WORK AND EMPLOYMENT POLICIES IN FRENCH ESTABLISHMENTS IN 1998: A KOHONEN ALGORITHM-BASED ANALYSIS♦

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Abstract

The present paper analyses current employment and work policies in French establishments on the basis of the REPONSE survey that was conducted in 1998. By employment and work policy we mean a parallel study of customary employment relationship characteristics as well as work organisation practices. Our study is rooted in several employment policy variables as well as variables relating to work organisation. The methodology used is based on two complementary analytical tools: multiple correspondence analysis (MCA); and Kohonen's neuronal algorithm (KMCA). After an exploratory study our interpretations are complemented by the construction of a typology.

Key-words: Kohonen, classification, work management

Introduction

The French productive system has gone through a number of major transformations in recent years. Changes affecting the mode of competition during the 1980s lead to a devaluation of the Fordist production mode. At the same time, work and employment practices derived from the concept of flexibility emerged. Such organisational mode may be characterised by individual carrier management and collective work organisation. It became, over the past 20 years, a topic of heated debate for many employment economists, and an emblem of the modern era. Yet questions remain over the magnitude and modalities of the mode's dissemination. Has flexible production replaced traditional forms of Fordist organisation (Boyer, Beffa and Touffut, 1999) or has it developed alongside them, as a sort of complement (Galtier, 1996)? To answer this question, we conducted a global analysis of the forms of production organisation that have been implemented in France in recent years.

Our study is based on the 1998 REPONSE survey. We define the varying forms of production organisation not only by the human resource management (HRM) practices they encompass but also

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by their modes of work organisation. These two poles are in fact highly complementary, and even inseparable when it comes to defining a firm's policy towards its employees. Our analysis therefore focuses on employment policy variables, i.e., the extent to which firms make use of part-time work, fixed term contracts (*hereafter FTC*) and temporary work; the presence of wage increases and negotiating systems; and spending on training on one hand and work organisation variables, such as the use of forms of collective work, flatter hierarchies or employee mobility on the other hand.

We have adopted a methodology that uses multiple correspondence analysis and a neuronal method based on the Kohonen algorithm to complement one another. We first study the relationships that tie together the whole set of qualitative variables which relate to the management of work modes. The results of a traditional multiple correspondences analysis (MCA) both complement and accord with the results we derive from neuronal methods (KMCA, based on the Kohonen algorithm). They highlight a clear polarisation between establishments pursuing a restrictive policy and others who have adopted novel wage policies, negotiating systems and organisational innovations. To describe these HRM policies with greater precision, we create a typology of the establishments involved, by means of a standard classification method whose implementation is rooted in neuronal analysis. It turns out that with this method it is easier to build up classes that are more discriminatory (i.e., that avoid over-emphasising abnormal observations) than would be the case with traditional classification methods. This is very useful when dealing with a set of variables that are as complex as the ones we are working with. The typology we set up in this manner defines 5 types of employment and work practices.

1 Presentation of the survey

Our study is rooted in the REPONSE 98 survey (*Relations Professionnelles et Négociations d'Établissements*) carried out by the DARES (from France's *Ministère de l'emploi et de la Solidarité*). This survey covered 3,022 non-farm, non public administration establishments with 20 or more employees. It is divided into three sections, by respondent. Information was supplied by management representatives, by some establishment's employees or by staff representatives. We pay particular attention to the employer database, comprised of 2,978 establishments that provide information on 962 variables which have been derived either from this survey or else from matching with the DMMO *(Déclarations Mensuelles de Mouvements de Main-d'œuvre)* and the DIANE (*DIsque pour l'Analyse Economique*) data sets.

