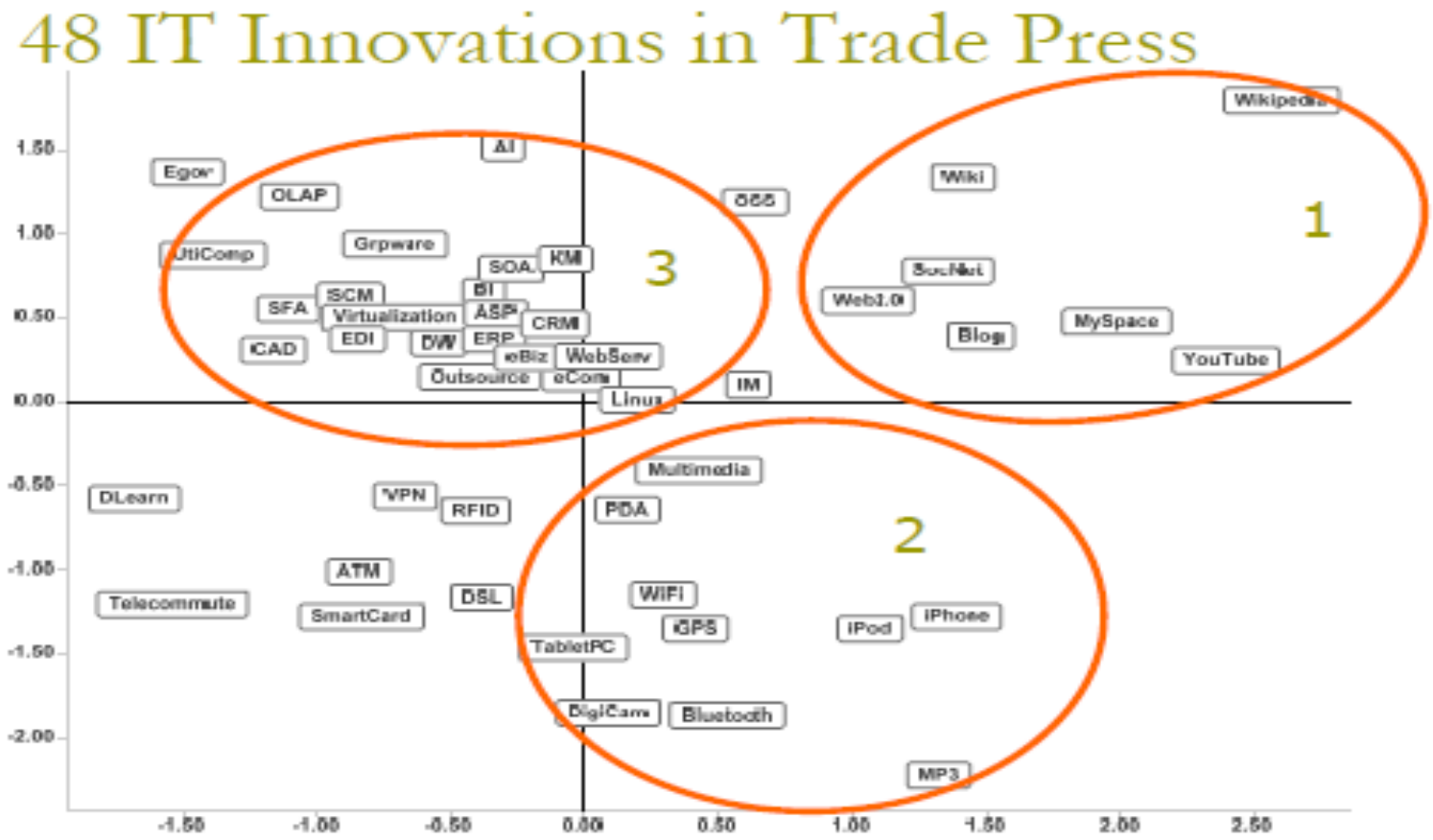
Measurement

- **Example 2**: " What Drives Differences in Management?"
  Bloom, Brynjolfsson, Foster, Jarmin, Patnaik, Saporta-Eksten, Van Reenen, 2018
  - **Management and Organizational Practices Survey (MOPS)** - 2010
  - some forms of "structured management practices" are a productivity enhancing technology
  - 16 management questions in three main sections: **monitoring**, **targets** and **incentives** inspired from principles of lean manufacturing (Bloom and Van Reenen, 2007)
  - 13 questions focused **on decision making within the firm**: number of direct reports to the plant manager, layers of direct reports, delegation of task allocation, availability