Knowledge Management, Innovation and Productivity: A Firm Level Exploration Based on the French CIS3 Data[1]

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Version : March, 12, 2003

For presentation at the ZEW Workshop: Empirical Economics of Innovation and Patenting. Mannheim, March 14 and 15, 2003

Abstract

Promoting information sharing, motivating employees to stay with the firm, forging partnerships for knowledge acquisition – manufacturing firms are becoming increasingly aware of the need to manage individual and collective knowledge.

The larger the firm and the stronger its connection with technology intensive industry, the more it is likely to set up such policies.

The advantages in terms of innovative and productivity performances deriving from knowledge management are not only explain by firm size, industry or group belonging, specialization or research & development efforts. They persist "all things being equal". It seems, however, that what matters is knowledge management intensity, specific practices being apparently interchangeable in terms of their estimated impact on firm performances.

[1] We are grateful to Dominique Foray and Fred Gault for encouraging us strongly to perform this study and to Kathryn Shaw and participants to NBER Summer Institute and IFS workshop for their comments. We thank SESSI for giving us access to the data.

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Knowledge management (KM) is the management of individual and collective knowledge. With the emergence of the knowledge driven economy, firms are becoming more and more aware of the fact that knowledge is a resource requiring explicit and specific management policies and practices to be processed efficiently. Among other objectives, the role of knowledge management is to foster all types of firm innovation, whether process or product oriented or mainly organizational, and to improve firm productivity and its medium and long term competitive advantage.

As part of the pilot project initiated by OECD and Statistics Canada to study firm KM behavior, Sessi, the statistical Agency of the French ministry of manufacturing industries, has introduced a set of four new questions, specifically relating to important and relatively well defined KM policies, in the French Third Community Innovation Survey (CIS3).[2] They respectively concern the existence in the firm of a written policy (W) of knowledge management, of a culture (C) of knowledge sharing, of a policy of retention (R) of employees and executives, and of alliances (A) and partnerships for knowledge acquisition (*see Box 1*).

In the first section of our exploratory study, we document the diffusion of these four KM policies among the French manufacturing firms in 2000, and that of three other related practices (also surveyed in CIS3). In the second section we provide evidence on the complementarity between the KM policies and introduce an indicator of intensity of knowledge management (KMI). In the third section and in the last one we make an attempt to assess the impact of KM intensity. We look first at four indicators of firm innovative performance, controlling for a number of other factors, and then similarly at firm productivity. We briefly conclude.

I- DIFFUSION OF KNOWLEDGE MANAGEMENT

An increasing concern…

Several factors explain the increasing concern of firms for knowledge management. Firms have to deal with a more complex world because of rapidly changing technologies. Information and communication technologies (ICT) are ubiquitous, creating new needs and making old organizational structures inadequate, facilitating the automation of some tasks and the outsourcing of others, promoting technological watch and improving access to external knowledge. This spreading of ICT requires increased codification and entails the set-up of the appropriate organizational structures.

Firms have to react faster to keep their competitive edge and to be able to build on all or part of their past experience. They are more and more aware of the fact that competencies often rely on individuals or on tacit knowledge special to the company. They are worried about the loss of skills caused by the extreme mobility of their personnel within or outside the company. Companies are striving to motivate their employees and executives to stay with the firm, raising wages and improving career mobility. They are setting up training courses and encouraging professionalism. They are also aware that they cannot maintain and develop their knowledge based only on internal forces. They have to form alliances and partnerships with other firms, competitors as well as suppliers and clients to acquire new knowledge and expertise.

[2] Note that we will indifferently use in what follows the words KM policies, practices or methods or even strategies.

…leading to the adoption of knowledge management practices

Over the past years, firms have adopted different knowledge management practices. In 2000, in manufacturing industries, nearly one out of two have adopted at least one of the four KM policies identified in the French CIS3 questionnaire (*see Box 1*). More precisely, 28% of manufacturing firms with 20 employees or more declared that they have a culture to promote knowledge sharing (C), and almost as many (27%) that they implemented an incentive policy to keep executives and employees in the firm (R). Likewise, 23% of them forged alliances or partnerships for knowledge acquisition (A), and significantly less (17%) put into practice a written knowledge management policy (W).

…especially in large firms

The diffusion of KM policies is much more widespread in large than in small firms (*see Chart 1*). Setting up a special organization is much less critical, and more costly, in smaller firms where information circulates more easily and informal procedures can be efficient. On the other hand, identifying the experts or knowledge holders in the larger firms is a requirement vis-à-vis other employees and working with outside experts is an asset for the company.

In 2000, almost four out of five (80%) of the firms with 2,000 employees or more declared they had a knowledge sharing culture or alliances for knowledge acquisition, while only one out of five (20%) of those with 20 to 49 employees said so. Likewise, adopting a written knowledge management policy is much more frequent in the large firms: one out of two of the firms with 2,000 employees or more had one, and merely one out of ten among the smaller firms.

By contrast, small firms are likely to be more dependent than large firms on the expertise and know how of a few number of their employees, and much more concerned if they leave. That is possibly why the adoption of a policy to retain employees in the firm, even if much less common in the smaller firms than in the larger ones, appears somewhat more frequent relatively to the adoption of the three other ones.