We select a set of (active) variables relating to workforce and work organisation policies, having chosen not to base the typology on the establishments' structural characteristics (i.e., size or sector of activity for example). The variables we keep focus on different aspects of the establishments' behaviour:
♦ employment and training policies: proportion of part-time workers vs. total staff members (TPART), percentage of temporary workers and FTC holders employed in the establishment (PRECA) and percentage of the total wage bill that is spent on general training (DEPFORM)
♦ wage policy: one variable providing information on whether any wage hikes (across the board or individualised, bonuses) took place in 1998, either for managers or non-managers (POLSAL) and another providing information on whether or not there was a profit-sharing arrangements for the establishment's employees in FY 1998 (INTERES)
♦ negotiation policy: one variable relating to whether or not there was any wage bargaining or discussion with employees in FY 1998 (NEGSL98) and another indicating whether over the past three years there had been any discussions or negotiations on issues other than wages, such as employment, technological changes, organisational innovations and working times (duration and organisation) (AUTNEGR)
♦ work organisation mode: one variable relating to the way in which work is specified (either through a description of the specific tasks that are to be executed or else through the setting of

overall objectives) (ORDRES) and other with information on employees' mobility in their work, *i.e.* whether their normal job allows them to move from one workstation to another (MAJMO), the shortening of the hierarchy (SUPNIV), collective work (percentage of the establishment's employees that participate regularly in entities such as quality groups, problem solving task forces, regular meetings at the workshop, office or departmental level, autonomous production teams, multidisciplinary working groups, project teams) (NVORGA).

The variables we use were recoded to ensure their appropriateness. This recoding was based on both analytical and methodological criteria. Methods such as multiple correspondences analysis (MCA) require a modality sample size that is large enough for active variables. This is because a modality's contribution to overall inertia is a decreasing function of its sample size, and a modality that is based on too small a sample will bias the analysis, much in the way that abnormal observations do. This caused us to recode the variables in such a way as to maintain a minimum sample size for each modality (around 10%). We also tried to ensure that the study only included those establishments that provided information on all of the active variables we had selected[1]. In the end, the sample we used covers 2,297 establishments. It remains a representative one, given the establishments' distribution by sector of activity, size and age.

2 Overall analysis

To analyse the relationships between the qualitative variables, alongside the MCA we used an alternative method that is based on the Kohonen classification algorithm, named SOM (Self Organising Map)[2]. This is called the KMCA. These analyses were carried out on the 2,297 establishments and 11 aforementioned active qualitative variables (for a total of 31 modalities).

2.1 MCA

The findings of our correspondences analysis can be synthesised by studying the first three axes [3]. The first axis (11% of the total inertia) is built around variables such as wages (POLSAL, INTERES), training (DEPFORM) and negotiation policy (NEGSL98 and AUTNEGR). The specificity of the organisational forms that the establishments implemented can be detected when this axis is analysed, even though it does not particularly stand out (only NVORGA and SUPNIV manifest themselves to a significant extent). Note that the 4 modalities of the DEPFORM variable are distributed uniformly, and that they constitute an axis which is almost parallel to axis 1. More generally, axis 1 contrasts "restrictive" and "voluntarist" workforce and work organisation policies. Indeed, on the right hand side we note an absence of wage bargaining, negotiations on any other issues, wage hikes or profit-sharing arrangements - as well as lower spending on training. These behaviours are twinned with the infrequent implementation of forms of collective work or of flatter hierarchies. Regardless of whether this relates to work or to employment policies, such practices are the embodiment of an attitude we can term "restrictive". Behaviours of this ilk almost always involve a *non*-implementation of specific

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[1] We regrouped into one and the same modality both the non-responses and the "Does not know", when the latter stemmed from nested questions. It remains that this modality generally involved a small sample size, leading us to only incorporate those establishments that never answered "Does not know" or " missing " to any of the active variables.