and use of data to support decision making at the plant (Bresnahan, Brynjolfsson and Hitt, 2002)

Measurement

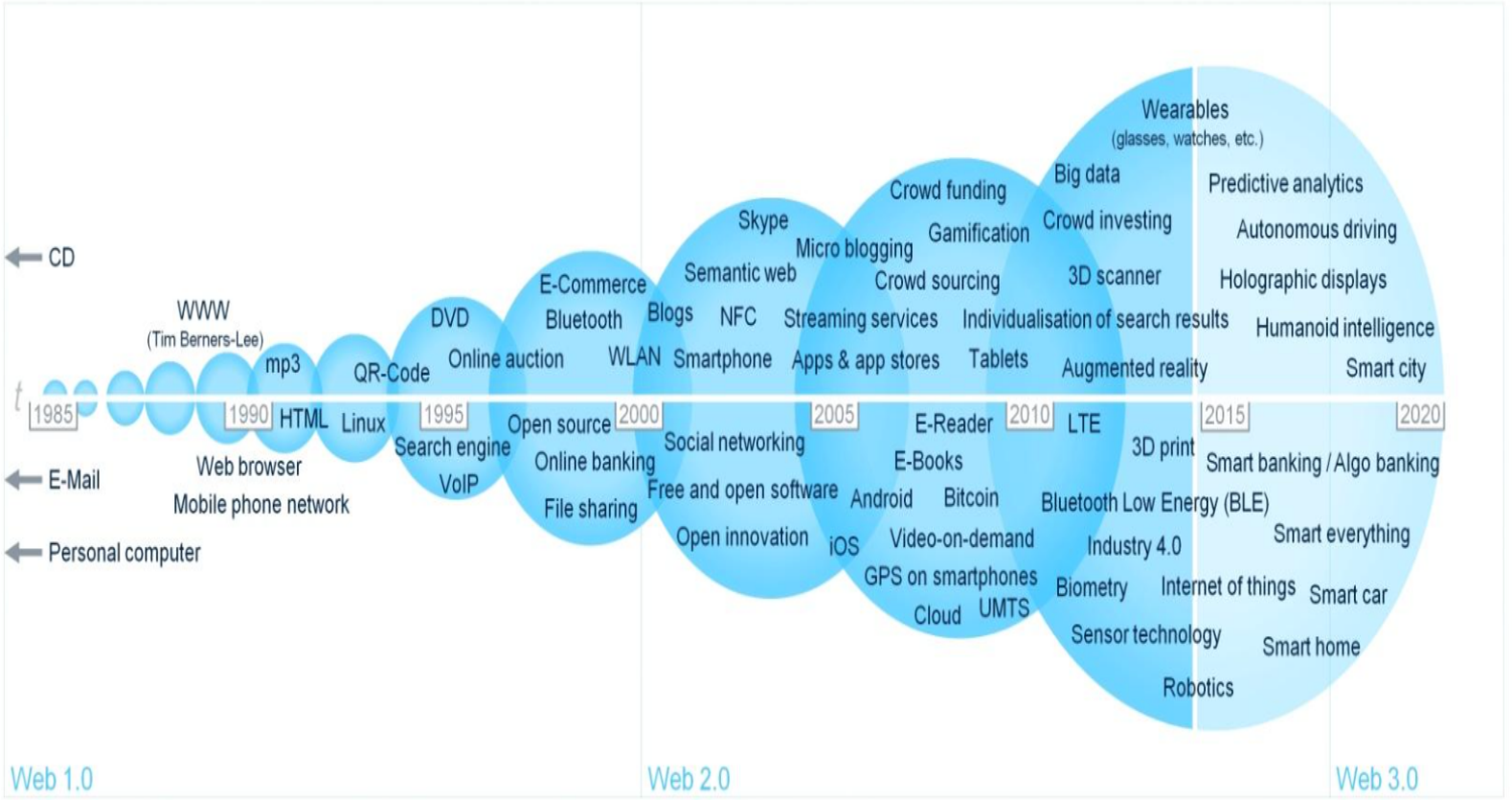
- **Choice in the COI survey**
  - Make a list of tools which diffusion is not in its beginning from the trade press
    - This list encompasses both technologies and management tools
    - This list has to be periodically renewed
  - Ask closed-ended questions about their use at the date of the interview and three years earlier
    - retrospective questions
  - Once the different dimensions of change have been covered, ask in an opened-ended question to describe in a few words
    - the most important change over the past three years