…and in high technology industries

KM policies are also particularly widespread in the high and medium-high tech industries, such as the pharmaceutical industry, aeronautic and space construction or electronic component manufacturing (*see Chart 2)*. In these industries, 40% to 45% of the firms have implemented policies to foster knowledge sharing, to retain employees or to establish partnerships to acquire knowledge, and about 25% have adopted a knowledge written policy. The diffusion of KM policies is twice less advanced in the low tech industries such as clothing and leather, publishing, printing and reproduction, or home equipment.

Knowledge management practices are more frequent in firms implementing new management methods …

From 1998 to 2000, in the manufacturing industries, one out of five firms has implemented new methods of management in the broad sense, that is concerning the different corporate functions and not only knowledge management. This was the case for project-based management that led to the generalization of corporate cross-departmental culture and altered existing working relations. Unsurprisingly, the four KM policies are more widespread in firms that had adopted these new management methods (*see Table 1*). Nearly four out of five (76%) among these firms have also implemented at least one of the four KM policies, while only two out of five (37%) had among the firms which have not adopted new management methods.

… in firms making R&D investments and innovating …

Almost four out of ten manufacturing firms generated product or process innovation from 1998 to 2000, and three out of ten are R&D doing firms. Innovative firms and R&D doing firms are much more intensive users of KM policies. Whatever the practice considered, the implementation is at least double in innovative firms and in R&D doing firms than in non innovative or non R&D firms *(see Table 1)*.

… and in innovating firms that use the Internet and ICT to acquire and share information

Innovating firms use in-house as well as external information sources to foster innovation. They organize the entire company to gain a firmer grasp on the technologies, materials, processes, customers, suppliers or competitors and used institutional information sources, i.e., databases, public research laboratories (with a focus on academic laboratories), seminars, trade fairs and exhibitions.

The Internet and ICT clear the way to accessing data mines. Indeed, 40% of the innovating firms use the Internet, 35% resort to computer resources for knowledge sharing and 25% state that they used both tools. Among this group, three out of five have a knowledge sharing culture and two out of five have a written knowledge management policy. These figures are twice as high as those for the entire manufacturing industry *(see Table 1)*.

II- COMPLEMENTARITY OF KNOWLEDGE MANAGEMENT PRACTICES

Firm adoptions of KM policies are strongly correlated, showing that firms view them as complementary and that the basic reasons of their adoption are similar *(see Table 2)*.[3] Firms which implement one KM policy are more likely to adopt a second one than firms which have not implemented the first one *(see Chart 4 and Table A2 in Appendix)*. For instance, three out of five firms among the 28% which have a knowledge sharing culture, implement an incentive policy to keep employees; one out of two of them develop partnerships to acquire knowledge, and about one out of two have also a written knowledge management policy. On the other hand, among the 72% of firms declaring they did not have a culture of knowledge sharing, one out of eight set up partnerships for knowledge acquisition or implement an incentive policy for employees retention, and fewer than one out of sixteen have a written knowledge policy.

Knowledge management intensity

The intensity of adoption of knowledge management, or knowledge management intensity for short (KMI), is a simple way to take into account the complementarity of the different policies. It is defined to be equal to zero for a firm if the firm implements none of the four KM policies, and respectively to one, two, three or four, if it adopts at least one policy, two, three, or all four policies.[4] KM intensity thus increases strongly with the size of the firm as well as with the industry technology intensiveness (*see Chart 3*). It is of about 2.7 in firms with 2,000

[3] The correlations between the four KM policy indicators remain high even when we control for the various factors of adoption, such as size, industry, and the other control variables we consider in the innovation and productivity equations.

[4] KMI roughly corresponds to the first component in a principal factor analysis (or multiple correspondence analysis) of the correlation matrix (or the contingency table) of the four KM policy indicators.

employees or more as against 0.7 in firms with 20 to 49 employees. Likewise, it is in average of about 1.6 in high-tech industries and of about 0.7 in low-tech intensity industries.

III- KNOWLEDGE MANAGEMENT AND INNOVATION

Simple descriptive statistics show that firms innovate more extensively and file more patents if they set up knowledge management policies *(see Table 3)*.

To estimate the impact of knowledge management practices on innovation performances, controlling, as usual, for several firm's characteristics, four variables are used to measure the innovation output of firms. The first indicator is the propensity to innovate. A second aspect is the innovation intensity, i.e. the share of turnover from new or significantly changed products in the overall turnover of the company. In the same way, the propensity to patent and the patent intensity are considered.

For each measure of innovation performance, almost the same set of control variables is used. We control for company size, industry, belonging to a group, use of new management methods, use of Internet and ICT for external data sharing[5], and R&D intensity, joint with a non R&D indicator.

Firms belonging to a group have a higher propensity to innovate and a higher propensity to patent, every thing being equal. But when firms innovate or patent, belonging to a group does not have a significant impact on the innovation intensity or the patent intensity. Implementing new management methods, doing R&D, and R&D intensity have also a positive effect on innovation performances, every thing being equal *(see Table 3)*.