[2] Kohonen, 1984, 1993, 1995. See Allison, Yin, Allinson and Slack, 2001, Cottrell, Fort and Pagès, 1998, Cottrell, Gaubert, Letremy and Rousset, 1999 and Oja and Kaski, 1999 for presentations of these methods.
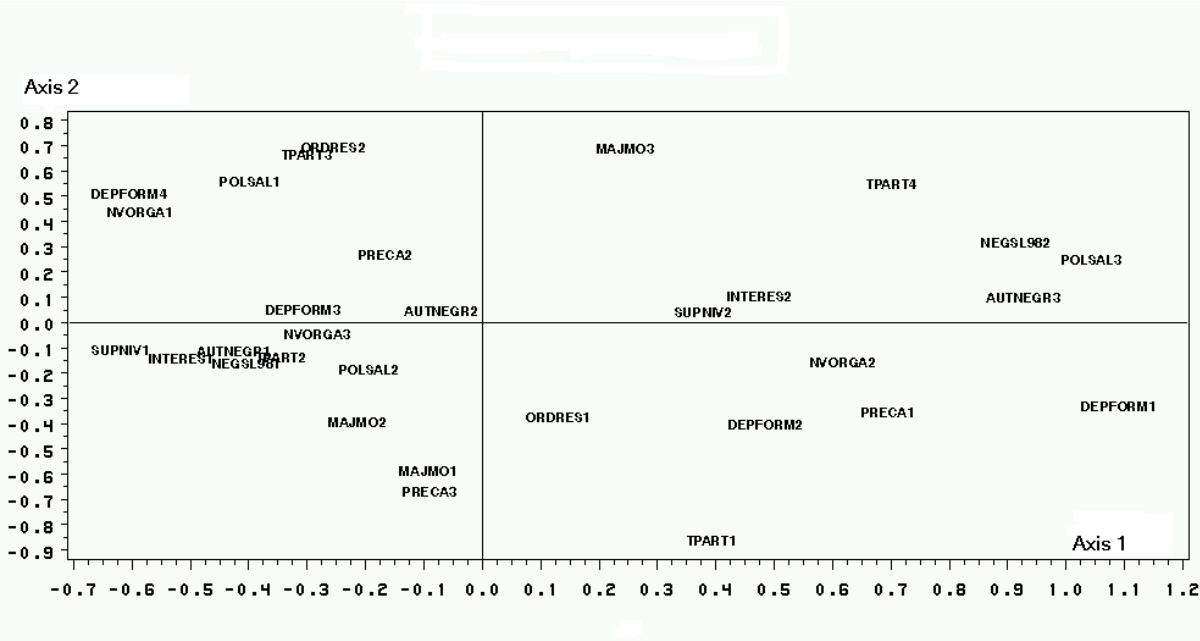
[3] Our interpretation will only cover the three first factorial axes. This will allow us to account for around 25% of the total inertia. See the appendix for the results of this analysis. Note that all the modalities are represented, but we will only interpret those modalities that have the greatest contribution to the axes' construction (as well as those that are well represented).