Measurement



Source: Ping Wang (2006)

Measurement



reduction in product life cycles & increase in innovation intensity

Graph: Oliver Ullmann. Deutsche Bank Research.

Selected tools in COI 2006

ICT

1. Web site
2. Local area network
3. Intranet
4. Extranet
5. Electronic data interchange system
6. Database(s) on the management of human resources
7. Database(s) for R&D
8. Tools for data analysis
9. Tools for interfacing databases
10. Tools for automated data archiving
11. ERP
12. Software or firmware for the management of human resources
13. Software or firmware for R&D
14. Groupware
15. Workflow software

Management

1. Quality certification
2. Environnemental and ethical certification
3. Methods of problems solving
4. Tools for labelling goods and services
5. Satisfaction surveys of customers
6. Management of production just in time
7. Tools for tracing goods and services
8. Contractual commitment to provide a product or a service or customer service within a limited time
9. Requirement for suppliers to meet tight deadlines
10. Long term relationships with suppliers
11. Call and contact Centres
12. Teams or autonomous work groups
13. Customer relationship management

Measurement

- Changes measured through closed-ended retrospective questions

Adoption of tools	**38.1**
…at least one ICT	31.3
…at least one management tool	15.5
Evolution of the organisational structure	**44.2**
… functional perimeter	12.0
… the allocation of tasks	12.4
… hierarchical layers	12.4
…organisational chart	28.6
Evolution of the governance	**22.4**
…change in the corporate group	2.7
…financial restructuring	21.7
At least one change	**64.4**
No change	**35.6**

Measurement

- Opened-ended question on change

Closed-ended questions	Opened-ended question		
	Most Important change	No change	
At least one change	21.0	43.5	**64.4**
No change	2.9	32.7	35.6
	23.9	76.1	100

Measurement

Closed-ended questions	%	% most important change
No change	**35.6**	**8.2**
1 change	**33.1**	**20.3**
Adoption of tools	14.4	17.7
Corporate change	3.8	17.7
Change in structure	14.9	23.5
2 changes	**22.3**	**40.5**
Tools & corporate	2.1	29.1
Tools & structure	12.7	40.1
Corporate & structure	7.6	44.4
3 changes	**9.0**	**57.9**
Overall	100	23,9

Linked employer-employee data collection device

- To capture the linkage between
  - …the **formal framework of action** imposed by management and management work and
  - **emerging and informal social processes** that influence work content and work experience
- To seize **adjustments between employers and employees** which are not directly governed by the labour contract
- To **observe simultaneously** points of view of employers and of employees

Linked employer-employee data collection device

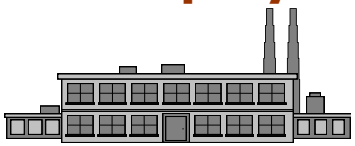
- **Build a balanced linkage at reasonable cost**
  - Representative samples at both interrogation levels
  - Independence between the responses of employees and that of employers
  - In this case small samples of employees per employer are sufficient