The impact of knowledge management practices is estimated with three different models. In the first model, the impact of the KM intensity is considered (*see Table 4*). This regression model is tested against two others: one with the four KM indicators alone and one fully interacted. Table 5 gives the tests, and Chart 5 compares the impact of each of the KM indicator on innovation performances.

Finally, whatever company size, industry belonging or group belonging, setting up of new management methods, and research and development efforts, firms innovate more extensively if they roll out more knowledge management policies. Hence all things being equal, the propensity to innovate increases by 4% when knowledge management intensity increases by one. Beyond the mere propensity to innovate, the share of product innovation in company turnover is also impacted by the implementation of several KM policies. The innovation intensity increases by 0.9%.

This finding is not as strong for patent applications and intensity. The KM intensity has a significant impact of 1.6% on the propensity to patent, while the effect is small (+0.9) and not significant on the patent intensity.

Chi2 Tests reject the hypothesis that a model with the four different indicators separately instead of a measure of KM intensity will give better results *(see Table 5)*. So the main message is that innovation performance is as sensitive to the intensity of the use of different practices than to the use of a specific one. What is important, is the awareness of a firm to explicit knowledge management methods.

[5] only in the case of innovation intensity and patent intensity as dependent variables.

Nevertheless, looking at the impact of each practice, all things being equal, gives some more information (Chart 5). The propensity to innovate is significantly higher for firms implementing an incentives policy to keep executives and employees and for companies forging alliances or partnerships for knowledge acquisition. The propensity to innovate is not significantly different for firms setting up a written knowledge management policy.

On the contrary, the innovation intensity is significantly higher (at the 10% level) for firms with a written knowledge management policy, but no significant impact can be shown of the three other KM practices.

The propensity to patent is significantly higher for firms implementing an incentives policy to retain executives and employees. None of the policy has a significant impact on the patent intensity, which is not surprising as the KM intensity variable was not significant either.

IV- KNOWLEDGE MANAGEMENT AND PRODUCTIVITY

Knowledge management also has a positive effect on labor productivity. The same models are tested than for innovation performances. Another control variable is introduced, the physical capital intensity (*Table 4, last column*).

But the tests of the different manners to take into account knowledge management practices tell us something different. The model with KM practices introduced separately is more powerful (*Table 5, last column*) than the model with only the KM intensity variable. More specifically, Chart 6 shows that, all things being equal, firms stating they have a culture to promote knowledge sharing and firms implementing an incentives policy to retain executives and employees have higher labor productivity levels than firms that did not adopt any.

V- TO CONCLUDE

In this first exploratory study of the diffusion and impact on firm performances of four specific KM policies for a large representative sample of French manufacturing firms, we have found not very surprising results and perhaps more surprising ones (at least to us). Among the expected observations, we substantiate the fact that the diffusion of the four KM practices is much more advanced in the larger firms and in the more technology intensive industries, and the fact that these practices appear highly complementary, their adoption being strongly correlated.

Among the less obvious findings, we show that knowledge management intensity, simply defined as the number, varying from zero to four, of KM practices implemented by the firm, has statistically significant impacts on the propensity and intensity to innovate and to patent, and on labor productivity, even controlling for firm size and industry and other important factors such as R&D intensity and physical capital intensity. More surprising perhaps is that KM intensity (that is the cumulative adoption of the specific practices) is what matters and that the specific practices seem interchangeable, their individual not being statistically different. Somewhat surprising also is the finding that the impact of the adoption of these KM practices appears equivalent or larger than the overall impact of the implementation of new management methods in the broad sense.

Further studies are of course needed to confirm, better understand and enrich these first findings. It is clear that our econometric evidence of a significant impact of knowledge management on firm performance does not necessarily mean causality, although such a causal link seems a priori more likely than unlikely, and the order of magnitude of the estimated impact seem economically reasonable.

BOX 1 – Knowledge Management in the Third Community Innovation Survey (CIS3) in French Manufacturing

The Third Community Innovation Survey, which covers the period 1998-2000, was conducted in France jointly by INSEE and the Statistical Departments of the three Ministries respectively in charge of the Manufacturing Industry, Agriculture, and Research. It is a mandatory survey. The Sessi (Service des Etudes et Statistiques Industrielles) was in charge of surveying some 5500 manufacturing firms with 20 employees or more. Firms are chosen randomly, using the business register based on legal units and according to the following stratified sampling design:

- all firms over 500 employees
- 1/2 for firms from 100 to 499 employees
- 1/4 for firms from 50 to 99 employees
- 1/8 for firms from 20 to 49 employees

The rate of response was of 86%, corresponding to an overall coverage of 89% of the total turnover for the manufacturing sector in 2000. See below the note on the weighting of the results presented in this study.