forms of action (in terms of training, pay policies, negotiations or work organisation). This type of policy can be contrasted with the behaviours that are described on the left hand side of axis 1, characterised by greater spending on training; the existence of profit-sharing arrangements, wage bargaining and negotiations on other issues; and a flat hierarchy. All in all, the management mode at this end of the axis can be called "voluntarist". Faced with this binary opposition, axes 2 and 3 specify behaviours in terms of work organisation and in terms of the use of certain forms of employment.
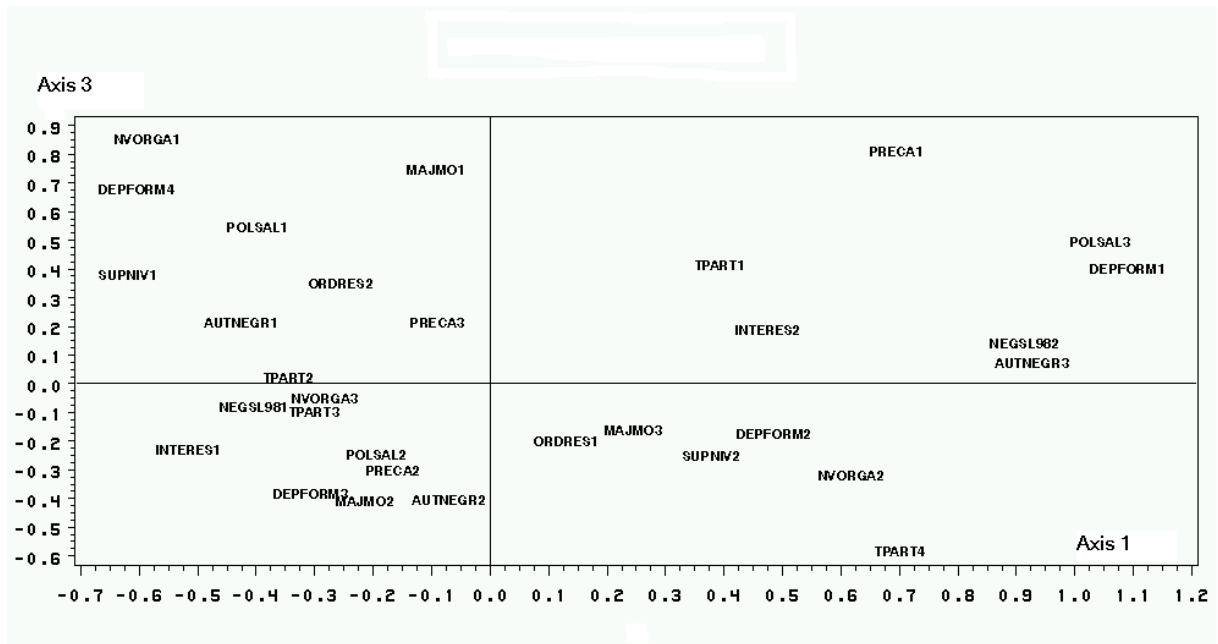
The second axis (7% of the total inertia) is built around variables that relate to the forms of employment (TPART and PRECA) and to the other variables which describe the work organisation (this time around ORDRES and MAJMO). It contrasts policies based on workers' lesser mobility between workstations, a prescription of work through the setting of objectives and a relatively widespread use of part-time contracts (situated to the top) with diametrically opposed behaviours (situated below). Hence the factorial representation (1,2), which reveals four types of behaviours. Amongst the "restrictive" policies we distinguish behaviours in the north-east quadrant, characterised by work that involves very little mobility and by the presence of a large number of part-timers, with behaviours that ally themselves to the "restrictive" policies found in the south west quadrant, where work is prescribed through specific tasks and very few part-timers are employed. "Voluntarist" behaviours include an opposition between a major use of part-timers and a work prescription that is defined by overall objectives, versus a great deal of work mobility and a large number of fixed term jobs.

Axis 3 (6% of the inertia) is built around employment policy variables (DEPFORM4 and PRECA1) and around certain work organisation modalities (NVORGA1, MAJMO1)[4]. The northern part of the axis associates a relatively insignificant recourse to fixed term contracts (FTC or temporary work) with a high level of spending on training. This type of behaviour is also linked to the use of a specific mode of work organisation, replete with highly mobile employees and featuring the implementation of a wide array of forms of collective work. The lower part of the axis is not very specific.

Figure 1: Representation of the factorial axes

Axis 3

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 0.9                                                                              
 0.8    NVORGA1                                            PRECA1                  
 0.7    DEPFORM4                        MAJMO1                                     
 0.6                                                                              
 0.5            POLSAL1                                                  POLSAL3   
 0.4    SUPNIV1                                    TPART1              DEPFORM1    
 0.3                        ORDRES2                                               
 0.2        AUTNEGR1              PRECA3              INTERES2                     
 0.1                                                              NEGSL982        
 0.0                    TPART2                                    AUTNEGR3        
-0.1            NEGSL981 NVORGA3                                                  
-0.2        INTERES1     TPART3            ORDRES1  MAJMO3    DEPFORM2             
-0.3                    POLSAL2                      SUPNIV2                       
         PRECA2                                          NVORGA2                  
-0.4          DEPFORM3 MAJMO2  AUTNEGR2                                           
-0.5                                                                 Axis 1      
-0.6                                                     TPART4                   
   -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0  0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9  1.0  1.1  1.2
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2.2 KMCA

The Kohonen map provides us with an all-encompassing and synthetic vision of these various types of work and employment modes.