Linked employer-employee data collection device

- **Employer** and **employee**-level information are **complementary**
  - information from one level enriches information from the other one
  - the most informed respondent can be chosen for each topic
  - easier to reflect on the collective nature of an organisation
- **A richer set of information** allows deepen the analysis
  - fewer characteristics remain unobserved, better estimates
  - analysis with one level related to the other one can be conducted

COI survey

« Employers »



1997: 4025 firms in manufacturing, 50 employees and more, randomly selected, 82% response rate

2006: 7000 firms in the private sector, 20 employees and more, Harmonized European survey on ICTs. Exploratory survey at 800 employers in the public sector 89% response rate

« Employees»

1997: 9000 employees with at least 1 year of seniority small samples (2 or 3) randomly selected within firms 75% response rate

2006: 23000 employees (private sector) + 4000 employees (public sector) selected in firms 18 month before, employees are interviewed whether they are still in the firm or not. 71% response rate

General findings on the dynamics of changes from COI

- **Inertial forces in organizations**
  - Rapid diffusion of ICTs…but
  - …associated structural change takes time
  - ✓ Organisational inertia
  - ✓ Long time scale of the genesis and stabilisation of the uses that move the technological frontier
  - ✓ Work content evolves slowly
  - ✓ An emerging phenomenon is not necessarily a revolution
- ✓ We still learn a lot about tomorrow by looking at structural trends

General findings on the dynamics of changes from COI

Co-evolution of complementarity ICTs / organisations in the private sector

- Companies coordinate their choices of ICT equipment with their organisational choice
- ✓ These two domains of investment share common drivers
- ✓ There are productive complementarities between ICTS and management tools
- ✓ …but organisational structures and uses of management tools evolve at a slower pace than uses of ICTs

ICTs, decentralisation of organisations and empowerment of workers

Theoretical considerations

- The theoretical literature argues that many factors push towards more decentralisation within organisations
  - Increased market uncertainty
  - Exploration of new technological opportunities
  - More efficient processing of information in terms of speed and cost
  - Knowledge can be acquired at favourable price
  - Strengthening of democratic aspirations
  - Increased level of education of the workforce
- Decentralisation implies
  - Delegation of decision rights to lower levels of hierarchies
  - Flattening of hierarchies
  - Empowerment of workers

Theoretical considerations

- However, ICTs are likely to generate productivity gains in both centralised and decentralised organisations
- **In a centralised organisation**
  - ICTs enables the centralisation and central use of knowledge
  - ICTs contribute to solving coordination problems
  - ICTs allows real time electronic performance monitoring
  - ICTs automates routine tasks
- **In a decentralised organisations**
  - ICTs enables workers to use their specific knowledge
  - ICTs facilitate problem solving
  - ICTs facilitates network coordination
  - ICTs frees workers from space and time constraints

Theoretical considerations

- At the level of employees, dual nature of ICTS (Sewell and Barker, 2006)
  - Coercive: the human serves the technology
  - Caring: the technology serves the human
- No technological determinism
  - All is a matter of design of …
    - how ICTS and digital technologies are embedded into organisations
    - how organisations impose constraints on their uses
- What empirical findings?

Employer level data – Trend - COI

- Trend in the manufacturing industry
  Greenan & Walkowiak, 2010

Surveys	COP 93	COI 97	COI 2006
Period	1988-1993	1994-1997	2003-2006
Coverage	Manufacturing 50+ employee	Manufacturing 20 + employees	Private sector 10 + employees

  - Common coverage: Manufacturing firms with more than 50 employees
- Limitations related to:
  - Time periods (5 years and 3 years, discontinuity between 1997 and 2006)
  - Some differences in the way questions are asked

Employer level data – Trend - COI

- Similar questions in the three surveys on
  - The number of hierarchical layers and/or its evolution over time
- The allocation of tasks on the shop floor and its evolution

Employer level data – Trend - COI

Hierarchical layers	1988	1993	1994	1997	2003	2006
Average number	-	-	3.47	3.33	3.19	3.15
Average growth rate	-		-1.0		0.6	
% decrease	24		18		9	
% stable	71		74		84	
% increase	5		8		7	
Number of companies	1803		2718		2226	

