

# How are Firms Organized? A Descriptive Analysis of Firm-Level Network of Establishments

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# Outline

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- Research question

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- Extent of firms' and plants' specialization

- Evolution of firms' and plants' specialization

## Looking inside multi-plants firms

- How specialization is related to firms' size?

- How similar plants within the same firm are?

- Are plants in the same firms dissimilar and connected?

## Labor Market Consequences of Organizational change

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## Introduction: Motivation

- ▶ The nature and organization of production activities have changed over time
  - ▶ More recently, the reallocation of activities has occurred within companies
- ▶ We consider a very specific type of organizational structure within the firm: specialization of the workforce (Cortes and Salvatori (2016), Kramarz et al. (1996))

- ▶ There is growing evidence that firms need to adapt constantly:
  - ▶ Firms add and drop products on the basis of their relative productivity across products (Bernard, Redding and Schott (2010))
- ▶ Decentralization of decision (Bloom et al. (2011))
- ▶ Firms organize their plants around products and business function to maximize workers' efficiency and productivity (Walker and Lorsch (1998))
- ▶ Benefit from knowledge spillovers (Lafourcade and Mion (2006))
- ▶ Efficiently move intangible inputs across production units (Atalay and al. (2014))

# Motivation

- ▶ The way firms organize their network of plants may have important consequences on labor market outcomes.
- ▶ Specifically, the firm structure and organization of the workforce in the firms' network of plants may play an important role on the decision to close a plant (Bernard and Jensen (2007))
- ▶ The existing literature is almost silent on the role of organization of plants and their connection within them on plant survival

## Introduction: Research Question

- ▶ In this presentation, we will answer several questions
  - ▶ How are firms organized? What is organizational change?
  - ▶ What is the consequence of organizational change on plant shutdown?
  - ▶ What is the role of firm structure and plant network in the decision to close a plant?
    - ▶ Firm concentration of occupations
    - ▶ Plant dissimilarity
    - ▶ Plant connectivity with other plants

- ▶ Our source for information on plants' workforce composition is the *DADS Postes*.
- ▶ The data is based on mandatory annual reports filed by all firms in the private sector.
- ▶ We keep only workers full-time, full-year workers in the company
- ▶ We keep only plants with more than 5 workers and multi-plant firms.
- ▶ We then measure the workforce composition by categorizing occupations within different groups at the plant level
- ▶ Our final database reports information on 274,529 plants in 42,384 firms

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## Identification of specialization

- ▶ How do firms organize their workforce across different plants? Are they specialized? How many occupations do they employ?
- ▶ Are firms and plants are organized in business functions?
  - ▶ There is growing evidence that the slicing up of the value chain does not only concern fragments of production stages but also takes the form of a division of business functions (Sturgeon and Gereffi (2008), Markusen and Venables (2013), Defever (2012), Brown (2008))

- ▶ We reproduce the same exercise by categorizing 8 groups of occupations based on occupational categories at the 2-digit level

**Table:** Definition of 8 groups of occupations

Title	PCS code	Description of occupations
Managers	23	Head of business
	37	Top managers and professional
Engineers	38	Technical managers and engineers
Mid level managers	46	Mid level managers and professionals
Technicians	47	Technicians
Foremen	48	Supervisors and foremen
Unskilled blue-collar workers	67	Unskilled industrial workers
	68	Unskilled manual laborers
Skilled blue-collar workers	62	Skilled industrial workers
	63	Skilled manual laborers
	64	Drivers
	65	Skilled transport and wholesale workers
Administrative employees	54	Office workers
	55	Retail workers

- ▶ We use information collected by the ROME database (Répertoire Opérationnel des Métiers et des Emplois) of the French Bureau of Labor (Pôle Emploi)
- ▶ ROME ranges occupations according to a wide classification of business functions
- ▶ We link 56 main ROME business function to Brown (2008) classification of business functions that are split into core business processes and support business processes

