RENEWAL OF LABOR FORCE AND FIRM MODERNIZATION

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Summary

According to the skilled biased technical change theory, firm modernization would imply a change of its skill structure favorable to skilled workers. Moreover, several models highlight the segregation process of workers according to their skills resulting from organizational changes. The consequence of this process is a decrease in the labor force heterogeneity. In this paper, we empirically identify the evolution in the labor force composition associated with the firm modernization trajectory and determine the job flows (creations, destructions) that could result from such transformations. Rather than considering organizational and technological changes separately, we provide a measure of modernization of firms which reflects their coordination in a dynamic perspective. Thus, we can determine if the impact of the firm modernization on its labor force renewal is durable or transitory. These tests are conducted on a sample of 2431 French manufacturing firms questioned in the survey on "Organizational Changes and Computerization".

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1-Introduction

For the last two decades, the industrial enterprise landscape has been transformed by major reorganizations and the spread of Information and Communication Technologies (ICT). These generic technologies impact communication, affect co-ordination within the firm and satisfy the logic of rationalizing the production of knowledge. The extent, duration and persistence of the adoption of innovative organizational practices such as quality management, just-in-time production systems, project teams, out-sourcing or even re-engineering, leads us to consider them as reflecting real structural changes within organizations (Osterman (2000)). These new practices of organization (NPO) favor the development of work logic of a more horizontal nature where decision taking is decentralized, where the employee becomes more autonomous, polyvalent and multi-skilled, and where collective dynamics are encouraged.

We consider how the way firms conjugate technological and organizational changes defines their modernization trajectory. This paper aims at identifying the labor force renewal during the modernization of French manufacturing firms. This study of the joint dynamics of labor force renewal and modernization of firms should help to understand the evolution of inequalities characterizing advanced economies since the beginning of the 80s: the increase in inequalities (wages, unemployment) associated with the skills of workers, but above all, the growth in residual inequalities (unexplained by the difference in skills) (Lemieux (2003)).

This empirical work relates to the skilled biased technological change (SBTC) theory, to the organizational theory and the recent empirical analysis of the reallocation of jobs within the firms.

According to the theoretical and empirical papers on skilled biased technical change (SBTC) (Acemoglu (2002)) and productive complementarities (Milgrom and Roberts (1990)), the decline in price of ICTs would generate coordination in technological and organizational choices, which in turn would require a more skilled workforce. This approach explains the evolution in the structure of occupations within the firms. In France, papers that test this assumption lead to contrasting results. Caroli and Van Rennen (2001) observed that between 1992 and 1996, the change of the skill structure is due to both technological and organizational changes. During the period 1992-1998, Coutrot (2000) found that the skill structure of firms is more sensitive to technological innovations than organizational ones. On the contrary, Greenan (2003) showed, on the period 1988-1993, that the change of the skill structure has been mainly due to organizational changes.

To understand these different results, we propose to dissociate the effects of ICT and NPO from the effect associated with their stage of diffusion. Indeed, Goldin and Katz (1997) showed that the technological bias in favor of skilled workers would be more important during the introduction stage of a new technology than during its diffusion stage. This could explain the differences in results obtained by Greenan (2003) who measured technological change by the diffusion of automated machines and Coutrot (2000) who measured it by the diffusion of more recent technologies such as Internet.

Moreover, rather than considering organizational and technological changes separately, we provide a measure of modernization of firms which reflects their coordination in a dynamic perspective. Indeed, this measure allows distinguishing firms that coordinate their technological and organizational choices at the beginning of the process of modernization, from those which achieve this coordination more gradually with time, and finally from those which do not coordinate these choices. While many empirical papers study the impact of the coordination of technological and organizational changes on performance ((Caroli and Van Reenen (2001), Brenahan, Brynjolfsson and Hitt (2002), Greenan and Mairesse (2004))), they do not analyze the effect of this coordination on the structure of skills.

Theoretical models of organizational changes ((Kremer (1993), Kremer and Maskin (1996), Caroli, Greenan and Guellec (2001), Thesmar and Thoenig (2000), Wigniolle (2001)) lead us to identify how the modernization dynamics of firms impact the evolution of diversity of the labor force. By formalizing the reinforcement of interdependencies between workers that are caused by organizational changes, these models highlight the segregation mechanisms (according to skills or competencies) during firms' reorganizations. The direct consequence of the increase of segregation is that the labor force composition should become more uniform.

Finally, if the modernization trajectories of firms impact their skill structure and labor force composition, it would also entail job flows within and between firms. Empirical studies on job reallocation in the economy generally focus on the flows of jobs between and within economic sectors. They show that most of the job flows results from reallocations within the sectors whatever the country analyzed (Davis and al (1996); Duhautois (2002)). Identifying jobs which are created and destroyed at the firm level will enable taking into consideration the heterogeneous behavior of firms, in terms of recruitment and lay-off. Indeed, the modernization of firms is accompanied by an increase in jobs flows in France (Greenan (2003)) as in the US (Osterman (2000)) and some very recent work in France (Askenazy and Moreno-Galbis (2004)) and Germany (Bauer and Bender, 2004) seem to confirm that job flows and modernization of firms are linked. Our study is complementary to this previous work and will discuss if these links are durable or transitory.

This paper is organized in the following way. In the second part, we start by identifying the dynamics of modernization of firms and present the used data. We then analyze in the third part the effect of dynamic of modernization on the change of the skill structure, on creations and destructions of jobs within the firm and finally on the diversity of the labor force.

2- The dynamics of modernization and labor force renewal of firms

2-1. The measures of technological and organizational innovations in 1997

The measure of the modernization dynamic of the French firms is based on the survey on Organizational Changes and Computerization conducted in 1997. The COI survey is a group of three business surveys matched with one labor force survey[2]. In this paper, we focus on the

[2] One business survey covers manufacturing and food industries. The Ministry of Industry (Sessi) conducted the survey in the former while the Ministry of Agriculture (Scees) took care of the later, the two others are exploratory surveys in a branch of

business section of the manufacturing sector which has a high response rate (88%). This part of the survey provides information on the adoption of innovative practices and ICTs between 1994 and 1997, the reasons of their adoption, and also the obstacles and the difficulties encountered in their implementation.

At the technological level just like at the organizational level, reconfigurations of firms are the consequence of the adoption of a set of practices. This is why the indicators used in this work aim at taking into account simultaneously of the diversity of the adopted innovative devices (technological and organizational) and their regrouping. Several methods are used to catch the complexity of firm reorganization. For example, Black and Lynch (2001) identify work reorganization through a vector of measures, Osterman (1994) consider that a reorganized firm has adopted at least two new work practices.

For assessing organizational and technological reorganizations with the COI survey, Greenan and Mairesse (1999, 2003) use multiple correspondence analyses (MCA). From a very large group of questions, their indicators synthesize principal dimensions of the NPOs and the ICTs adopted by the companies in 1994 and 1997. Our measurements of the modernity of the configurations of firms are based on the most recent results obtained by Greenan and Mairesse (2004)[3].

To assess the organizational configuration of firms, Greenan and Mairesse use a large set of questions describing the organization of firms at these dates that can be classified into five categories: quality management[4]; management of time constraints[5]; management of transactions within the firm and with the outside[6], evolution of the allocation of responsibilities[7] between management, specialists and production workers, evolution of the internal structure of the firm[8]. These variables and the graphic representation of this MCA are reported in the appendix 1. The first factor resulting from the MCA measures the intensity in the use of NPOs. It explains 14% of the inertia[9]. From the coordinates of firms on this first factor, we split our sample into two categories which each gather 50% of the firms. The first category that represents the firms that use intensively the NPO is noted HO (H for High and O for organizational practices). The other category, noted LO (L for Low), represents traditional firms that have a low use of NPO. In this manner, we determine the organizational configuration of firms (modern HO or traditional LO). We can consider that firms with a modern configuration innovated at the organizational level before 1997.

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commerce (home depots type of stores) and in a branch of business services (accountants) carried out by Insee (National Institute for Statistics and Economic Studies). The labor force survey has been conducted by the Ministry of Labor (Dares). 8812 workers have been interviewed, belonging to 4025 firms with more than fifteen employees in manufacturing and food industries and with more than twenty employees in the service branches.

[3] I thank Nathalie Greenan to have placed these indicators at my disposal.

[4] ISO or EAQF certifications, total quality management, value analysis, functional analysis

[5] Just-in-time production and delivery; total productive maintenance; just-in-time delivery required to suppliers and/or subcontractors.

[6] Organization in profit centers, use of formal in house customer/supplier contracts, outsourcing of functions, sub-contracting of production.

[7] Allocation of responsibilities for ten tasks on the shop floor.

[8] Number of hierarchical levels, number of department.

9 Its singular value is 0.48.

We proceeded in a symmetric way to determine the technological configurations of firms in 1997. The questions synthesized by the MCA of Greenan and Mairesse (2004) are about the type of equipment used by management and production departments of the firm, the intensity of digital transfers inside and outside the firm, the use of Internet, and the organization of the computer department. The first factor resulting from the MCA, which represents 14% of the inertia[10], measures the intensity in the use of ICTs. We noted HI (I for ICT) the firms that have a high use of ICTs and LI those which have a low use. We can consider that firms with a modern configuration innovated at the technological level before 1997.

These synthetic indicators which lead to reason within a binary framework have two advantages. Firstly, they facilitate the comparisons of the configurations of firms which are either "modern" or "traditional". Secondly, the continuous measurement obtained by the first factorial axis is likely to be skewed because of the existence of errors of measurement. Dichotomizing this variable reduces the risks of skews related to these errors of measurement.