Hierarchical flattening

Which stops

Employer level data – Trend - COI

- Allocation of tasks on the shop floor
  - Distinction between three type of workers:
    - Supervisors
    - Direct producers
    - Experts
- Questions asked at two dates:
  - Who is responsible for performing a list of indirect tasks, for example
    - Share the tasks between production workers
    - Maintain machines and tools

Employer level data – Trend - COI

- **88-93** : Operational decentralisation with dilution of decision-making
- **94-97** : Same trend but weaker
- **03-06** : High stability of the shop-floor division of work

✓ In French manufacturing, **the decentralising trend**

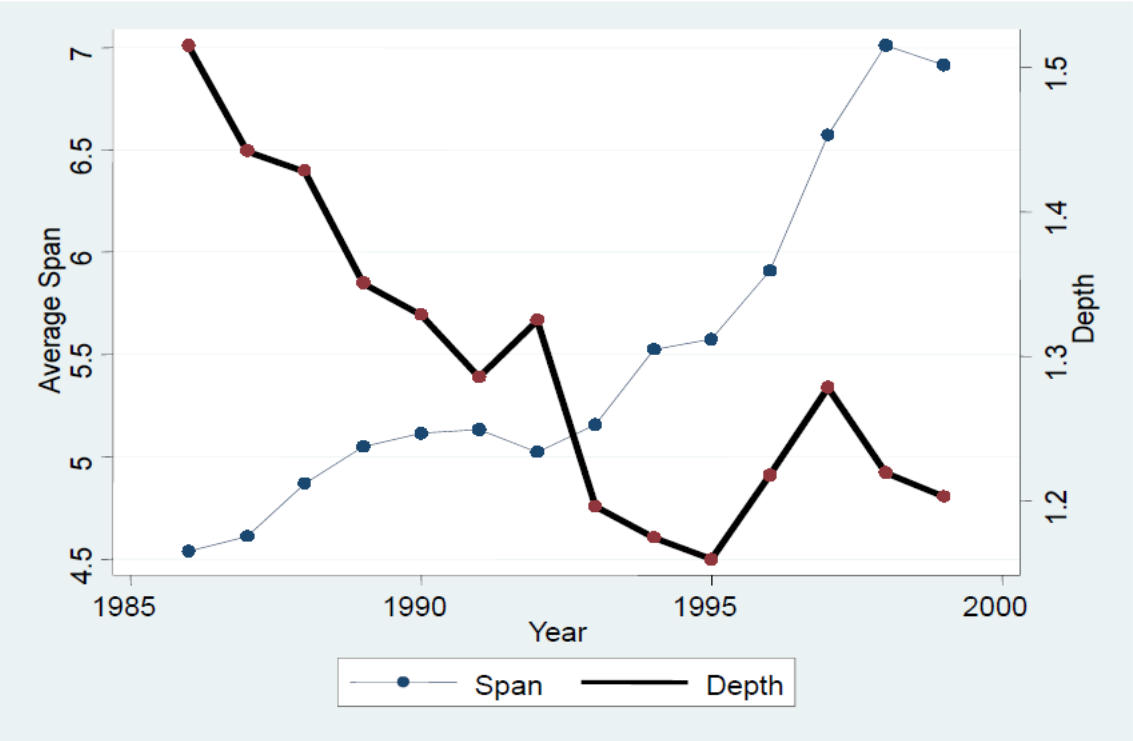
- is strongest towards the end of the 80s/beginning of the 90s
- It then weakens and stops at the turn of the millennium
- While a post-bureaucratic model seems to have spread among manufacturing enterprises in the 1990s, the changes are stagnating at the end of the period
- The rapid diffusion of the Internet since 1997 and the beginning of digitization could be accompanied by new centralising forces