An initial north-south opposition arises between policies characterised by varying degrees of strictness with respect to their training, wage and negotiation system policies. The northern part (the first two rows) corresponds to an absence of wage hikes, profit-sharing arrangements and negotiations (wage bargaining or else other issues); and to little spending on training. Conversely, the policies located to the southern side of the map are characterised by wage hikes; employee profit-sharing schemes; wage bargaining and other negotiations; and major spending on training. We rediscover the opposition between "restrictive" and "voluntarist" policies that the MCA had highlighted.

A second contrast can be ascertained along the second diagonal (from the northwest to the southeast). This relates to work organisation practices and to wage hike and training modalities. One of these regroupings includes mixed or general (across-the-board) wages hikes, an absence of profit-sharing arrangements, non-flattened hierarchies, a work prescription that involves an allocation of specific tasks, the non-implementation of forms of collective work and lesser mobility for employees in their jobs[5]. Inversely, the southeastern part regroups policies featuring individualised wages, a team-based work organisation, much employee mobility, the elimination of hierarchical levels and a work prescription expressed in overall objectives. These practices go together with major spending on training.

With the Kohonen map, we are able to summarise the main findings of the MCA approach. Indeed, in reading this map we again encounter an analysis that focuses on the axes' variation. The north-south opposition mostly corresponds to informations that can be used to structure the first factorial scale, whereas the second diagonal cuts across informations we could detect on axes 2 and 3. This crossing of analytical sources is a precious tool for interpreting the multidimensional phenomena we analyse.

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[5] This finding appears to contradict our reading of axis 2 of the MCA, which associated a lesser mobility with a work prescription that is expressed in terms of overall objectives. On the other hand, it corresponds to our reading of axis 3. In addition, the result is a robust one, in that it is able to withstand a repetition of the algorithm.

Figure 2 : The Kohonen map (5*5)

SUPNIV2 ORDRES1 INTERES2		NVORGA2 NEGSL982 AUTNEGR3		TPART4 PRECA1 DEPFORM1 POLSAL3
	MAJMO3			
PRECA2 NEGSL981 POLSAL2		AUTNEGR2		TPART1 PRECA3 DEPFORM2
	NVORGA3 INTERES1		MAJMO1	
MAJMO2 DEPFORM3 AUTNEGR1		TPART2 SUPNIV1 ORDRES2		TPART3 NVORGA1 DEPFORM4 POLSAL1

Figure 3: Distance between cells and their closest neighbours
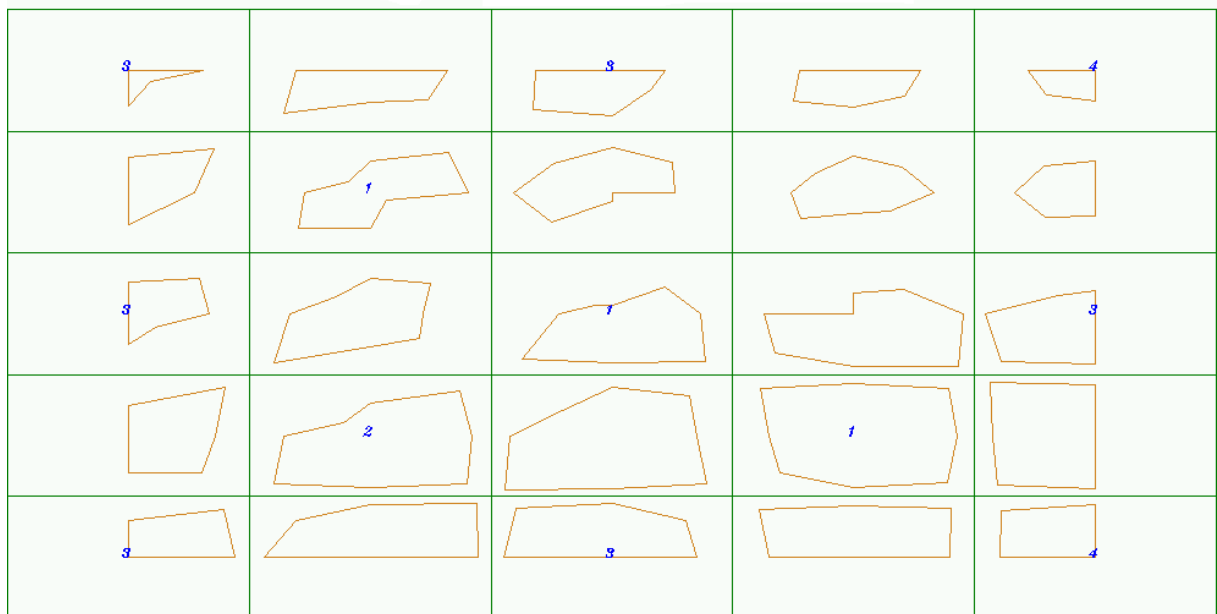
Note: we can regroup cells according to the distances that separate them. A breakdown into 3 classes regroups the 4 squares to the upper left into a first class, the 9 squares to the right (light gray and darker) into a second class, and the rest into a third one. A breakdown into 5 classes would make us split classes 2 and 3 in two.