These two indicators of technological and organizational innovations are similar to those used in the empirical literature. Indeed, the reorganizations of firms are generally associated to the level reach at a given date (Bresnahan, Brynjolfson and Hitt (2002), Osterman (2000), Greenan (2002), Askenazy and Galbis (2004)). We will keep these indicators to compare our results to the existing literature. In the next section, we will provide a more detailed measurement of the modernization trajectories of firms, that will allow to take into account the timing of the modernization and the coordination of technological and organizational choices realized by the firm.

2-1. An original measure of the modernization of firms

In the same way the survey COI allow to assess the technological and organizational configurations of firms in 1997, it allows to asses these configurations in 1994. We thus determine if the firm had a modern organizational (resp. technological) configuration in 1994. Finally, we crossed the organizational and technological indicators in 1994 and 1997 and obtain four configurations of firms ($CONFIG_{HIHO}$, $CONFIG_{LILO}$, $CONFIG_{LIHO}$, $CONFIG_{HILO}$). Graph 1 gives the distribution of these configurations in 1994 and 1997. The evolution of the proportions of modern ($CONFIG_{HIHO}$) and traditional ($CONFIG_{LILO}$) firms between 1994 and 1997 clearly shows a movement of modernization. This movement of modernization is illustrated in appendix 3 and 4 where we show the diffusion of NPOs and ICTs in 1994 and 1997 synthesized by our indicators.

To measure the modernization trajectory of firms, we have crossed the configurations of firms in 1994 and 1997, as indicated in table 1. This leads to consider potentially sixteen modernization dynamics of firm. The number of dynamics realized in our sample is lower, since a modern firm in 1994 is still modern in 1997, which translates the irreversibility of the technological and organizational changes over our period of observation. That reduces considerably the number of modernization dynamics of firms limiting them to nine. Let us bring some precisions to the notation used. On the diagonal of this matrix, one finds the companies which remained stable, noted S, at the organizational and technological level over the two periods. There are thus four

[10] The singular value is 0.48.

configurations of dynamic stability corresponding to the four possible firms' configurations (SHIHO, SHILO, SLIHO and SLILO). The situations of change in the firms' configurations between 1994 and 1997 are noted Δ (ΔHIDO, ΔHIDO, ΔDIDO, ΔDILO, ΔLIDO). Each of these dynamics is denoted by 4 letters. The situations of change are indicated by the letter D, letters I and O identify if this change relates to technology or the organization. For example, the trajectory ΔDIDO characterizes firms that have changed technological and organizational configurations between 1994 and 1997 at the same time, and ΔHIDO.represents firms that was modern at the technological level in 1994 and that have changed at the organizational level between 1994 and 1997.

Two criteria can be used to describe these modernization dynamics: the coordination of the technological and organizational choices and the stage of diffusion of the ICTs and NPOs. When the firm has at the same time a modern technological and organizational configuration in 1997, we consider that its technological and organizational choices are coordinated. This coordination can take time: it can be carried out before 1994 or between 1994 and 1997. Finally, when it is observed that ICTs (resp. NPOs) were adopted intensively between 1994 and 1997, we regard this period as a phase of introduction of ICTs (resp. NPOs). Conversely, we consider that the firms having an intensive recourse to these ICTs (resp. NPOs) before 1994 are in a stage of diffusion in 1997. Table 2 gives a classification of the modernization dynamics of firms according these criteria.

2-2. The labor force renewal dynamic

The modernization dynamics of firms between 1994 and 1997 that we have just identified measure a change in the short term (three years). Nevertheless, the firm configurations in 1997 are the results of changes that have occurred in the medium term, since the COI survey focuses on organizational practices and technologies which were yet innovating in 1994. To determine the effect of the modernization of firms on their dynamics of labor force renewal, we thus will seek to identify this medium-term dynamics, i.e. over a six years period. The choice of this temporal horizon is justified by the fact that we have in COI a qualitative information on the changes occurred in firms between 1994 and 1997, but the date of their implementation is not specified. Moreover, several studies stress that the effects of the modernization of the companies on the productivity take five to six years (Greenan and Mairesse (2004), Brynjolfsson and Hitt (2003)).

To measure the labor force renewal dynamics in the medium term, we matched the COI survey with the Survey on the Structure of Employment (ESE). The ESE is produced by the Department on the Statistics of Enterprises of INSEE. It is a compulsory administrative declaration which takes the census of the workforce for each establishment and breaks it down by skills. It thus makes it possible to measure the redistributions of jobs within the firm, the skill structure of the firm, the diversity of the occupations. As the ESE is updated every year, we constituted a panel of establishments present in the ESE throughout the period 1990-1996. The workforce retained in the ESE corresponds to the number of workers registered as of December 31st of each year; we thus have the evolution in the labor composition between the beginning of the year 1991 and the beginning of the year 1997.

To measure the skills of workers, some empirical papers oppose direct labor to indirect labor, while others oppose the workers according to the level of education reached. The classification of the workers in the ESE follows the Professions and Socio-economic Categories (PCS) provided by INSEE. It allows crossing these two criteria by subdividing the workers into five groups of skills: executives (subscripted by EXE), white collar worker (WC), middle management (MM) and skilled blue collar workers (SBC) and unskilled blue collar workers. The share of these four groups of skills in the total staff ($P^{EXE}, P^{WC}, P^{MM}, P^{SBC}, P^{UBC}$) of the firm provides its structure of skills. To summarize the information on the structure of skill, we will also distinguish workers according their hierarchical responsibilities, considering that high skilled workers have hierarchical responsibilities $P^{H} = P^{EXE} + P^{MM}$, contrary to other execution workers noted $P^{U} = P^{WC} + P^{SBC} + P^{UBC}$.

In order to take into account a possible substitution between skilled and unskilled workers, we compute two ratios. The first ratio P^{U} / P^{S} will allow assessing the substitution of execution workers by high skilled workers within the firm. The second one, measures the ratio of the unskilled blue collar workers on skilled blue collar workers ($P^{UBC/SBC}$).

Graph 2 represents the average skill structure of firms at the end of 1996. As our sample is focused on manufacturing firms, blue collar workers account for almost 60% of the labor force.

To measure the diversity of skills within the firm, we use the finer classification into 19 skills provided by the ESE. We have set up a synthetic indicator of diversity *DIV* measuring the probability that two observations taken at random in the population belong to different modalities. If N represents the total number of workers in a firm, K the total number of categories of labor and n_k, the size of the modality k (k=1,…..,K), then *DIV* can be expressed as:

$$DIV = \frac{1 - \sum_{k=1}^{K} \left(\frac{n_k}{N} \right)^2}{D_{\max}}$$

The numerator measures the diversity but its value depends on the number of modalities K taken by the variable considered. The denominator, D_{max} neutralizes this effect, thus allowing the comparison of different diversity indicators. D_{max} measures the case of maximum diversity where the N workers are distributed with equal probabilities in the K modalities. In this case, we have N/K workers by modality, thus:

$$D_{\max} = 1 - K\left(\frac{N/K}{N} \right)^2 = \frac{K-1}{K}$$

The diversity indicator varies between 0 and 1, illustrating a continuum of cases ranging from a perfect homogeneity of the labor force to the maximum possible diversity.

The last indicators used in this paper aim at measuring the job flows within the firms. Each firm contributes in two distinct ways to the job flows. First, the net variations in the size of the

workforce imply recourse to the labor market. Second, substitutions of jobs within the firm imply an activation of the internal labor market of the firm. Our measures of job flows include the two types of job flows, by aggregating the created and destroyed jobs within the firm.

To calculate these indicators we distinguish five groups of skills, subscripted *i=1,...,5* (executives, white collar workers, middle management, skilled and unskilled blue collar workers). For each firm, the volume of created jobs (noted CREA) corresponds to the sum of the jobs creations per skill *i,* obtained by calculating the differences in the size of the workforce each year for each skill. In the same way, the volume of destroyed employment (noted DEST) is the aggregation of the destructions by skill i. The sum of volumes of creation and destruction give job flows (noted FLOW). We also calculated the net variation rate which measures the growth in the workforce size. By noting $L^i_{j,t}$ the number of workers of skill i, at date t in the firm j, we have :

$$\begin{cases} CREA_{j,t} = \sum_{\substack{i=1 \\ (L^i_{j,t-1} < L^i_{j,t})}}^{5} (L^i_{j,t} - L^i_{j,t-1}) \\ DEST_{j,t} = \sum_{\substack{i=1 \\ (L^i_{j,t-1} > L^i_{j,t})}}^{5} (L^i_{j,t-1} - L^i_{j,t}) \\ FLOW_{j,t} = CREA_{j,t} + DEST_{j,t} \\ VNET_{j,t} = \sum_{i=1}^{5} (L^i_{j,t} - L^i_{j,t-1}) = CREA_{j,t} - DEST_{j,t} \\ T^{CREA}_{j,t} = \frac{CREA_{j,t}}{(L_{j,t} + L_{j,t-1})/2}, T^{DEST}_{j,t} = \frac{DEST_{j,t}}{(L_{j,t} + L_{j,t-1})/2}, T^{FLOW}_{j,t} = \frac{FLOW_{j,t}}{(L_{j,t} + L_{j,t-1})/2}, T_{j,t} = \frac{VNET_{j,t}}{(L_{j,t} + L_{j,t-1})/2} \end{cases}$$

In our sample, each year, firms create on average 8% of jobs and destroy 9% of them.