Employer level data – Trend -large US firms

- Trends in big US companies
  - Rajan & Wulf (2006)
    - sample of 300 large US companies representative of Fortune 500 firms over 1986-1998 period
    - increasing average CEO span of control
      - from 4.5 position directly reporting to the CEO on average to almost 7
    - A hierarchical depth decreasing on average by 25% in fourteen years
      - from 1.6 to 1.2 positions between the divisional manager and the CEO
    - leading to the conclusion that **organisational flattening** was pervasive in this population of firms.
    - Several additional finding on pay and promotion suggest that firms
      - greater decision-making authority was delegated to divisional managers as they delayered

Employer level data – Trend - large US firms

Division Depth an CEO span of control



Source: Based on data described in Rajan and Wulf (2006) and Guadalupe and Wulf (2010).

Employer level data – Trend - large US firms

- Wulf (2012)
  - dataset covering 1986-2006 + CEO interviews and time use survey conducted from 2010 to 2011
  - the alleged benefit of flattening is conventionally related to decentralisation
    - decisions are pushed downward to enhance customer and market responsiveness as well as improve accountability.
  - after taking a closer look with more recent data at what a broader CEO span of control meant for decision-making
    - opposite conclusion
  - as organizations delayer
    - the scope of business portfolio becomes less diversified
    - executive teams change their structure
      - more higher paid functional managers making corporate-wide decisions
      - a CEO with higher span of control gets directly connected deeper down in the organisation to get closer to the businesses and more involved in decision making
  - flattening at the top is a complex phenomenon that in the end looks more like centralisation

Employer level surveys – Dec & ICTs

- Acemoglu, Aghion, Lelarge, Van Reenen & Zilibotti (2007)
  - 3 employer level datasets:
    - COI 1997 and Reponse 1998
    - WERS 1998
  - Measures of decentralisation
    - existence of profit centers (COI)
    - Delayering (Reponse)
    - degree of autonomy of plant manager (WERS)
  - Findings:
    - Firms in more heterogeneous environments, those that are closer to the frontier of their industry and younger ones are more likely to choose decentralisation.
    - Results are stronger for firms in high-tech sectors

Employer level surveys – Dec & ICTs

- Bloom, Brynjolfsson, Foster, Jarmin, Patnaik, Saporta-Eksten & Van Reenen (2014)
  - CEP management and organisation survey 2006
  - Measures of decentralization
    - Plant manager autonomy
      - over 4 types of decision
    - Worker autonomy
      - on pace of work and allocation of tasks
    - Plant manager span of control
      - number of people directly managed
  - ICTs: distinguish
    - Information technologies (IT): ERP, CAD/CAM
    - Communication technologies (CT): Intranet
  - Findings:
    - technologies that lead to low information costs promote decentralisation when those that lead to low communication costs promote centralisation

Employee level data - Trend

- Greenan, Kalugina and Walkowiak (2014)
  - Using the European working conditions survey pooled over 1995-2005
    - Results remain valid over 1995-2015
  - A representative sample of EU workers are asked about their work experience
  - We measure trends in a synthetic indicator of work complexity which signals empowerment
    - Core variables
      - Complex tasks
      - Learn new things
      - Choose or change the order or tasks
      - Choose or change the methods of work

Employee level data - Trend

% of the EU work force	1995	2000	2005	2010	2015
Does your main paid job involve…?					
Complex tasks					
Yes	58.55	55.51	58.18	56.81	60.50
No	41.45	44.49	41.82	43.19	39.50
Learning new things					
Yes	75.79	70.41	69.56	68.35	72.12
No	24.21	29.59	30.44	31.65	27.88
Are you able, or not, to choose or change…?					
Your order of tasks					
Yes	65.7	64.17	63.44	65.95	68.76
No	34.3	35.83	36.56	34.05	31.24
Your methods of work					
Yes	72.09	70.4	67.71	67.89	70.64
No	27.91	29.6	32.29	32.11	29.36