Figure 4: Cell representatives (final weights)
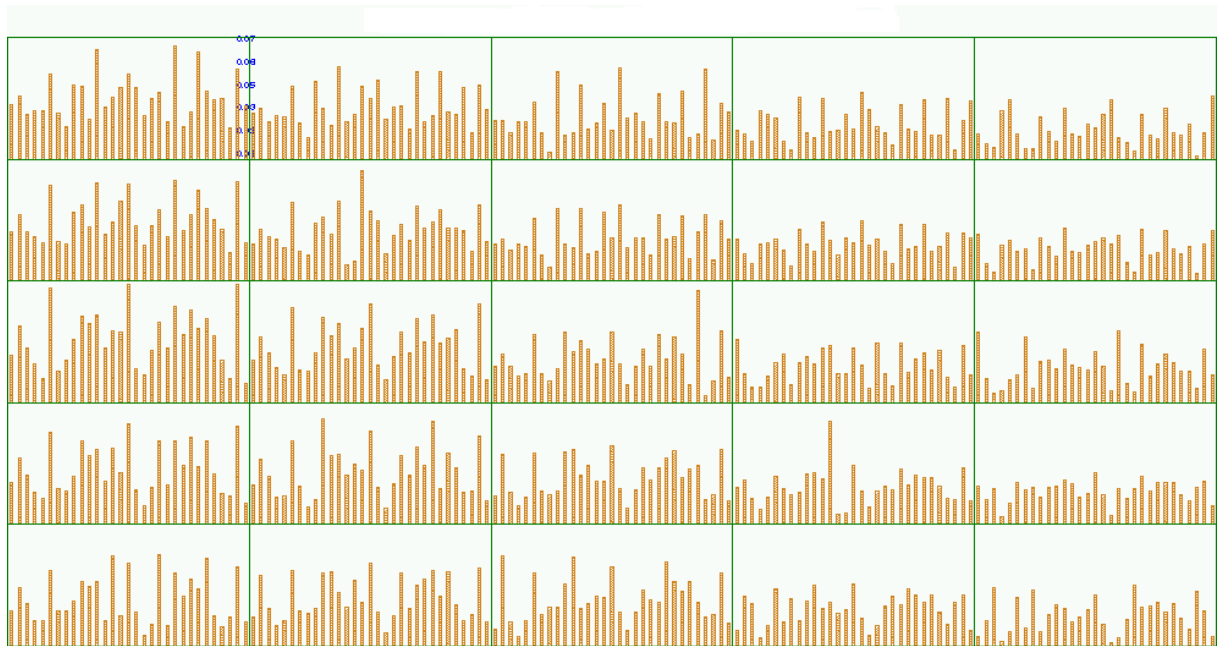
Note: each cell contains the representation(s) of the vector codes that are associated with the varying modalities, in the following order : Tpart1 Tpart2 Tpart3 Tpart4 Preca1 Preca2 Preca3 Nvorga1 Nvorga2 Nvorga3 Supniv1 Supniv2 Majmo1 Majmo2 Majmo3 Negsl981 Negsl982 Depform1 Depform2 Depform3 Depform4 Ordres1 Ordres2 Interes1 Interes2 Autnegr1 Autnegr2 Autnegr3 Polsal1 Polsal2 Polsal3.