The last survey we use in this paper is the annual survey on enterprises (Enquête Annuelle d'Entreprise: EAE) produced by the INSEE. This survey that is produced each years gives information on different accounting results of the firms. More specifically, it allows to measure the evolution of the added value of the firm.

Finally, after the matching of these three surveys (COI, ESE and EAE), our sample represents 2264 industrial firms with more than 50 workers. We provide in the appendix 5, some descriptive statistics of this sample.

3- How do firm renew their workforce when they modernize?

With these indicators, we will now answer the three questions asked in introduction: Is there a skilled bias technological and/or organizational change associated with the firm modernization in French manufacturing firms? Do the companies which are modernized favor the homogeneity or the diversity of their labor force? Do these changes in the composition of labor force induce

creations, destructions of jobs or both at the same time? After having presented the model tested, we will successively answer these questions.

3-1. The empirical methodology

We will test a model which is very close to the one used in studies aiming at highlighting a skilled technological or organizational bias. Let us take the simplest example of a production process based on two types of factors, the skilled labor (L^q) and the unskilled labor (L^u). The technological and organizational changes of the firm *j* are described by a vector noted Z_j. In the case of a Translog cost function, the logarithm of the total cost (noted *C*) depends on the logarithm of the production (*Y*), on organizational and technological choices carried out by firm (Z), on the logarithm of the prices of the various factors (noted respectively w^q and w^u). The share of the wage bill devoted to the workers of skill i (with i=q, u) in the firm j at the date t is noted $S^i_{jt} = \frac{w^i_{jt} L^i_{jt}}{C_{jt}}$. After cost minimization according to Shephard's lemma, we have:

$$(1) \qquad \frac{\partial \ln C_{jt}}{\partial \ln w^i_{jt}} = \frac{w^i_{jt} L^i_{jt}}{C_{jt}} = S^i_{jt} = \alpha_i + \gamma_{ii} \ln w^i_{jt} + \gamma_{ii'} \ln w^{i'}_{jt} + \gamma_{iY} \ln Y_{jt} + \gamma_{iz} Z_{jt}.$$

In this expression, if $i=q$ then $i' =u$ and if $i=u$ then $i' =q$, and α_i is a constant. Coefficients γ_{ii}, $\gamma_{ii'}$ measure the effects of relative changes in the factor prices on S^i_{jt}, γ_{iY} measures the effect of a variation in the production scale, and the vector γ_{iY} measures the impact of the organizational technological changes. This model allows determining whether there is a biased technological and/or organizational change. According to the contexts, the up-skilling trend of skilled work wage bill share could reflect only a quantity phenomenon or also a price effect. In anay case, the implementation of ICTs and/or NPOs requires more skilled workers.

Except of the UK, it appears that in Europe, the skilled biased technological change will mainly affect the skill structure (for example, Mairesse and al (2001) for France, Bratti and Matteucci (2004) for Italy). For example, for the case of France, Mairesse et al (2001) showed that technological and organizational changes don not seem related to productivity and wages dynamics, but are significantly and negatively correlated with the share of blue collar workers. We do not estimate (1) since we do not know the labor costs (w^q and w^u). In our estimates, the dependant variables are the shares of each skill in the total employment ($P^{EXE}, P^{WC}, P^{MM}, P^{SBC}, P^{UBC}$ and P^U), the ratio of execution workers on high skilled worker (P^U / P^H) and the ratio of unskilled blue collar workers on skilled blue collar workers (P^{UBC} / P^{SBC}). In addition, the Z_{jt} vector corresponds to the qualitative variables defined in the previous section. Thus, we estimated a co-variance model. Moreover, we introduce into our regressions a vector indicating the firm size (in logarithm) and its sector (15 industrial sectors are distinguished). We suppose that this vector of variables, allows controlling the differences in the cost of work. The level of output is measured by the added value.

However, this model is likely to pose several problems: non observed heterogeneity and the endogeneity of dynamic of modernization. To avoid these problems and to take into account of the dynamic character of our variables of modernization of the companies, we will explain the variation in each proportion of skills i in firm j, and the variation of ratios over six years (end of 1990-end of 1996). Let us note ΔP_j^i the vector of explained variables.

In the simplest model, we will check if the technological innovation (HI_{97}) and organizational innovation (HO_{97}) introduced before 1997 have an impact on the skill structure of the firm. The first equation that we will estimate is expressed in the following way:

$$\Delta P_j^i = (\alpha^i{}_{10} - \alpha^i{}_{00})HI_{j,97} + (\alpha^i{}_{01} - \alpha^i{}_{00})HO_{j,97} + (\alpha^i{}_{11} - \alpha^i{}_{00})HI_{j,97} * HO_{j,97} + \alpha^i{}_{00}LILO_{j,97} + \beta^i \Delta Y_j + \eta^i SECTOR_j + \lambda^i \ln(size_j) + \varepsilon_j^i \quad (2)$$

In our regressions, LILO represents traditional firms that did not innovate before 1997. They represent the reference group, thus, α_{00} is null. ε is an error term

In the second model, the vector Z is given by the modernization trajectories of the firm. The second equation that we will estimate is expressed in the following way:

$$\begin{aligned}\Delta P_j^i = {} & +(\varphi_{11}^i - \rho_{00}^i)\Delta_{j,DIDO} + (\Phi_{10}^i - \rho_{00}^i)\Delta_{j,DIHO} + (\varphi_{10}^i - \rho_{00}^i)\Delta_{j,DILO} \\ & + (\Phi_{01}^i - \rho_{00}^i)\Delta_{j,HIDO} + (\varphi_{01}^i - \rho_{00}^i)\Delta_{j,LIDO} \\ & + (\rho_{11}^i - \rho_{00}^i)S_{j,HIHO} + (\rho_{10}^i - \rho_{00}^i)S_{j,HILO} + (\rho_{01}^i - \rho_{00}^i)S_{j,LIHO} + \rho_{00}^i S_{j,LILO} + \\ & + \beta^i \Delta Y_j + \eta^i SECTOR_j + \lambda^i \ln(size_j) + \varepsilon_j^i{}'\end{aligned} \quad (3)$$

In our regressions, the dynamics S_{LILO} which represents "traditional" firms was taken as reference. The coefficient which is associated with this dynamic (ρ_{00}) is thus null. Coefficients ρ are associated with trajectories of stable firms between 1994 and 1997 and the coefficients φ (resp. Φ) are associated with trajectories of firms which began (resp. completed) their modernization between 1994 and 1997. These estimated coefficients provide the average deviation from the population of reference of the proportion of *i* skilled workers that is associated with each modernization trajectory.

Implicitly, this equation takes into account non observable variables characterizing the firm and which are constant with time. It allows eliminating the fixed effects in time and corrects possible skews of endogeneity. In the next sections, by testing the equations (2) and (3), we will begin to analyze the impact of firms' modernization dynamics on the evolution of their skill structure and on the changes in the workforce diversity (ΔDIV). We will then study the job flows entailed by such transformations.

3-2. Changes in the labor force composition when firm modernize

The results of the first model these regressions are indicated in table 3 and the results of the second model are indicated in table 4a. Variations in the proportion of each skill group and variation in the labor force diversity between 1990 and 1996 appear in columns. The dynamics of

modernization of firms are indicated in rows. Several dimensions of the modernization can be related to the evolution of the distribution of skills and the diversity of labor force within firms: the nature of the modernization (technological, organizational); the coordination (more or less fast) of the technological and organizational choices; the stage of diffusion of ICTs and NPOs. These dimensions constitute the line of interpretation of our results.

Is there skilled biased technological and/or organizational change?

First of all, in the table 3 we observe that the change of skill structure is sensitive both to the technological and organizational innovations. When firms innovate at the technological level, they increase their share of executives, and when they innovate at the organizational level they decrease significantly their share of white collar and unskilled blue collar workers. We observe a great symmetry in the effects technological and organizational innovations, that both entail a substitution of execution workers by high skilled workers. Moreover, among blue collar workers, organizational innovations seem to imply a substitution of unskilled blue collar workers by skilled blue collar workers. These results confirm the idea of a skilled biased technological and organizational change.

This great symmetry between the effects of the technological and organizational changes on evolution of skill structure is also observed with the evolution of labor force diversity. Indeed, technological and organizational innovations both imply an increase in the skill diversity of labor force. The conclusions of the theoretical models had led us to think that the firm modernization would be accompanied by an increase in the labor force homogeneity. We observe the opposite phenomenon with regard to the evolution of diversity of skills. This means that modernized firms increase the share of the minority categories of workers and decrease the share of the majority ones. The change in the skill structure of firms represents an increase in the labor force diversity.

The results of the table 4a allow a better understanding these first results. We observe that most of the trajectories that imply a high use if ICTs (ΔDIDO, ΔDILO, SHIHO, SHILO) in 1997 are associated to an increase in the evolution of the share of executives. The skilled biased technological change can be the consequence of very different modernization trajectories of firms.

On the contrary, the decrease in the share of white collar and blue collar workers that we observed in table 3, seems mainly due to the trajectory ΔLIDO. This modernization trajectory represents firms that are traditional at the technological level, but that have changed at the organizational level between 1994 and 1997. This trajectory also explains the substitution of unskilled blue collar workers by skilled blue collar workers. It that sense, this result shows that the skilled biased organizational change is mainly due to the introduction of NPOs in traditional firms, at least for production workers.