Employee level data -Trend

EU workforce	ISCO code	Changes in employment shares	Learning new things	Change your methods of work
		% point change 1995-2015		
High-paying occupations		3,89	**-1,63**	**-2,84**
Legislators&Managers	1	-1,22	-2,54	-1,39
Professionals	2	4,66	-1,7	-3,25
Technicians	3	0,45	-3,22	-2,95
Middling occupations		**-10,77**	**-1,69**	**-0,88**
Clerks	4	-1,59	-4,61	-2,45
Agricultural and fishery workers	6	-1,31	-3,06	0,37
Craft and related trade workers	7	-5,77	0,96	2,23
Plant and machine operators	8	-2,09	-0,73	-3,12
Low-paying occupations		6,88	**-9,09**	**-2,74**
Service and sales workers	5	3,38	-8,58	-7,21
Elementary occupations	9	3,49	-7,99	4,24

Employee level data -Trend

- significant negative residual trend effect associated with
  - learning new things
  - changing your methods of work
  - The synthetic indicator of work complexity
- …in a multi-level model taking into account individual characteristics of employees and those of countries
- …In a pseudo panel estimation with cohort fixed effect
- This effect is all the more important that structural evolutions by age, occupations and education should favour an increase in work complexity
- The use of a computer is positively correlated with work complexity
  - the diffusion of ICT use should also favour the development of complexity

Linked employer–employee data - COI

- Greenan, Hamon-Cholet, Moatty, Rosanvallon (2012)
  - Explore the relationship between ICTs, employee empowerment and monitoring using COI 2006
  - ICT are measured at the company level and at the employee level, allowing to distinguish between
    - **ICT equipment of firms** (7 different) technologies : they are one element of the working context of the employees, whether they are or not user of the considered technology
      → ex : handling employees may be affected by physical flows managed by ICTs without being ICT users
    - **The ICT equipment and uses of employees** that contribute to defining their work practices : we identify both employee access and differentiated uses
  - Empowerment and monitoring are measured at the employee level
  - Large set of individual and company level controls which availability is due to the linkage

Linked employer – employee data -COI

		ICT equipment of the firm							ICT equipment and uses of employees					
	% employees	ERP	Intranet Local Area Network	Extranet EDI	Group ware	Work flow	RFID	Call Center	Internet	Intensive mails	Tasks on line	Mobile computing	Less or not connect.	Non users
You have to achieve set targets	62.2	+	+	+	+	+	+	+		(+)	+	++		
Possibility to change these targets	28.0								++	++	++	+		
You have to follow strict quality procedures	66.3		++	+	+		+		(-)	++	++		(+)	++
You receive precise instructions on work methods	20.9	+				+	+	+	-	--	-		+	+
Work controlled at least once a month	61.2			+	+	+	+	+	-	-	-		(+)	
Work controlled by ICTs	26.0		+	+	+	(+)		+	-		(-)	(-)	++	-
Monitor the work of colleagues	46,8			-		-		-	+	++	++		(+)	-

Conclusion

- Empirical findings do not support the decentralisation and empowerment hypothesis associated with the diffusion of ICTs
  - The development of decentralisation coexists with that of centralisation
  - On average autonomy is at best stable and it is associated with more procedural constraints and increased ICT based monitoring – the empowerment trend is far from obvious
- Explanations?
  - No technological determinism and dual nature of ICTs
  - Organisational design choices made by management are critical
  - Organisational inertia, switching cost, reluctance to empower
  - Low cost of standardisation in a globalised context
  - Competition and IPR issues?
- Consequences?
  - New cycle of exploration slow to start
  - Aspirations of the workforce not met, increased psychosocial risks

Conclusion

- Increased availability of data on organisations both in the public and in the private sector
- Development of
  - International data sets (not linked yet!)
    - EWCS, ECS, PIAAC, STEP
  - Linked data sets at the national level
    - France: COI, Reponse, Conditions de travail, Risque psycho-sociaux
    - Germany: Linked personnel panel
    - Meadow surveys in Nordic countries
- InGRID EU-project
  - Network of distributed but integrating European research infrastructure
  - Transnational visiting grants to data centers
  - CNAM-CEET is a TNA in InGRID

- Thank you!