Some modalities are systematically associated with one another, regardless of the factorial representation or Kohonen map involved. We can therefore already draw certain conclusions regarding the behaviour of the establishments we have studied. On one hand, an absence of wage bargaining is associated with the absence of negotiations on any other issues; with a lack of wage hikes; and with a lesser spending on training. On the other, organisational innovations, whether this involves working in teams or flatter hierarchies (very often associated with a work prescription that is expressed in global objectives) are tied to a major spending on training and to individualised wage increases. A typology of establishments according to their employment and work practices should help us to further fine-tune this analysis.

3 A typology of the establishments

In observing the classification tree featured in the appendix, we can clearly see that the sample is split into two classes whose sizes (number of firms) are the same. This corresponds to the aforementioned dualistic opposition that crops up in MCA or KMCA analyses. A more refined breakdown (into 5 classes) allows us to define the so-called "restrictive" and "voluntarist" policies with greater precision. The various classes have been reinterpreted through a projection of nearly 200 additional variables. Note that at present we will only be summarising the main conclusions of this analysis.

Table 1 : Repartition of establishments and employees by class

	Restrictive policies			Voluntarist policies	
	Class 1	Class 2	Class 3	Class 4	Class 5
% establishments	8	40	18.7	21.2	12.1
% employees	7.6	28.9	11	33.6	18.9

3.1 Establishments that pursue a restrictive policy

On one hand, we find establishments that pursue a **restrictive and relatively inactive policy**, whether in terms of their wage policy, negotiation system or organisational innovations. They are more frequently characterised by an absence of wage hikes and negotiations, even when the latter only relates to wage bargaining. Profit-sharing arrangements or individualised wage polices are relatively under-developed, and fixed term forms of employment are relatively rare. Lastly, organisational innovations are applied sporadically, at best. On the other hand, such establishments behave differently from one another in terms of their use of part-time work, their training policies and certain aspects of their work organisation (the way in which tasks are prescribed or employee mobility).

We distinguish an initial group largely comprised of mutuals or associations operating in the healthcare sector and featuring a large number of female employees. This group represents 8.5% of all establishments and 7.4% of all employees. These are establishments that manifest a certain desire for projects entailing innovative and qualitative types of work organisations and training programmes, and which opt more generally for a strategy based on a qualitative type of product offer. However, they also rely on employment management tools that are very restrictive in nature, whether this relates to the wage policies, negotiation systems or forms of employment concerned. Despite poor working conditions, employees seem to be often motivated by their identification with the firm's objectives. The employment relationship seems to be based on a reciprocal commitment that has been established at a relatively low level. This type of system can be termed *compromise-oriented cost management*.

A second group, representing 30% of all establishments and 17.4% of employees is comprised of small, less capital-intensive establishments that practice a restrictive policy combined with a very little utilisation of so-called atypical forms of employment. Their commercial strategy is mainly geared towards costs (both in terms of their product offer and also as regards their internal management). This type of approach can be termed *stabilised cost management*.

A third group, representing 11.5% of all establishments and 4% of employees, regroups establishments that are even smaller than in the preceding group. This is a category that accounts for a large number of production workers. The employment management methods it uses are quite severe, with fewer wage hikes, negotiations and above all training. This orientation can be termed *strict cost management.*

3.2 Establishments that pursue a voluntarist policy

The other establishments pursue a policy that we can call **voluntarist.** This second class is characterised by the fact that it frequently resorts to collective work, active wage policies (with individualised pay hikes and profit-sharing arrangements), frequent negotiations, a great deal of spending on training and a frequent use of precarious forms of employment. Moreover, the work organisation in these establishments is more or less geared towards polyvalence. Two groups of

establishments can be distinguished in this category however. This distinction is based on their contrasting wage practices (general or individualised hikes); the varying proportions of fixed term employment they offer; and/or their recourse to collective work mechanisms.