As in table 3, the table 4a shows a great symmetry in the effect of technological and organizational innovations. If we focus on firm that begin their modernization after 1994 (ΔDIDO, ΔDILO, ΔLIDO), we observe a symmetry in the effects of technological changes and organizational changes. All these trajectories imply an increase in the share of executives and a substitution of execution workers by high skilled workers that are significant. This symmetry is also observed for the firms that are in a situation of transition and have begun their modernization

before 1994 (ΔDIHO and ΔHIDO). The effects are also similar but not significant. On the contrary, when we focus on firms that stabilize their choices, this great symmetry disappears. It leads us to think that ICTs and NPOs could produce very similar effects on the evolution of skill structure in firms that are in a transition situation, while their effects could differ in firms that stabilize their technological and organizational choices.

In summary, firms that significantly substitute execution workers by high skilled workers are all in a situation of transition. They began their process of modernization after 1994. The period 1994-1997 constitutes a stage of introduction of ICTs and NPOs. Moreover, the most significant effects are observed in firms that "begin" a gradual modernization, without coordinating their technological and organizational choices. In the next section, we will check if the coordination of technological and organizational choices and of the stage of diffusion of ICTs and NPOs can explain the evolution in the skill structure.

Coordination of technological and organizational choices and labor force composition

In the last row of table 3 and in table 4b, we calculate the effect of coordination on the evolution of labor force composition. This coordination effect allow to assess if the effect of ICTs and NPOs reinforce each other (or reduce each other) when technological and organizational innovations are implemented conjointly. It can be viewed as a crossed effect between technology and organization. The coordination of technological and organizational can be realized at the beginning of the process of modernization when firms introduce ICTs and NPOs. It can also be realized more gradually, with time.

In the last line of table 3, we observe that the crossed effects (or coordination effect) between technological and organizational innovations are negative. It means that globally, the effect of the technological and organizational innovations are stronger in firms that implement separately these innovations than in firms that coordinate them. This negative effect of coordination on the evolution of skill structure in favor of skilled workers is mainly due to the coordination in the introduction of ICTs and NPOs during 1994-1997 (ΔDIDO). For other firms, the coefficients associated to the effect of coordination are not significant. Nevertheless, they all show a negative effect of the coordination of technological and organizational choices. It means that the implementation of ICTs do not reinforce the effect of NPOs, but reduce it, and vice-versa.

Are skilled biased technological and organizational changes durable or transitory phenomenon?

As argued before, the skilled biased technological and organizational changes could differ in their strength according the stage of diffusion of ICTs and NPOs. In table 4c, we calculate the difference in the effects on the skill structure of introduction and diffusion of ICTs and NPOs to check this assumption. In order to identify the effect of the stage of diffusion of NPOs (resp. ICTs), we have to compare firms that are identical according to their stage of diffusion of ICTs (resp. NPOs), but that differ in their stage of diffusion of NPOs. We can refer to the table 2 to identify the relevant comparisons.

First of all, coefficients are not significant. It means that the diffusion stage of NPOs and ICTs can not explain some differences in the evolution of the skill structure.

Nevertheless, this table can help to see if the effect of ICT and NPOs are stronger during the introduction stage. We know that the implementation of ICTs and NPOs imply a decrease in the share of execution workers (ΔP^U). When the coefficient equals -0.006, it means that the introduction effect is superior to the diffusion effect. We observe that the introduction effects on the evolution of the share of execution workers are superior of the diffusion effects of ICTs and NPOs in firms that do not coordinate their technological and organizational choices. We observe the opposite situation in firms that coordinate their choices.

We have just seen that the modernization of firms impacts the change of the skill structure and the evolution of diversity within the firm between 1990 and 1996. These changes reflect a destabilization movement of labor within the firms which are modernized. Does this movement imply jobs creations, destructions or both and a growth in the workforce? We will answer to these questions in the next section.

3-3. Job reallocations and firm modernization

We will now measure the impact of dynamics of modernization of firms on job flows by taking as dependant variables ΔT^{CREA}, ΔT^{DEST}, ΔT^{FLOW} and ΔT^{VNET} in equation (2) and (3). As in the previous part, our regressions are controlled by variable on size, added value and sector of the firm. The sectorial variables take into account the possible shifts in the activity cycles of the sectors. Furthermore, we add a control variable which indicate whether the first country holder of the capital is French or foreign when the firm belongs to a group. We introduced this variable because we think that the nationality of the majority owners can influence their employment policy when they restructure their labor force. Table 5 and 6a, 6b, 6c provide results of these regressions.

In the previous part, we observe a great symmetry in the impact of technological and organizational innovations on the evolution of skill structure. We do not find this symmetry concerning job flows.

Technological innovation is associated with a decrease in the evolution of job creation destructions and destruction rates (higher job security). They tend to stabilize their labor force. On the contrary, the organizational innovation is associated to a renewal of labor force. They tend to increase job creations and destructions, so that the job flow rate increases. In firms that innovate both at technological and organizational level, the employment security is higher (decrease in the destructions rate) and the job creations increase. The consequence is an increase in the number of workers within the firm. The firms that innovate both at technological and organizational level tend to hire more workers.

Among these trends, only the effects of organizational innovation are significant. As shown in the table 6a, the renewal dynamic of labor force is mainly due to the trajectory SLIHO. These firms innovated at the organizational level before 1994 and did not innovate at the technological level. In these firms, technological innovations have a virtuous impact since they increase job creations and favor new hiring. This virtuous effect of organizational innovations implemented before 1994

is also observed for the dynamic ΔDIHO. These firms have innovated also at the technological level during 1994 to 1997. They provide a higher job security and increase their employment.

In fact, these results show that the effect of the diffusion of NPOs tend to reinforce over time. As shown in the table 6c, the diffusion effect of NPOs on the net variation of employment is stronger than its introduction stage.

4- Conclusion

The literature on the skilled biased technological change and the models of organizational changes explain why firms that modernize also change their labor force composition. We sought, in this paper, to identify the dynamics of renewal of the labor of the firms that modernize. In this perspective, we differentiated the dynamics of modernization of firms according to: the nature of this modernization (technological, organizational), the coordination of the technological and organizational choices in 1997, the diffusion stages of ICTs and NPOs. We then studied the impact of modernization on three dimensions of the labor force renewal dynamics: the skill structure change, the evolution of labor heterogeneity and the job reallocations within the firms.

We find evidence of a skilled biased technological and organizational change for French manufacturing firms on the period 1994-1997. The strength of these skilled biased technological and organizational changes can not be explained by the stage of diffusion of ICTs and NPOs.

Moreover, it appears that the skilled biased organizational change is accompanied by a real renewal of the labor force. In firms that innovated before 1994, a real virtuous circle on employment takes place (increase in job creations and growth of employment).

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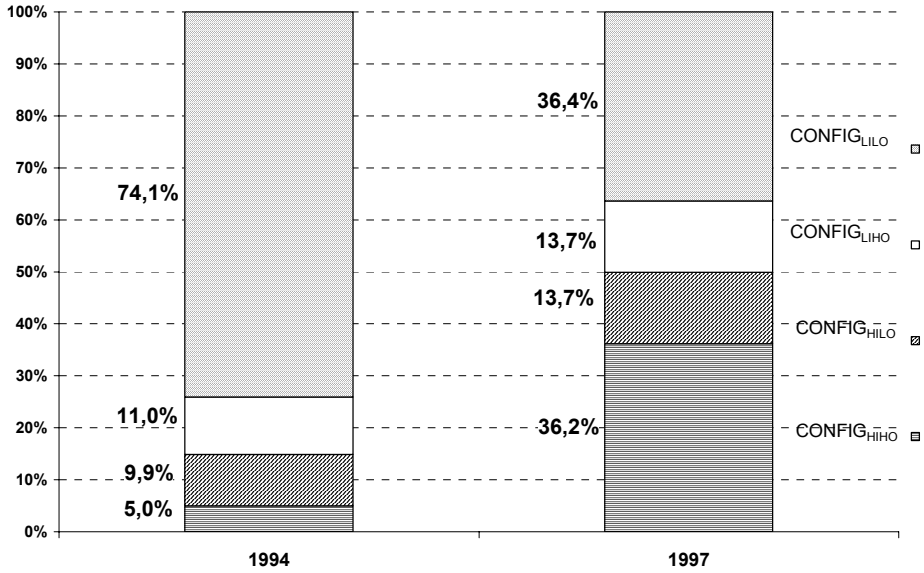
Graph 1: Distribution of firm configurations in 1994 and 1997



Source : Survey COI matched with the survey ESE. Sample of 2431 manufacturing firms with more then 50 employees.