The four questions on Knowledge Management…

Among the 23 questions on knowledge management considered in the pilot survey by Statistics Canada (L. Earl and F. Gault, 2003), the four of them directly referring to the firm policies and strategies have been introduced in the French CIS3 for the manufacturing industries. They are precisely the following:

- By the end of 2000, did your firm have a written knowledge management policy? (WP)
- Did it have a culture to promote knowledge sharing? (CU)
- Did it put into practice an incentive policy to keep employees and executives in firm? (RE)
- Did it forge partnerships or alliances for knowledge acquisition? (AL)

… and three other related ones

The French CIS3 also includes three other questions which can be related to the KM policies. They concern the adoption of new management practices in general and the use of Internet and ICT to acquire and share information for innovation purposes. They are the following:

- From 1998 to 2000, did your company implement new managerial methods?
- Do you use the Internet to acquire information (from the different possible sources, whether internal or external, private or public) for your innovating activities?
- Do employees use ICT resources (data updates, Intranet, and so on) to share information from external sources?

The last two questions on Internet and ICT use were only asked to the innovating firms, that is in accordance to the definitions of the Oslo Manual (OECD, 1997) firms having answered they have introduced new or significantly improved products or production processes during the 1998-2000 period.

Note on the Weighting of Results

The descriptive statistics presented Charts 1 to 4, and Tables 1 to 3 are weighted to be representative of the manufacturing sector (i.e., in order to take into account the differences by size and industry in the sampling and response rates). However, following the prevalent practice, the econometric results given in Charts 5 and 6 and in Tables 4 and 5 are not weighted, but size and industry indicators are introduced in all the regression models. The weighted estimates are not meaningfully different.

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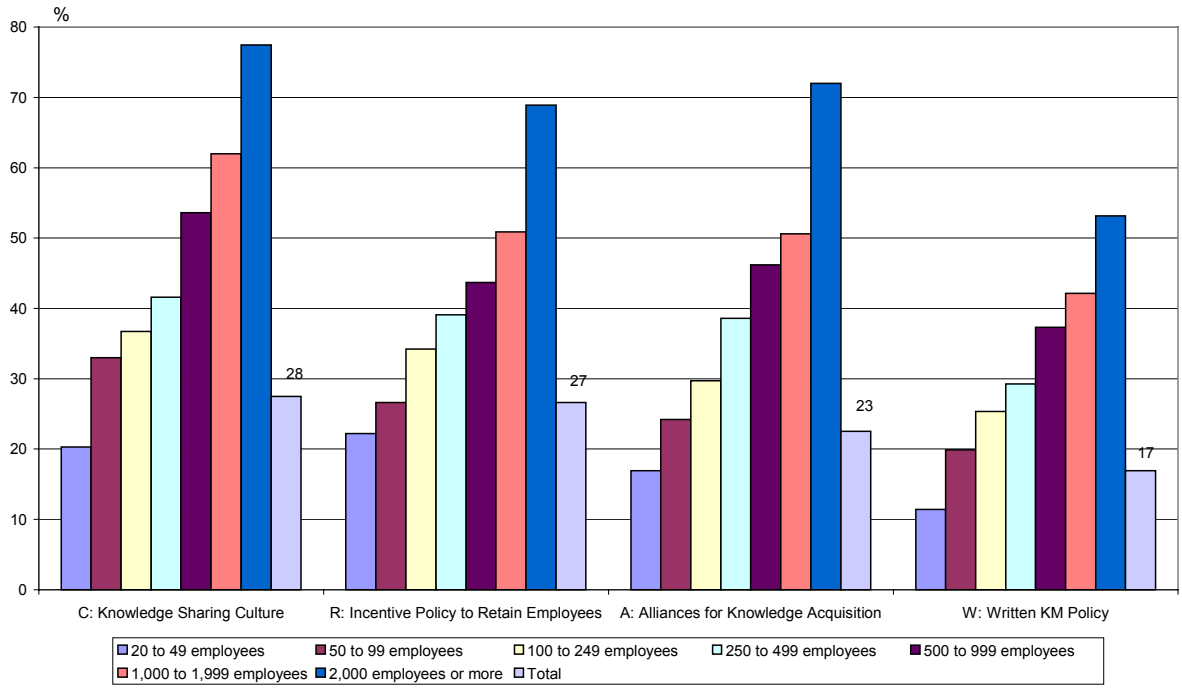
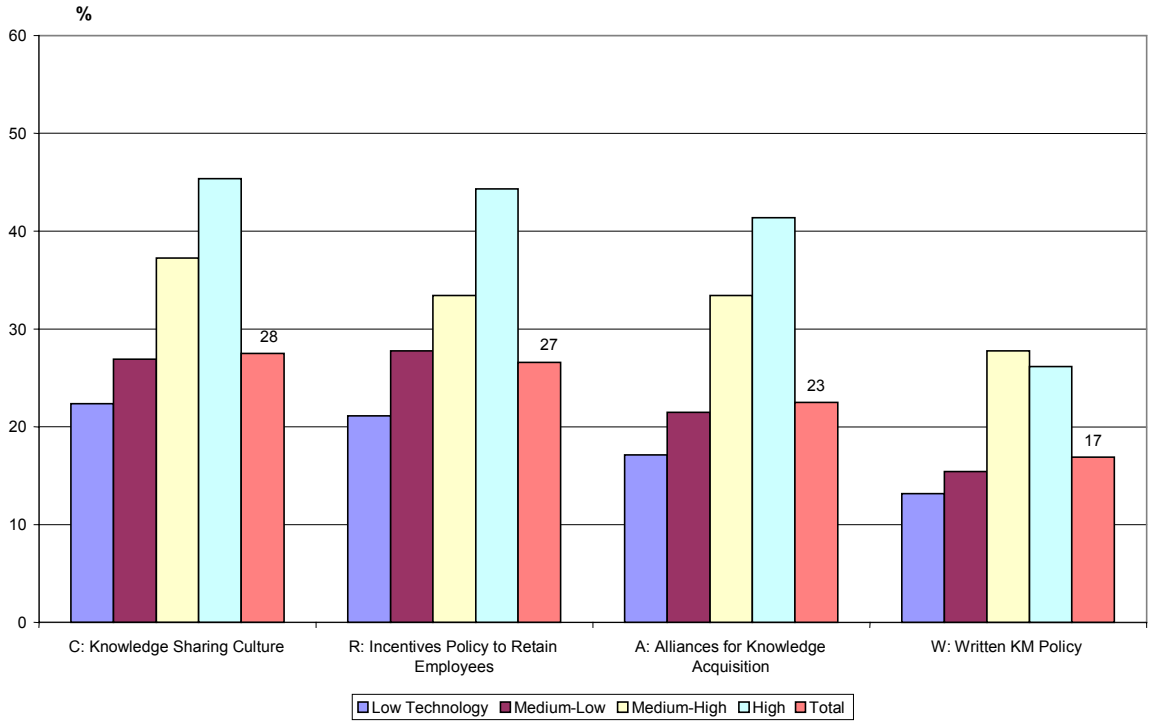
Chart 1: Diffusion of Knowledge Management Practices by Firm Size