# Definition of business functions

**Table:** Definition of business functions

Definition	Associated tasks
Core business processes	
Strategic management	Coordinating activities, identifying new investments
Procurement, logistics and distribution	Buying, Shipping, distributing, receiving
Operation	Assembling products, managing production, conducting quality control
Product or service development	Developing products, services, business plans
Marketing, sales and customer accounts	Advertising, market research, branding
Customer and aftersales service	Call center services, maintaining and repairing, technical support
Support business processes	
Human resources management	Providing employee assistance Hiring and firing personnel
General management and firm infrastructure	Accounting, managing contracts, security, providing legal documents
Technology and process development	Developing computer systems, providing internet services

- ▶ In function *Procurement logistics and distribution*
  - ▶ Engineers in logistics
  - ▶ Technicians in logistics
  - ▶ Unskilled cargo handler

**Table:** Distribution of Employment Share, by 8 groups of Occupations

## Panel A: Within plants

	1	2	3	4	5	6	7	8
1	100	77.6	63.2	54.3	52.2	50.8	47.6	46.1
2		22.4	22.6	22.2	21.3	21.2	21.2	20.7
3			14.2	13.5	12.3	11.8	12.3	12.2
4				9.8	8.1	7.4	7.7	7.8
5					6.0	5.0	5.2	5.4
6						3.7	3.5	3.7
7							2.4	2.5
8								1.6
% of plants	6.9	21.1	21.4	19.6	12.2	8.5	6.7	3.5
% of employment	1.5	4.6	7.1	11.7	14.7	17.8	23.5	19.1

## Panel B: Within Firms

	1	2	3	4	5	6	7	8
1	100	65.1	56.4	49.8	49.5	47.8	44.4	43.1
2		18.1	20.2	21.6	20.8	20.8	21.1	21.0
3			12.1	13.6	12.5	12.5	13.2	13.0
4				8.6	8.0	7.8	8.1	8.2
5					5.0	5.4	5.9	6.0
6						3.4	3.9	4.2
7							2.5	2.8
8								1.6
% of firms	0.9	2.9	4.1	6.7	10.2	13.0	18.6	43.6
% of employment	0.2	0.6	1.1	2.6	5.5	8.8	16.3	65.0

**Table:** Distribution of Employment Share, by Business Functions

## Panel A: Within plants

	1	2	3	4	5	6	7	8	9
1	100	74.9	67.1	65.3	63.8	60.5	56.9	52.7	57.0
2		25.0	22.1	20.4	20.2	21.1	20.1	19.6	17.8
3			10.7	9.0	8.5	8.8	9.9	10.8	9.8
4				5.2	4.5	4.8	5.9	6.9	6.1
5					2.9	2.8	3.6	4.6	3.9
6						1.8	2.2	2.9	2.5
7							1.2	1.7	1.5
8								0.9	0.8
9									0.5
% of plants	31.7	30.3	17.1	8.7	5.7	3.9	1.9	0.9	0.1
% of employment	6.9	11.9	13.1	13.5	15.8	17.4	10.1	9.9	1.3

## Panel B: Within Firms

	1	2	3	4	5	6	7	8	9
1	100	80.9	73.3	69.4	66.9	63.5	63.2	59.1	60.7
2		19.0	19.2	20.1	20.0	21.9	20.0	21.8	23.4
3			7.4	7.2	7.8	8.0	8.7	8.8	6.6
4				3.3	3.5	3.7	4.5	4.8	4.3
5					1.8	2.0	2.5	2.5	2.4
6						1.1	1.3	1.5	1.4
7							0.5	0.8	5.6
8								0.4	3.1
9									1.5
% of firms	7.3	9.1	9.5	11.0	11.8	13.0	14.8	20.43	3.33
% of employment	1.8	2.6	4.6	6.7	9.9	12.9	14.3	29.5	17.5

## Extent of firms' and plants' specialization

- ▶ Given the first descriptive statistics, we consider a very specific type of organizational structure within the firm which is specialization of the workforce.
- ▶ Since there are many measures of dispersion and no particular reason to favor one or the other, we also sought to characterize firms' and plants' specialization with a number of concentration indices:
  - ▶ The Herfindhal index for the occupational concentration of employment within-firms and within plants
  - ▶ The coefficient of variation of occupation shares
  - ▶ The log variance of occupation shares
  - ▶ The GINI coefficient for the inequality of occupation shares
  - ▶ Share of plants with more than 50% of the workforce in one single occupation