Table 1: Distribution of the modernization dynamics of firms

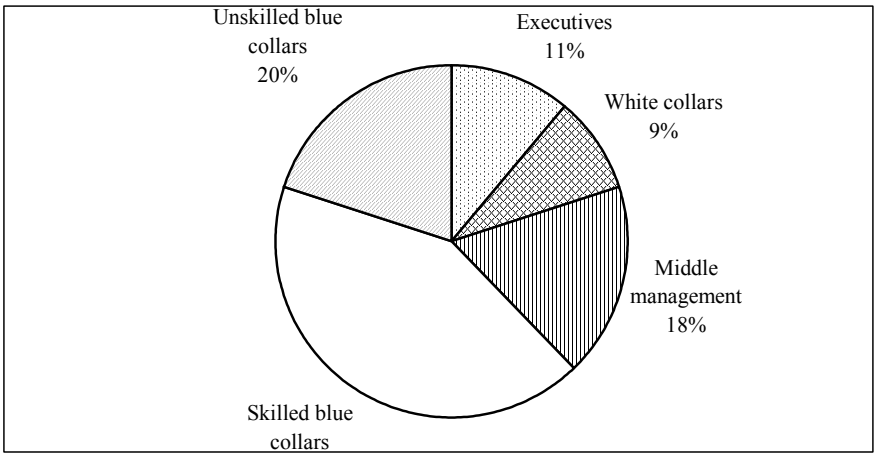
		FIRM CONFIGURATIONS IN 1997				
		$CONFIG_{HIHO}$	$CONFIG_{HILO}$	$CONFIG_{LIHO}$	$CONFIG_{LILO}$	TOTAL
FIRM CONFIGURATIONS IN 1994	$CONFIG_{HIHO}$	4.9% S_{HIHO}				4.9%
	$CONFIG_{HILO}$	6.6% Δ_{HIDO}	3.3% S_{HILO}			9.9%
	$CONFIG_{LIHO}$	7.2% Δ_{HIDO}		3.9% S_{LIHO}		11%
	$CONFIG_{LILO}$	17.4% Δ_{DIDO}	10.5% Δ_{DILO}	9.8% Δ_{LIDO}	36.3% S_{LILO}	74.1%
		36.2%	13.8%	13.7%	36.3%	100%

Source : Survey COI matched with the survey ESE. Sample of 2, 264 manufacturing firms with more then 50 employees.

Tableau 2: Three criteria to distinguish the modernization dynamics

	Diffusion stage between 1994 and 1997		**Coordination of technological and organizational configurations in 1997**
	ICT	***NPO***	
S_{HIHO}	Diffusion	Diffusion	yes
Δ_{DIDO}	Introduction	Introduction	
Δ_{HIDO}	Diffusion	Introduction	
Δ_{DIHO}	Introduction	Diffusion	
Δ_{DILO}	Introduction	Not introduced	no
Δ_{LIDO}	Not introduced	Introduction	
S_{HILO}	Diffusion	Not introduced	
S_{LIHO}	Not introduced	Diffusion	
S_{LILO}	Not introduced	Not introduced	yes

Graph 2: Skill structure of firms



Source : Survey COI matched with the survey ESE. Sample of 2, 264 manufacturing firms with more then 50 employees.

Table 3: Evolution of the labor force composition and innovation within the firms

	ΔP^{EXE}	ΔP^{WC}	ΔP^{MM}	ΔP^{SBC}	ΔP^{UBC}	ΔP^{U}	$\Delta P^{U/H}$	$\Delta P^{UBC/SBC}$	ΔDIV
Intercept	-0.006	0.004	0	0.013	-0.012	0.005	0.001	-0.022	0.016
	(0.006)	(0.006)	(0.008)	(0.018)	(0.017)	(0.009)	(0.015)	(0.023)	(0.014)
Technological innovation (α_{10})	**0.009*****	-0.003	0	-0.006	0	**-0.009***	**-0.018****	-0.002	**0.02*****
	(0.003)	(0.003)	(0.004)	(0.01)	(0.01)	(0.005)	(0.009)	(0.013)	(0.008)
Organizational innovation only (α_{01})	0.005	**-0.007****	0.005	0.013	**-0.016***	**-0.01****	**-0.022*****	**-0.025****	**0.015****
	(0.003)	(0.003)	(0.004)	(0.01)	(0.009)	(0.005)	(0.008)	(0.012)	(0.007)
Technological & organizational (α_{11})	**0.007****	-0.004	-0.001	0.001	-0.003	-0.006	**-0.014***	-0.003	0.008
	(0.003)	(0.003)	(0.004)	(0.009)	(0.009)	(0.005)	(0.008)	(0.012)	(0.007)
No innovation (α_{00})	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Automobile industry	0.005	0.004	0.002	-0.004	-0.008	-0.007	-0.016	-0.002	0.005
	(0.005)	(0.005)	(0.007)	(0.017)	(0.016)	(0.009)	(0.015)	(0.022)	(0.013)
Wood and paper industry	0.001	0.014***	0.002	0.009	-0.026*	-0.003	-0.013	-0.021	0.006
	(0.005)	(0.005)	(0.007)	(0.015)	(0.014)	(0.008)	(0.013)	(0.02)	(0.012)
Pharmacy & perfumery	0.012**	-0.01*	0.017**	-0.007	-0.012	-0.029***	-0.032**	-0.014	-0.003
	(0.005)	(0.005)	(0.008)	(0.017)	(0.016)	(0.009)	(0.015)	(0.022)	(0.013)
Plastic. rubber. chemical industry	0.006*	0.002	0.017***	-0.033***	0.008	-0.023***	-0.038***	0.024	0.021**
	(0.004)	(0.004)	(0.005)	(0.012)	(0.011)	(0.006)	(0.01)	(0.016)	(0.009)
Industry of electric & electronic components	0.018***	0.001	0.015**	-0.013	-0.021	-0.033***	-0.047***	-0.009	0
	(0.004)	(0.004)	(0.006)	(0.014)	(0.013)	(0.007)	(0.012)	(0.018)	(0.011)
Coal, lignite, peat & uranium extraction	0,003	-0.007	0.031*	-0.06	0.033	-0.034*	-0.034	0.066	-0.017
	(0.012)	(0.012)	(0.017)	(0.038)	(0.037)	(0.02)	(0.034)	(0.05)	(0.03)
Printing, copy & publishing industry	0.017***	-0.007	-0.008	-0.016	0.014	-0.009	-0.012	0.023	-0.008
	(0.005)	(0.005)	(0.007)	(0.015)	(0.015)	(0.008)	(0.013)	(0.02)	(0.012)
Industry of electric & electronic equipments	0.04***	-0.005	0.003	-0.038*	0	-0.043***	-0.048***	0.018	-0.003
	(0.007)	(0.007)	(0.009)	(0.021)	(0.02)	(0.011)	(0.018)	(0.028)	(0.016)
Industry of home appliances	0.004	0.013***	0.002	0	-0.019	-0.006	-0.02	-0.016	0.019*
	(0.004)	(0.004)	(0.006)	(0.014)	(0.013)	(0.007)	(0.012)	(0.018)	(0.011)
Machine equipment industry	0.005	0.007*	0.001	-0.012	-0.001	-0.006	-0.009	0.01	-0.008
	(0.004)	(0.004)	(0.005)	(0.012)	(0.011)	(0.006)	(0.01)	(0.015)	(0.009)
Textile industry	0.009*	0.022***	-0.001	-0.044***	0.014	-0.008	-0.017	0.04*	0.02
	(0.005)	(0.005)	(0.007)	(0.016)	(0.015)	(0.008)	(0.014)	(0.021)	(0.012)
Clothing, fur & leather industry	0.003	0.017***	-0.002	-0.027*	0.009	-0.001	-0.011	0.025	0.019*
	(0.005)	(0.005)	(0.007)	(0.015)	(0.014)	(0.007)	(0.013)	(0.019)	(0.011)
Metal working industry	0	0.004	0.012**	0.004	-0.02*	-0.012**	-0.025**	-0.016	-0.001
	(0.004)	(0.004)	(0.005)	(0.012)	(0.011)	(0.006)	(0.01)	(0.015)	(0.009)
Minerals industry	0.009*	0.008*	0.009	-0.028*	0.002	-0.018**	-0.036***	0.022	0.009
	(0.005)	(0.005)	(0.007)	(0.015)	(0.014)	(0.008)	(0.013)	(0.02)	(0.012)
Naval. aeronautic & rail construction	0.008	0.009	0.02**	-0.037**	0	-0.028***	-0.046***	0.022	0.017
	(0.006)	(0.006)	(0.008)	(0.018)	(0.017)	(0.009)	(0.016)	(0.024)	(0.014)
Food processing	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Log (size)	0.001	-0.002**	0.002	0.003	-0.004	-0.003*	-0.004	-0.004	-0.005**
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
r2	0.04	0.04	0.02	0.01	0.01	0.04	0.02	0.01	0.01
Coordination effect (α_{11}-α_{10}-α_{01}+α_{00})	**-0.007***	0.006	-0.006	-0.006	0.013	**0.013***	**0.026****	0.024	**-0.027*****
	(0.004)	(0.004)	(0.006)	(0.013)	(0.013)	(0.007)	(0.012)	(0.017)	(0.01)

Lecture: Variables that are explained are respectively : the evolution in the skill structure (evolution une the share of executives, middle managers, white collars workers, skilled blue and unskilled blue collars workers), the evolution in the part of execution

workers, the substitution of execution workers by executives or middle management, the substitution of unskilled blue collars by skilled blue collars, and the evolution in labor force diversity by the modernization dynamics. All these variables are explained by the innovation within the firm, the sector, the size, and the evolution of added value. The evolution of added value is not significantly correlated to the variables we explain.
The reference population is traditional firms (no technological nor organizational innovation) of food processing industry.
The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2,264 manufacturing firms with more than 50 employees.