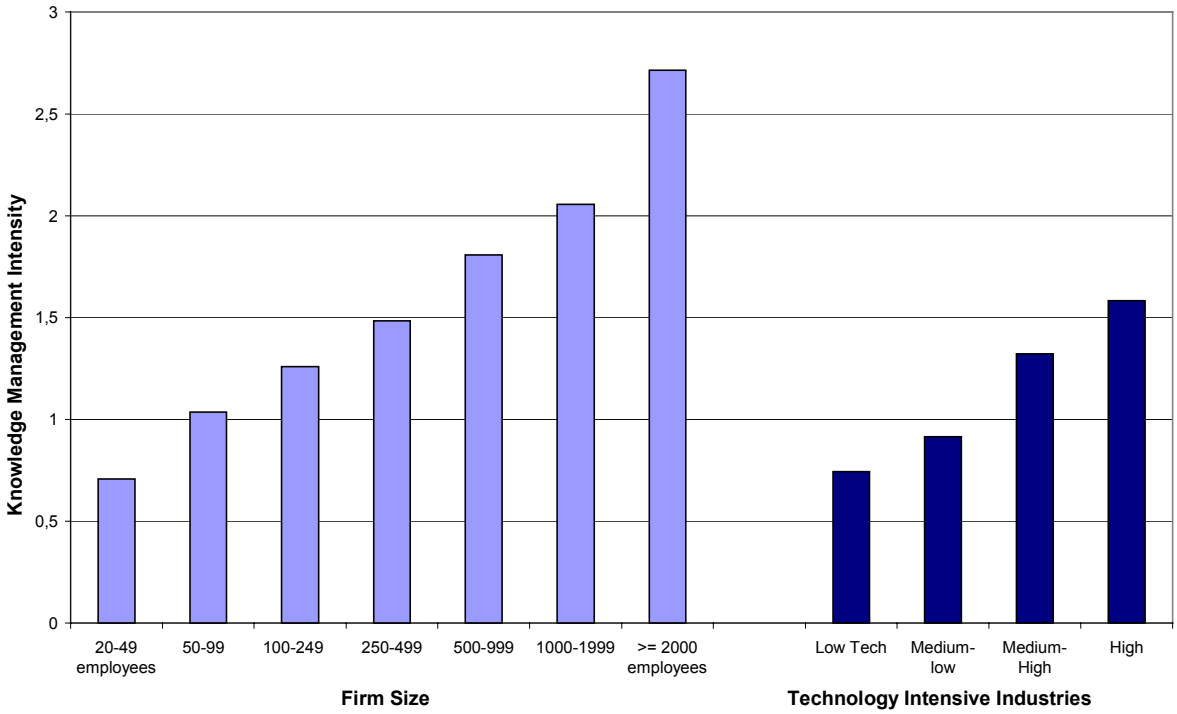
Scope: Manufacturing firms with 20 employees or more (excluding the food industry).
Source: Sessi, CIS3 Survey.

Chart 2: Diffusion of Knowledge Management Practices According to Technology Intensive Industries



Definition: The classification of industries by technological intensity is mainly based on the average ratio of R&D to output of the industry at the CITI rev2 level (OECD, 1997). See Table A1, in appendix.
Scope: Manufacturing firms with 20 employees or more (excluding the food industry).
Source: Sessi, CIS3 Survey.