**Table:** Average concentration indexes at the firm and plant level, year 2007

	Herfindhal		GINI		Coeff Var		Log Variance		Specialization	
	Firm	Plant	Firm	Plant	Firm	Plant	Firm	Plant	Firm	Plant
1-digit	0.59 [0.21]	0.61 [0.21]	0.57 [0.12]	0.58 [0.12]	1.28 [0.44]	1.33 [0.43]	0.18 [0.39]	0.22 [0.38]	73.20	84.78
2-digit	0.51 [0.23]	0.54 [0.23]	0.74 [0.11]	0.76 [0.10]	1.93 [0.58]	2.00 [0.57]	0.61 [0.31]	0.65 [0.29]	48.70	67.70
Business Functions	0.70 [0.26]	0.77 [0.24]	0.81 [0.08]	0.84 [0.07]	2.39 [0.58]	2.53 [0.52]	0.84 [0.27]	0.90 [0.23]	80.71	93.19

- ▶ Firms and plants always look more specialized when looking at business functions
- ▶ Plants are consistently more specialized than firms across all metrics



## How firms' organization has changed over time?

**Table:** Evolution of specialization 2002-2007

	2002	2007
Number of plants	147.56	152.03
Average employment	79.1	69.2
Firm level		
Number of functions	5.80	5.54
Number of occupations (2-digit)	6.93	6.84
Number of occupations (1-digit)	3.18	3.11
Specialization index (function)	0.66	0.69
Specialization index (2-digit)	0.46	0.48
Specialization index (1-digit)	0.55	0.57
Plant level		
Number of functions	2.53	2.40
Number of occupations (2-digit)	3.91	3.76
Number of occupations (1-digit)	2.91	2.82
Specialization index (function)	0.73	0.75
Specialization index (2-digit)	0.49	0.51
Specialization index (1-digit)	0.58	0.60

- ▶ Specialization has increased over time
- ▶ Unreported results show that 76.5% of total variance of change in HI occurs within firms in large firms

## Looking inside multi-plants firms

- ▶ We open the black box of the multi-plant firms to analyze:
  - ▶ How organizational change occurs within the firm ?
  - ▶ Does specialization correlate with firm and plant size?
  - ▶ How similar and connected plants within the same firm are?

**Table:** Firm-level and plant-level occupation Switching in plants and firms

	% of firms	% of plants
	Occupations	Occupations
Add	16.30	27.91
Drop	35.68	32.27
Stable	48.02	39.72

**Table:** Plant-level occupation switching within firms, 2002-2007

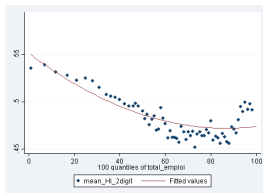
Stable	4.84
Add Only	13.48
Drop only	10.60
Add and drop	71.07

- ▶ 71.07% of French firms alter their mix of occupations in their plants

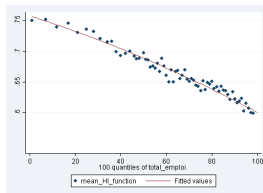
## Does specialization relate to firm and plant size?

- ▶ Larger plants are less specialized, but larger firms have more specialized plants.

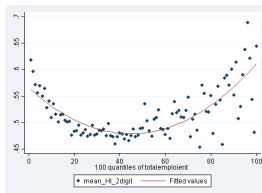
**Figure:** Evolution of Herfindahl index at the establishment level according to size