Table 4a: Evolution of the labor force composition and modernization trajectory of firms

	ΔP^{EXE}	ΔP^{WC}	ΔP^{MM}	ΔP^{SBC}	ΔP^{UBC}	ΔP^{U}	$\Delta P^{U/H}$	$\Delta P^{UBC/SBC}$	ΔDIV
Intercept	-0.004	0.004	-0.001	0.018	-0.016	0.006	0.001	-0.028	0.018
	(0.006)	(0.006)	(0.008)	(0.018)	(0.017)	(0.009)	(0.016)	(0.024)	(0.014)
Δ_{DIDO} (φ_{11})	**0.007****	-0.003	-0.001	-0.001	-0.002	-0.006	**-0.015***	-0.002	0.01
	(0.003)	(0.003)	(0.004)	(0.01)	(0.01)	(0.005)	(0.009)	(0.013)	(0.008)
Δ_{DIHO} (Φ_{10})	0.005	-0.006	0.001	-0.001	0.002	-0.005	-0.012	0.003	0.002
	(0.004)	(0.004)	(0.006)	(0.013)	(0.012)	(0.007)	(0.011)	(0.017)	(0.01)
Δ_{DILO} (φ_{10})	**0.009****	-0.003	0.002	-0.01	0.002	**-0.01***	**-0.018***	0.003	**0.019****
	(0.003)	(0.003)	(0.005)	(0.011)	(0.01)	(0.006)	(0.01)	(0.014)	(0.008)
Δ_{HIDO} (Φ_{01})	0.007	-0.005	-0.002	0.012	-0.012	-0.005	-0.014	-0.021	0.015
	(0.005)	(0.005)	(0.007)	(0.015)	(0.014)	(0.007)	(0.013)	(0.019)	(0.011)
Δ_{LIDO} (φ_{01})	**0.006***	**-0.007****	0.005	0.016	**-0.021****	**-0.012****	**-0.024*****	**-0.031****	**0.014***
	(0.003)	(0.003)	(0.005)	(0.011)	(0.01)	(0.005)	(0.009)	(0.014)	(0.008)
S_{HIHO} (ρ_{11})	**0.012****	-0.002	-0.006	0.004	-0.008	-0.007	-0.015	-0.009	0.006
	(0.005)	(0.005)	(0.007)	(0.016)	(0.016)	(0.008)	(0.014)	(0.021)	(0.013)
S_{HILO} (ρ_{10})	**0.011****	-0.003	-0.007	0.009	-0.01	-0.004	-0.018	-0.02	**0.024***
	(0.005)	(0.005)	(0.008)	(0.017)	(0.016)	(0.009)	(0.015)	(0.022)	(0.013)
S_{LIHO} (ρ_{01})	0.001	-0.007	0.005	0.005	-0.003	-0.006	-0.016	-0.011	0.019
	(0.005)	(0.005)	(0.007)	(0.016)	(0.015)	(0.008)	(0.014)	(0.021)	(0.012)
S_{LILO} (ρ_{00})	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Sector	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Log (size)	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Δadded value	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
r2	*0.04*	*0.04*	*0.02*	*0.02*	*0.01*	*0.04*	*0.03*	*0.01*	*0.01*

Lecture: The reference population is traditional firms (no technological nor organizational innovation) of food processing industry. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2,264 manufacturing firms with more than 50 employees.

Table 4b: The effect of the coordination of technological and organizational choices on the evolution of labor force composition

	ΔP^{EXE}	ΔP^{WC}	ΔP^{MM}	ΔP^{SBC}	ΔP^{UBC}	ΔP^{U}	$\Delta P^{U/H}$	$\Delta P^{UBC/SBC}$	ΔDIV
Coordination in the introduction of ICTs and NPOs									
Stable firms (ρ_{11}-ρ_{10}-ρ_{01}+ρ_{00})	0 (0.008)	0.008 (0.008)	-0.003 (0.012)	-0.01 (0.026)	0.005 (0.025)	0.003 (0.013)	0.018 (0.023)	0.023 (0.034)	**-0.037*** (0.02)
Firms in transition (φ11-φ01-φ10-ρ00)	**-0.008*** (0.005)	0.007 (0.005)	-0.008 (0.007)	-0.007 (0.016)	0.017 (0.015)	**0.016**** (0.008)	**0.027**** (0.014)	0.026 (0.02)	**-0.023*** (0.012)
Gradual coordination									
Technological change (Φ10-φ10)	-0.004 (0.005)	-0.004 (0.005)	-0.001 (0.006)	0.008 (0.014)	0 (0.014)	0.005 (0.007)	0.006 (0.013)	0.001 (0.019)	-0.016 (0.011)
Organizational change (Φ01-φ01)	0 (0.005)	0.001 (0.005)	-0.007 (0.007)	-0.004 (0.016)	0.009 (0.015)	0.007 (0.008)	0.01 (0.014)	0.01 (0.021)	0.002 (0.012)

Lecture: The coefficient obtained to measure the effect of the coordination of technological and organizational choices are a combination of the coefficient of the table 3a. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2264 manufacturing firms with more than 50 employees.

Table 4c: The effect of the stage of diffusion of NPOs and ICTs on the evolution of labor force composition

	ΔP^{EXE}	ΔP^{WC}	ΔP^{MM}	ΔP^{SBC}	ΔP^{UBC}	ΔP^{U}	$\Delta P^{U/H}$	$\Delta P^{UBC/SBC}$	ΔDIV
Difference in the effect of introduction – diffusion of NPOs and ICT in firms that do not coordinate their choices in 1997									
NPOs (φ_{01}-ρ_{01})	0.005 (0.006)	0.001 (0.006)	0.001 (0.008)	0.011 (0.018)	-0.018 (0.017)	-0.006 (0.009)	-0.008 (0.015)	-0.02 (0.023)	-0.005 (0.014)
ICTs (φ_{10}-ρ_{10})	-0.002 (0.006)	0 (0.006)	0.009 (0.008)	-0.019 (0.018)	0.012 (0.018)	-0.006 (0.009)	-0.001 (0.016)	0.023 (0.024)	-0.006 (0.014)
Difference in the effect of introduction – diffusion of NPOs and ICT in firms that coordinate their choices in 1997									
ICTs+NPOs (φ_{11} – ρ_{11})	-0.006 (0.005)	0 (0.005)	0.005 (0.007)	-0.005 (0.015)	0.006 (0.015)	0.001 (0.008)	0 (0.013)	0.006 (0.02)	0.003 (0.012)
NPOs (Φ_{01} – ρ_{01})	-0.006 (0.006)	-0.003 (0.006)	0.004 (0.008)	0.009 (0.018)	-0.004 (0.017)	0.002 (0.009)	0.001 (0.015)	-0.013 (0.023)	0.009 (0.014)
ICTs (Φ_{10} -ρ_{01})	-0.008 (0.006)	-0.004 (0.006)	0.006 (0.008)	-0.005 (0.017)	0.01 (0.017)	0.001 (0.009)	0.003 (0.015)	0.012 (0.023)	-0.004 (0.014)

Lecture: The coefficient obtained the difference between the effect of the introduction or the diffusion of NPOs and/or ICTs are a combination of the coefficient of the table 3a. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2264 manufacturing firms with more than 50 employees.

Table 5: Jobs flows and innovation within the firm

	ΔT^{FLOW}	ΔT^{CREA}	ΔT^{DEST}	ΔT^{VNET}
Intercept	0.009 (0.033)	-0.012 (0.023)	0.021 (0.019)	-0.033 (0.026)
Technological innovation (α_{10})	-0,015 (0,018)	-0,003 (0,012)	-0,012 (0,01)	0,01 (0,014)
Organizational innovation only (α_{01})	**0.032*** (0.017)	**0.022*** (0.012)	0.009 (0.01)	0.013 (0.014)
Technological & organizational (α_{11})	-0.005 (0.016)	0.009 (0.011)	-0.014 (0.009)	**0.023*** (0.013)
No innovation (α_{00})	*Ref*	*Ref*	*Ref*	*Ref*
Automobile industry	-0.036 (0.031)	-0.017 (0.022)	-0.019 (0.018)	0.002 (0.025)
Wood and paper industry	-0.037 (0.028)	-0.031 (0.02)	-0.006 (0.016)	-0.025 (0.023)
Plastic. rubber. chemical industry	-0.023 (0.024)	-0.016 (0.017)	-0.007 (0.014)	-0.009 (0.019)
Industry of electric & electronic components	-0.055** (0.026)	-0.029 (0.018)	-0.026* (0.015)	-0.003 (0.021)
Coal, lignite, peat & uranium extraction	0.008 (0.067)	0.038 (0.047)	-0.029 (0.039)	0.067 (0.054)
Printing, copy & publishing industry	-0.048 (0.029)	-0.022 (0.02)	-0.026 (0.017)	0.004 (0.023)
Industry of electric & electronic equipments	0.002 (0.039)	0.007 (0.027)	-0.005 (0.023)	0.012 (0.031)
Industry of home appliances	-0.021 (0.027)	-0.022 (0.019)	0 (0.016)	-0.022 (0.021)
Machine equipment industry	-0.016 (0.023)	-0.003 (0.016)	-0.014 (0.013)	0.011 (0.018)
Textile industry	-0.003 (0.03)	-0.019 (0.021)	0.016 (0.017)	-0.034 (0.024)
Clothing, fur & leather industry	-0.038 (0.027)	-0.032* (0.019)	-0.006 (0.016)	-0.026 (0.021)
Metal working industry	-0.034 (0.022)	-0.013 (0.016)	-0.022* (0.013)	0.009 (0.018)
Minerals industry	-0.057** (0.029)	-0.036* (0.02)	-0.02 (0.017)	-0.016 (0.023)
Naval. aeronautic & rail construction	-0.02 (0.033)	-0.024 (0.023)	0.004 (0.019)	-0.028 (0.027)
Pharmacy & perfumery	-0.142*** (0.032)	-0.084*** (0.022)	-0.058*** (0.019)	-0.026 (0.026)
Food processing	*Ref*	*Ref*	*Ref*	*Ref*
Log (size)	-0.001 (0.006)	0 (0.004)	-0.002 (0.004)	0.002 (0.005)
r2	0.02	0.01	0.02	0.01
Coordination effect (α_{11}-α_{10}-α_{01}+α_{00})	-0,022 (0,023)	-0,011 (0,016)	-0,011 (0,014)	-0,01 (0,014)

Lecture: The reference population is traditional firms (no technological nor organizational innovation) of food processing industry. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a

threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%. Controls on country owner and evolution of added value.
Source : Survey COI matched with the survey ESE. Sample of 2,264 manufacturing firms with more than 50 employees.