Chart 3: Knowledge Management Intensity by Size and Technology Intensive Industries



Definitions:
The intensity of knowledge management is equal to zero when the firm implements none of the four KM practices; and to 1, 2, 3 or 4 respectively, when the firm implements at least one, two, three, or all four. The classification of industry by technological intensity is mainly based on the average ratio of R&D to output of the industry at the CITI rev2 level (OECD, 1997). See Table A1, in appendix for some indications about the link between classification of industries by technological intensity and the NES36 classification.
Lecture: Firms with more than 2,000 employees have a knowledge management intensity of 2.7; firms belonging to the high-intensive industries have a knowledge management intensity of 1.6.

Scope: Manufacturing firms with 20 employees or more (excluding the food industry).
Source: Sessi, CIS3 Survey.

Table 1: Diffusion of Knowledge Management Practices, According to the Adoption of New Management Methods, to R&D and Innovating Activities, to Internet and ICT Use

Among	% of firms	% of firms having					KM intensity
		Knowledge Sharing Culture	Incentives Policy to Retain Employees	Alliances for Knowledge Acquisition	Written KM Policy	At least one of the four policies	
All firms		28	27	23	17	45	0.94
Firms having adopted new management methods	21%	51	47	42	29	76	1.69
Firms NOT having adopted new management methods	79%	21	21	17	14	37	0.74
R&D Doing Firms	30%	45	42	39	28	71	1.55
Non R&D Doing Firms	70%	20	20	15	12	34	0.67
Innovating Firms	34%	41	42	38	26	68	1.51
Non Innovating Firms	66%	19	19	14	12	34	0.65
Innovating Firms * using the Internet and ICT for external data sharing	28%	62	56	51	39	82	2.09
Innovating Firms * NOT using the Internet and ICT for external data sharing	68%	37	36	34	21	63	1.28
Firms with patents	20%	40	39	35	26	62	1.40
Firms with no patent	80%	25	24	20	15	41	0.83

Definition
The innovating firms are firms earning a turnover from new or significantly changed products on the market from 1998 to 2000 (in %).
The firms with patents are firms having patented products in 2000 (in %).

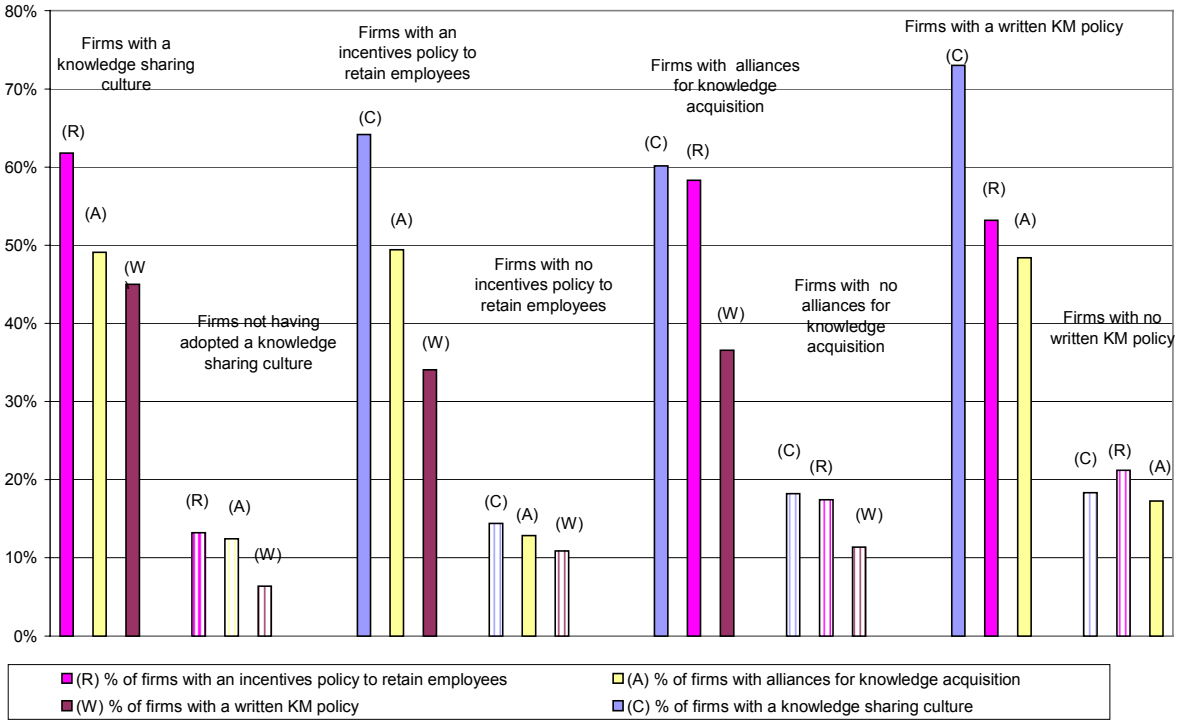
Lecture: 28% of all firms have implemented a knowledge sharing culture; 51% of firms have adopted new management methods and 21% of firms have NOT adopted these methods; etc…
Scope: Manufacturing firms with 20 employees or more (excluding food industry), weighted results.
Source: Sessi, CIS3 Survey.