On one hand, we have a group representing 33.5% of all establishments (and 45.1% of employees) that is comprised of large capital-intensive groups which often belong to the industrial sector. Such firms employ a great number of technicians and workers and feature very active training or pay policies. They also seem to favour internal careers, meaning that the level they operate at is closer to the traditional internal market model. Note however that these forms of employment are accompanied in this group by policies that involve innovative work organisation policies and production techniques. Moreover, the strong reliance on temporary work or FTC contracts in this context means that we can hypothesise a dualistic type of employment management, i.e., a *renewed internal market*.

We distinguish another group, representing 16.5% of all establishments and 26.1% of employees, which like the one above is comprised of larger and relatively older groups, but where such firms are less confined to the industrial sector. The establishments here employ more managers, fewer workers, and just as many technicians. Their work organisation and production methods are very innovative. Spending on training is high and wage policies are based on individualisation and on profit-sharing. They resort relatively infrequently to fixed term contracts. All in all, we can call such work and employment policies *professionalised management.* Employees' working and employment conditions are relatively beneficial and people are very involved in (and associated with) the firm's objectives. The work and employment organisation twins independence in one's work with a personalised motivation, and employees feel a great sense of responsibility.

Conclusion

In terms of the data that was used in the present study, the Kohonen algorithm turned out to be entirely complementary to traditional methods of data analysis. An association of these two methods is particularly useful in a synthesis of complex information, whether this involves an overall analysis or the creation of a typology.

Regarding our interpretation of the transformations that have affected the structure of the labor market over the past 20 years, the present study has enabled us to advance two main conclusions. On one hand, we have been able to ascertain a mode of production and work organisation that is close to the canonical model of flexible production (involving individualised carrier management and polyvalence in work organisation). Note that to a certain extent this has developed *to the detriment* of the classical forms of the internal Fordist market, and not in parallel to them (as shows the emergence of a renewed ILM class). Secondly, our analysis enables a precise study of the extent to which the labour market segmentation schema has been globally incorporated. In addition to its definition of a professionalised work organisation segment (class 5), it has enabled us to differentiate three types of organisation within the entity that is generally considered globally and called the secondary market (with classes 1, 2 and 3).

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Appendix

Table 1: Results of the MCA analysis

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Singular  Principal Chi-
Values    Inertias  Squares Percents      3    6    9   12   15
                                        ----+----+----+----+----+---
0.45536   0.20735   5855.96  11.40%     *******************
0.35163   0.12365   3491.99   6.80%     ***********
0.33483   0.11211   3166.24   6.17%     **********
0.31729   0.10067   2843.15   5.54%     *********
0.31580   0.09973   2816.55   5.49%     *********
0.30901   0.09549   2696.73   5.25%     *********
0.30481   0.09291   2623.96   5.11%     *********
0.30077   0.09046   2554.78   4.98%     ********
0.29664   0.08799   2485.09   4.84%     ********
0.29346   0.08612   2432.14   4.74%     ********
0.28914   0.08360   2361.08   4.60%     ********
0.28176   0.07939   2242.04   4.37%     *******
0.28031   0.07857   2219.07   4.32%     *******
0.27711   0.07679   2168.63   4.22%     *******
0.27304   0.07455   2105.51   4.10%     *******
0.26938   0.07257   2049.43   3.99%     *******
0.26590   0.07070   1996.72   3.89%     ******
0.26069   0.06796   1919.33   3.74%     ******
0.24727   0.06114   1726.80   3.36%     ******
0.23755   0.05643   1593.71   3.10%     *****
          -------   -------
          1.81818   51348.9 (Degrees of Freedom = 900)
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Figure 6: Classification tree