Table 6a: Evolution of job flows and modernization trajectory of firms

	ΔT^{FLOW}	ΔT^{CREA}	ΔT^{DEST}	ΔT^{VNET}
Intercept	0.003 (0.033)	-0.013 (0.023)	0.017 (0.02)	-0.03 (0.027)
Δ_{DIDO} (φ_{11})	0.003 (0.018)	0.011 (0.012)	-0.008 (0.01)	0.019 (0.014)
Δ_{DIHO} (Φ_{10})	-0.018 (0.023)	0.008 (0.016)	**-0.026*** (0.013)	**0.034*** (0.019)
Δ_{DILO} (φ_{10})	-0.012 (0.019)	-0.001 (0.013)	-0.011 (0.011)	0.01 (0.016)
Δ_{HIDO} (Φ_{01})	-0.012 (0.026)	0.007 (0.018)	-0.019 (0.015)	0.026 (0.021)
Δ_{LIDO} (φ_{01})	0.024 (0.019)	0.012 (0.013)	0.012 (0.011)	0.001 (0.015)
S_{HIHO} (ρ_{11})	-0.018 (0.029)	0.005 (0.02)	-0.023 (0.017)	0.028 (0.023)
S_{HILO} (ρ_{10})	-0.027 (0.03)	-0.009 (0.021)	-0.019 (0.018)	0.01 (0.024)
S_{LIHO} (ρ_{01})	**0.05*** (0.028)	**0.047**** (0.02)	0.002 (0.017)	**0.045**** (0.023)
S_{LILO} (ρ_{00})	*Ref*	*Ref*	*Ref*	*Ref*
Sector	*Yes*	*Yes*	*Yes*	*Yes*
Log (size)	*Yes*	*Yes*	*Yes*	*Yes*
Δadded value	*Yes*	*Yes*	*Yes*	*Yes*
Country owner	Yes	Yes	Yes	Yes
r2	0.02	0.02	0.02	0.01

Lecture: The reference population is traditional firms (no technological nor organizational innovation) of food processing industry, owned by a French group. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%, ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2,264 manufacturing firms with more than 50 employees.

Table 6b: The effect of the coordination of technological and organizational choices on the evolution of job flows

	ΔT^{FLOW}	ΔT^{CREA}	ΔT^{DEST}	ΔT^{VNET}
Coordination in the introduction of ICTs and NPOs				
Stable firms (ρ_{11}-ρ_{10}-ρ_{01}+ρ_{00})	-0.041 (0.046)	-0.034 (0.032)	-0.039 (0.033)	-0.027 (0.037)
Firms in transition (φ11-φ01-φ10-ρ00)	-0.009 (0.027)	-0.001 (0.019)	0.007 (0.02)	0.008 (0.022)
Gradual coordination				
Technological change (Φ10-φ10)	-0.006 (0.026)	0.009 (0.018)	0.013 (0.018)	0.023 (0.021)
Organizational change (Φ01-φ01)	-0.037 (0.028)	-0.006 (0.019)	-0.001 (0.02)	0.026 (0.022)

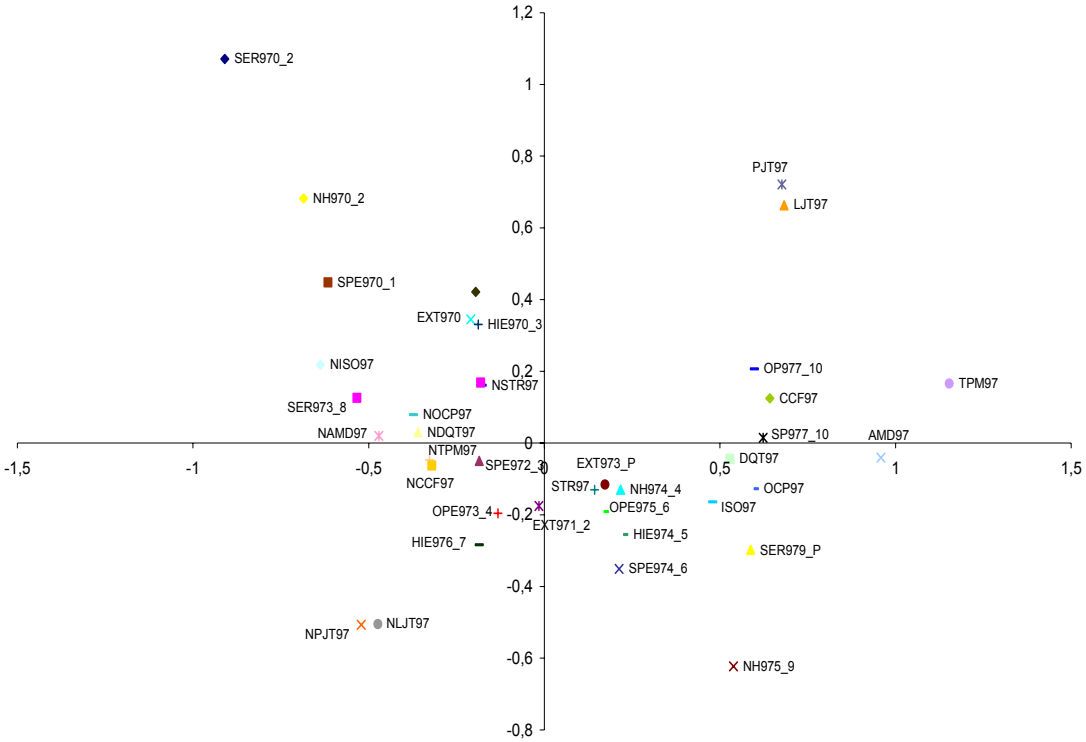
Lecture: The coefficient obtained to measure the effect of the coordination of technological and organizational choices are a combination of the coefficient of the table 6a. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%. ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2264 manufacturing firms with more than 50 employees.

Table 6c: The effect of the stage of diffusion of NPOs and ICTs on the evolution of job flows

	ΔT^{FLOW}	ΔT^{CREA}	ΔT^{DEST}	ΔT^{VNET}
Difference in the effect of introduction – diffusion of NPOs and ICT in firms that do not coordinate their choices in 1997				
NPOs (φ_{01}-ρ_{01})	-0.026 (0.031)	**-0.035** (0.022)	0.009 (0.018)	**-0.044*** (0.025)
ICTs (φ_{10}-ρ_{10})	0.015 (0.032)	0.008 (0.022)	0.008 (0.019)	0 (0.026)
Difference in the effect of introduction – diffusion of NPOs and ICT in firms that coordinate their choices in 1997				
ICTs+NPOs (φ_{11} – ρ_{11})	0.021 (0.027)	0.006 (0.019)	0.015 (0.016)	-0.009 (0.022)
NPOs (Φ_{01} – ρ_{01})	0.006 (0.031)	0.002 (0.021)	0.004 (0.018)	-0.001 (0.025)
ICTs (Φ_{10} -ρ_{01})	0.001 (0.031)	0.003 (0.021)	-0.003 (0.018)	0.006 (0.025)

Lecture: The coefficient obtained the difference between the effect of the introduction or the diffusion of NPOs and/or ICTs are a combination of the coefficient of the table 6a. The figures between brackets are the standard deviations. The coefficients followed by *** are significant with a threshold of 1%. ** significant with a threshold of 5% and * significant with a threshold of 10%. The other coefficients are not significant with a threshold of 10%.
Source : Survey COI matched with the survey ESE. Sample of 2264 manufacturing firms with more than 50 employees.