Table 2: **Correlation between Knowledge Management Practices**

	Knowledge Sharing Culture	Incentives Policy to Retain Employees	Alliances for Knowledge Acquisition	Written KM Policy	At least one of the four policies	KM intensity
Knowledge Sharing Culture	1	0.47	0.40	0.48	0.68	0.81
Incentives Policy to Retain Employees	0.47	1	0.40	0.28	0.66	0.74
Alliances for Knowledge Acquisition	0.40	0.40	1	0.27	0.59	0.71
Written KM Policy	0.48	0.28	0.27	1	0.50	0.68
At least one of the four policies	0.68	0.66	0.59	0.50	1	0.83
KM intensity	0.81	0.74	0.71	0.68	0.83	1

Scope: Manufacturing firms with 20 employees or more (excluding the food industry) weighted results.
Source: Sessi, CIS3 Survey.

Chart 4: Complementarity of Knowledge Management Practices



Lecture: Among the 28% of firms having a culture of knowledge sharing, 62% have an incentive policy to retain employees ,49% have alliances for knowledge acquisition, and 45% a written policy of knowledge management.
Among the 72% of firms NOT having a culture of knowledge sharing, 13% have an incentives policy to retain employees, 12% have alliances for knowledge acquisition, and 6% have a written policy of knowledge management.
Scope: Manufacturing firms with 20 employees or more (excluding the food industry).
Source: Sessi, CIS3 Survey.

Table 3: Descriptive statistics

	Full sample (3 474 firms)	Innovating firms sample (1 635 firms)	Firms with patent products sample (1 125 firms)	Labor Productivity sample (3 419 firms)
Performance variables				
Propensity to innovate	0.4724 (0.008)			
Propensity to patent	0.3217 (0.007)			
Innovation intensity		15.75 (0.412)		
Patent intensity			30.52 (0.912)	
Labor productivity (in K€ per person)				50.56 (0.008)
Explanatory variables				
KM intensity	1.25 (0.023)	1.77 (0.034)	1.78 (0.042)	1.24 (0.023)
Group Indicator	0.72 (0.008)	0.83 (0.009)	0.88 (0.010)	0.72 (0.008)
New management methods Indicator	0.27 (0.008)	0.39 (0.012)	0.34 (0.014)	0.27 (0.008)
Internet and ICT for external data sharing use Indicator	0.21 (0.007)	0.37 (0.012)	0.37 (0.014)	0.21 (0.007)
Non R&D doing Indicator	0.55 (0.008)	0.22 (0.010)	0.25 (0.013)	0.55 (0.008)
Physical Capital Intensity (in K€ per person)				40.45 (0.019)
R&D intensity (in %) (for R&D doing firms)	1.58 (0.040)	1.73 (0.045)	1.98 (0.053)	1.57 (0.041)
Number of R&D doing firms	1 559	1 269	848	1 537

Lecture: standard errors in parenthesis.
Labor productivity, physical capital intensity and R&D intensity are introduced in log on the different models. In this table, for theses three variables, we give the exponential of the mean of the log. The standard error corresponds to the log variable.
Definitions: *The propensity to innovate* variable is measured by the proportion of firms earning a turnover from new or significantly changed products on the market from 1998 to 2000 (in %).
The propensity to patent variable is measured by the proportion of firms having patented products in 2000 (in %).
The innovation intensity variable is measured by the share, in the firm's total turnover in 2000, of the turnover from new or significantly changed products introduced on the market from 1998 to 2000 (in %).
The patent intensity variable is measured by the share, in the firm's total turnover in 2000, of the patented products sales (in %).
The labor Productivity variable is measured by the logarithm of the firm's value added to the total number employees in 2000 (in K€ per person).
The physical capital intensity variable is measured by the logarithm of the firm's gross book value to the total number employees in 2000 (in K€ per person).
The R&D intensity variable is measured by the logarithm of the share of the firm's R&D expenditures in the firm's total turnover in 2000.
The knowledge management intensity variable is measured by the number (from 0 to four)of knowledge management practices implemented by firms (see definition in chart 3).
The group, new management methods, Internet and ICT for external data sharing use, and non R&D doing variables are binary 0-1 indicators (respectively equal to 1 if the firms belong to a group, have adopted new management methods, Internet and ICT for external data sharing use, or are NOT doing R&D).
Scope: manufacturing companies with 20 employees or more (excluding the food industry), not weighted
Source: Sessi, CIS3 Survey

Table 4: Estimated Impacts of Knowledge Management Intensity on Firm Innovation and Productivity, Controlling for Other Relevant Factors