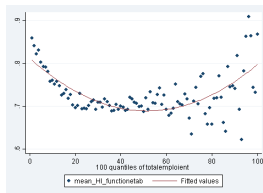
(a) 8 groups of occupations, plant size



(b) Business function, plant size



(c) 8 groups of occupations, firm size



(d) Business functions, firm size

Source: DADS Postes, year 2007, authors' calculations

## How firms concentrate their workforce in the network of plants?

- ▶ We construct an index of firms' concentration based on the GINI coefficient
- ▶ The Gini index has a value of 1 if firm employment in occupation  $o$  is concentrated in one plant and a value of 0 if employment is distributed identically to all plants.
- ▶ Because specialization changes with firms' size, we report the concentration measure based on 4 groups of occupation for 3 employment categories
  - ▶ Small firms: > 5 employees & <249 employees
  - ▶ Medium firms: > 250 employees <4999 employees
  - ▶ Large firms: > 5000 employees

**Table:** Concentration index, year 2007

	Small	Medium	Large
Concentration Unskilled BC	0.63	0.79	0.89
Concentration Skilled BC	0.54	0.71	0.78
Concentration Unskilled WC	0.52	0.70	0.77
Concentration Skilled WC	0.59	0.79	0.85
Average	0.57	0.75	0.82

## Are plants in the same firms dissimilar and connected?

- ▶ We follow Bernard and Jensen (2007) to measure dissimilarity:

- ▶  $dissimilarity = \left( \sum_{o=1}^{o=4} \left| \frac{s_{op} - s_{of}}{2} \right| \right)^{\frac{1}{2}}$  with  $s_{op}$  the share of occupation  $o$  in plant  $p$  and  $s_{of}$  the share of occupation  $o$  in firm  $f$  excluding plant  $p$

- ▶ *Dissimilarity* is 0 when plant  $p$  is identical to the firm workforce composition and approaches 1 as it diverges

## Are plants in the same firms dissimilar and connected?

- ▶ Plants' specialization may give important information on how some occupations need to be carried out in proximity with others
- ▶ We follow Kok and Weel (2016) to measure an index of connectivity of occupations
- ▶  $ec_{oo'} = c(s_{o,p}|s_{o',p})$  for  $o \neq o'$  representing the correlation coefficient between the employment share of employment  $o$  and  $o'$  in plant  $p$ 
  - ▶  $ec_{oo'}$  between administrative employees and managers is 0.15
  - ▶  $ec_{oo'}$  between administrative employees and unskilled blue-collar workers is 0.11
- ▶ The connectivity of the plant with other plant is measured as:  
$$Connectivity = \sum_{oo'} ec_{oo'} s_{po} s_{fo'}$$
- ▶ The higher the index, the more plant  $p$  employs occupations that interacts with occupations in other plants in the network.

## How similar plants within the same firm are?

- ▶ All means for each variables are significantly different between groups at the 1% level

**Table:** Means of characteristics according to firms' size

	Small	Medium	Large
Concentration	0.57	0.75	0.82
Connectivity	0.12	0.12	0.13
Dissimilarity	0.47	0.41	0.44



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- ▶ As a first step to understand the potential labor market consequences of organizational change, we consider a very specific type of organizational structure within the firm: specialization of the workforce.
  - ▶ We define a plant to be specialized if at least 50% of its workforce is employed in the same broad occupational category (of which there are 8).
- ▶ Plant closures (and the subsequent mass layoffs) are important drivers of the labor market consequences of trade and technological change.
  - ▶ We define plant to have died if it is absent from the panel in  $t + 5$

- ▶ We include a number of firms and plants characteristics.
  - ▶ Plant level:
    - ▶ *Standalone*: We construct an indicator variable that equals 1 if the plant is producing in a different 4-digit industry than the firm
    - ▶ Plant age, Plant size (log employment)
  - ▶ Firm level:
    - ▶ Number of occupations, firm size (log employment), number of plants in the firm (in log)

**Table:** Means of characteristics for surviving and closing plants

	Survivors	Deaths
Size (log)	3,11	2,83
Share of Different industry	15,23	17,26
Age	9,44	9,78
Share of specialized plants	84,7	85,8
Connectivity	0,12	0,11
Dissimilarity	0,41	0,45