Appendix 1: The intensity of use of new practices of organization in 1997

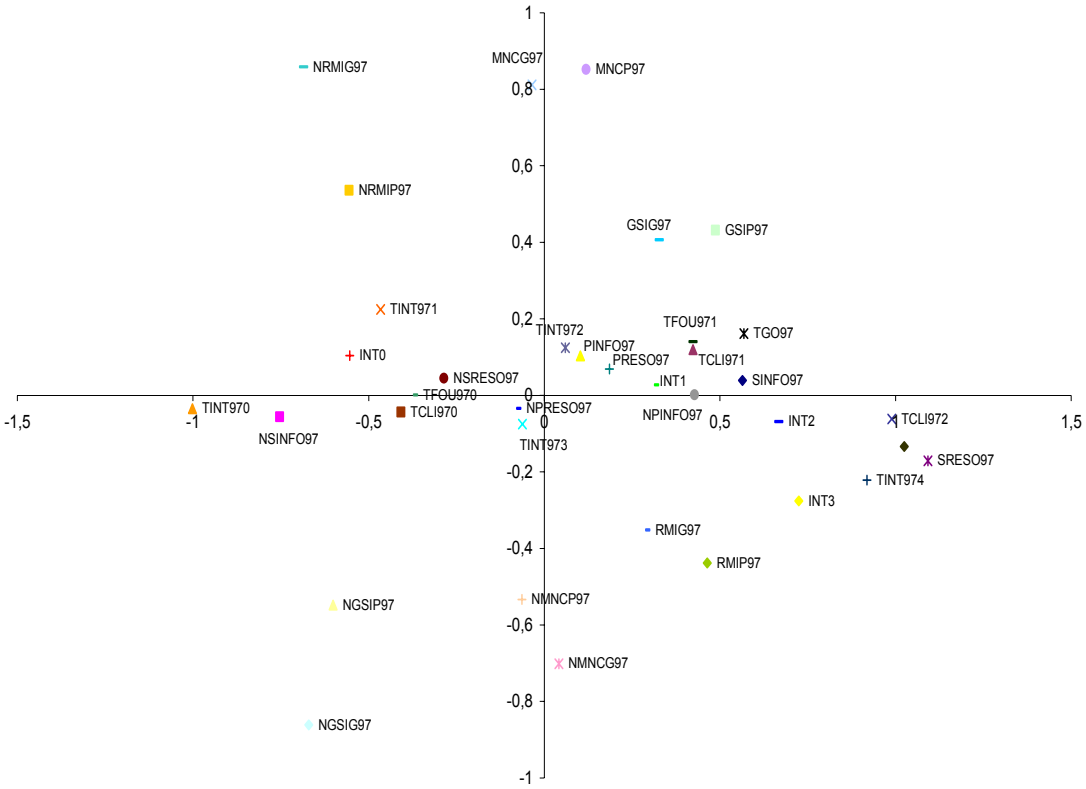


Legend:

- Use of ISO 9001. ISO9002. EAQF certification (ISO97) or not (NISO97)
- Use of other certification or total quality management (DQT97) or not (NDQT97)
- Use of value analysis. functional analysis or AMDEC methods (AMD97) or not (NAMD97)
- Use of a system of just-in-time delivery (LJT97) or not (NLJT97)
- Use of a system of jut-in-time production (PJT97) or not (NPJT97)
- Use of 5 S method or Total Productive Maintenance (TPM97) or not (NTPM97)
- Organization in profit centers (OPC97) or not (NOCP97)
- Use of formal in-house customer/supplier contracts (CCF97) or not (NCCF97)
- Number of outsourced activities : 0 (EXT970); 1 to 2 (EXT971_2); 3 and more (EXT973_P)
- Recourse to sub-contracting to adjust the production to the demand (STR97) or not (NSTR97)
- Number of services (1. Research/development/design; 2. Purchasing; 3. Production engineering/production management/scheduling; 4. Manufacturing/production; 5. Quality assurance; 6. Maintenance; 7. Sales; 8. Marketing/advertising; 9. IT; 10. Telephony/networks; 11. Human resources/staff training; 12. Accounting/management control; 13. Finance/cash management; 14. Legal affairs; 15. Environment/health and Safety): 0 to 2 (SER970_2); 3 to 8 (SER973_8); 9 and more (SER979_P)
- Number of tasks that a category of workers is authorized to do (1. adjust installations; 2. perform 1st level maintenance; 3. allocate tasks to production workers; 4. inspect quality of supplies; 5. inspect quality of production; 6. participate in performance improvements; 7. participate in projects teams; 8. stop production in case of an incident; 9. troubleshoot in case of an incident; 10. start the production again in case of an incident). For managers: 0 to 3 (HIE970_3); 4 to 5 (HIE974_5); 6 to 7 (HIE976_7); 8 to 10 (HIE978_10). For operators: 0 to 2 (OPE970_2); 3 to 4 (OPE973_4); 5 to 6 (OPE975_6); 7 to 10 (OPE977_10). For specialists: 0 to 1 (SPE970_1); 2 to 3 (SPE972_3); 4 to 6 (SPE974_6); 7 to 10 (SPE977_10)
- Numbers of hierarchical layers between production workers (level 0) and the head of company (level N): 0 to 2 (NH970_2); 3 (NH973_3); 4 (NH974_4); 5 to 9 (NH975_9)

Source: Survey COI. Greenan and Mairesse (2004)

Appendix 2: The intensity of use of new practices of ICTs in 1997



Legend:

- The management department (resp. production department) is equipped with a centralized system of terminals (GSIG97 (resp. GSIP97)) or not (NGSIG97 (resp . NGSIP97))
- The management department (resp. production department) is equipped with personal computers (MNCG97 (resp. MNCP97)) or not (NMNCG97 (resp. NMNCP97))
- The management department (resp. production department) is equipped with a network of interconnected computers (RMIG97 (resp. RMIP97)) or not (NRMIG97 (resp. NRMIP97))
- Number of digital internal transfers (1. within the management services like purchasing. sales. marketing. accounting. etc; 2. between the management services and production services like manufacturing. production engineering. production management. etc; 3. between the conception services like research or creation and the production services; 4. within the production services: 0 (TINT970). 1 (TINT971). 2 (TINT972). 3 (TINT973). 4 (TINT974)
- Number of digital transfers with suppliers (1. between the management services and the suppliers; 2. between the conception services and the suppliers; 3. between the production services and the suppliers): 0 (TFOU970). 1 (TFOU971). 2 (TFOU972)
- Number of digital transfers with clients (1. between the management services and the client firms; 2. between the production services and the client firms): 0 (TCLI970). 1 (TCLI971). 2 (TCLI972)
- Digital transfers with social or public organisms (TGO97) or not NTGO97)
- Number of uses of Internet (1. e-mail; 2. search information; 3. diffuse information): no use (INT0). 1 use (INT1). 2 uses (INT2). 3 uses (INT3)
- There is an IT service (SINFO97) or not (NSINFO)
- There is a network and telephony service (SRESO97) or not (NSRESO97)
- The company outsources the IT activities (PINFO97) or not (NPINFO97)
- The company outsources the network and telephony activities (PRESO97) or not (NPRESO97)

Source: Survey COI. Greenan and Mairesse (2004)

Appendix 3: The diffusion of NPOs in 1994 and 1997

	1994	1997
Quality management		
Use ISO 9001. ISO 9002. EAQF certifications	21%	58%
Use of other certification or total quality management	17%	41%
Use of value analysis. functional analysis or AMDEC methods	16%	33%
Management of time constraints		
Use of a system of just-in-time delivery	21%	43%
Use of a system of jut-in-time production	20%	41%
Use of 5 S method or Total Productive Maintenance	7%	22%
Management of transactions		
Organization in profit centers	24%	38%
Use of formal in-house customer/supplier contracts	17%	33%
Number of outsourced activities		
0	38%	29%
1 to 2	36%	32%
3 and more	25%	39%
Recourse to sub-contracting to adjust the production to the demand	37%	56%
Allocation of responsibilities		
Operators		
0 to 2	40%	24%
3 to 4	26%	23%
5 to 6	19%	26%
7 to 10	15%	27%
Specialists		
0 to 1	26%	26%
2 to 3	22%	22%
4 to 6	31%	31%
7 to 10	21%	21%
Managers		
0 to 3	17%	19%
4 to 5	24%	25%
6 to 7	35%	34%
8 to 10	24%	22%
Internal structure of the firm		
Number of services within the firm		
0 to 2	32%	9%
3 to 8	31%	40%
9 and more	26%	51%
Number of hierarchical layers		
0 to 2	20%	21%
3	23%	27%
4	26%	28%
5 to 9	31%	25%
Result of the MCA		
Innovative organizational configuration of firm	16%	50%

Source : Survey COI matched with the survey ESE. Sample of 2431 manufacturing firms with more than 50 employees.

Appendix 4: The computerization of firms in 1994 and1997

	1994	1997
Characteristics of equipments		
The management department is equipped with a centralized system	15%	69%
The production department is equipped with a centralized system	40%	47%
The management department is equipped with personal computers	22%	47%
The production department is equipped with personal computers	34%	36%
The management department is equipped with a network of interconnected computers	32%	71%
The production department is equipped with a network of interconnected computers	22%	49%
Intensité des transferts informatisés de données		
Number of internal digital transfers within the firm		
0	44%	23%
1	17%	16%
2	14%	17%
3	14%	21%
4	11%	23%
Number of digital transfers with suppliers		
0	85%	66%
1	9%	18%
2	6%	8%
Numbers of digital transfers with clients		
0	81%	59%
1	13%	28%
2	5%	13%
Digital transfers with social or public organisms	14%	26%
Usage Internet		
Number of use of Internet		
No use	100%	60
Complex use (3)	0%	13%
Organization of the IT and telephony service		
There is an IT service	35%	59%
Outsourcing of the IT service	23%	42%
There is a network and telephony service	11%	21%
Outsourcing of the network and telephony service	21%	32%
Résultats de l'ACM		
Configurations technologiques d'entreprises innovantes	15%	50%

Source : Survey COI matched with the survey ESE. Sample of 2431 manufacturing firms with more than 50 employees.

Statistics

STAT	MEAN	STD
ΔP^{EXE}	0,012187	0,044726
ΔP^{WC}	-0,00505	0,044634
ΔP^{MM}	0,017147	0,062647
ΔP^{SBC}	0,017692	0,139371
ΔP^{UBC}	-0,04198	0,133443
ΔP^{U}	-0,02933	0,072392
$\Delta P^{U/H}$	-0,05247	0,122568
$\Delta P^{UBC/BC}$	-0,04355	0,1821
ΔDIV	0,001277	0,108049
ΔT^{FLOW}	-0,01931	0,245327
ΔT^{CREA}	-0,01681	0,170413
ΔT^{DEST}	-0,00249	0,143047
ΔT^{VNET}	-0,01432	0,197029