- ▶ We consider the unconditional relationship between the set of variables and the probability of plant death.
- ▶  $Pr(D_{pt} = 1|X_t) = \Phi(c_t + \beta X_t)$
- ▶ We use the panel from 2002-2007 for multi-plant firms.
  - ▶ 232,618 observations in small firms
  - ▶ 255,330 observations in medium firms
  - ▶ 108,746 observations in large firms
- ▶ We are first interested in the role of specialization in explaining plant death
- ▶ We are then interested in understanding the role of the plant characteristic in the firm's network on plant death

- ▶ Being specialized is an important determinant of plants' closure in small and medium firms

**Table:** Univariate probit of plant death on characteristics

	Small firms	Medium firms	Large firms
Dep. Variable: Exit			
<i>Variables of interest</i>			
Plant specialization	0.037*** [0.011]	0.063*** [0.011]	0.009 [0.024]
<i>Plant control</i>			
Size	-0.189*** [0.007]	-0.209*** [0.005]	-0.161*** [0.006]
Age	-0.183*** [0.007]	-0.104*** [0.008]	-0.091*** [0.012]
Standalone	0.003 [0.012]	0.085*** [0.011]	0.549*** [0.020]
<i>Firm Control</i>			
Size	0.033*** [0.010]	0.055*** [0.008]	0.129*** [0.011]
Number of occupations	-0.048*** [0.003]	-0.014*** [0.004]	0.068*** [0.011]
Number of plants	-0.119*** [0.010]	-0.194*** [0.006]	-0.103*** [0.011]
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

- ▶ How organization of plants within the firm influence plant death?

**Table:** Univariate probit of plant death on characteristics

Dep. Variable: Exit	Small firms	Medium firms	Large firms
<i>Variables of interest</i>			
Plant specialization	0.026*** [0.006]	0.038*** [0.005]	-0.005 [0.009]
<i>Firm characteristics</i>			
Concentration	0.115*** [0.024]	0.049*** [0.022]	-0.086** [0.036]
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

- ▶ How the plants' characteristics in the firms' network influence plants' closure?

**Table:** Univariate probit of plant death on characteristics

	Small firms	Medium firms	Large firms
Dep. Variable: Exit			
<i>Variables of interest</i>			
Plant specialization	0.034*** [0.011]	0.065*** [0.011]	0.019 [0.024]
<i>Plant characteristics</i>			
Dissimilarity	0.327*** [0.024]	0.253*** [0.027]	0.107*** [0.041]
<i>Firms characteristics</i>			
Concentration of occupations	0.353*** [0.055]	0.185*** [0.064]	-0.403** [0.166]
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

**Table:** Univariate probit of plant death on characteristics

Dep. Variable: Exit	Small firms	Medium firms	Large firms
<i>Variables of interest</i>			
Plant specialization	0.034*** [0.011]	0.056*** [0.012]	-0.022 [0.024]
<i>Plant characteristics</i>			
Dissimilarity	0.328*** [0.029]	0.284*** [0.031]	0.317*** [0.050]
Connectivity	-0.006 [0.125]	-0.234* [0.125]	-1.425*** [0.219]
<i>Firms characteristics</i>			
Concentration of occupations	0.352*** [0.056]	0.188*** [0.063]	-0.400** [0.167]
Region dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes



## Conclusion

- ▶ These first correlates provides interesting stylized facts
  - ▶ First, firms and plants are specialized; Large firms have more specialized plants
  - ▶ Second, specialization has increased over time
  - ▶ Third, the vast majority of firms switch their occupational structure by adding and dropping occupations in their plants
  - ▶ Fourth, firms specialize their plants in business functions
  - ▶ Fifth, the network of plants matters in firm decision to close a plant
  - ▶ In small and medium firms, specialized plants are more likely to exit

## Conclusion

- ▶ These first descriptive results open the way to future theories and analysis on the consequences and determinants of organizational change
  - ▶ A first set of questions relates to how specialization is accomplished (associated with change in product mix, how reorganization is realized geographically)
  - ▶ A second group of questions concerns specialization and firms' growth
  - ▶ A final group of questions must provide insight into the role of specialization on reallocation of labor within firms.
- ▶ In future work, we intend to consider these questions, and notably by analyzing intra-firm mobility and organizational change