	Propensity to innovate	Propensity to patent	Innovation Intensity	Patent intensity	Labor Productivity
KM intensity	**4.1*** (0.5)**	**1.6*** (0.6)**	**0.9*** (0.3)**	**0.8 (0.7)**	**0.03*** (0.01)**
Intercept	94.5*** (5.3)	96.0*** (5.6)	23.6*** (2.6)	44.3*** (5.4)	4.94*** (0.07)
Group Indicator	3.9** (1.7)	4.7*** (1.8)	-0.5 (1.2)	0.0 (2.9)	0.04*** (0.02)
New management methods Indicator	7.6*** (1.5)	3.2** (1.6)	2.4*** (0.8)	1.9 (1.9)	-0.03* (0.02)
Internet and ICT for external data sharing use Indicator	--	--	0.4 (0.9)	-1.5 (2.0)	--
Non R&D doing Indicator	-57.1*** (3.1)	-41.0*** (3.3)	-4.7*** (1.6)	4.0 (3.7)	-0.14*** (0.03)
Physical Capital Intensity	--	--	--	--	0.15*** (0.01)
R&D intensity	1.5** (0.6)	4.0*** (0.7)	0.8** (0.3)	0.9 (0.7)	0.016** (0.01)
R^2	0.436	0.275	0.100	0.121	0.321
Root MSE	37.6	40.0	16.0	29.3	0.394
Number of firms	3 474	3 474	1 635	1 125	3 419
Mean of left hand variable	47.1%	32.4%	15.8%	30.5%	5.64

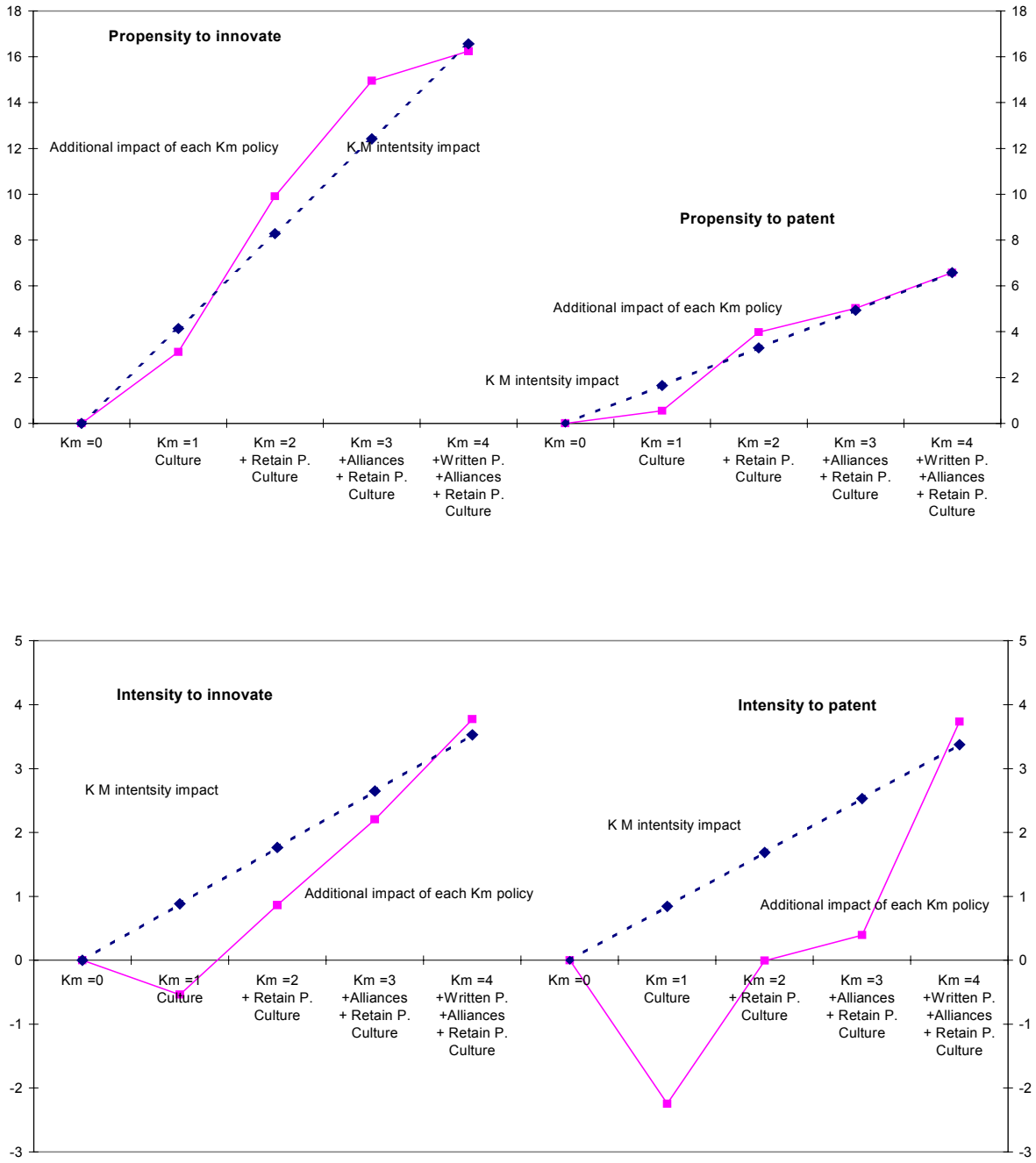
Definitions: see table 3.
Lecture :
Estimated standard errors of estimated coefficients in parenthesis. ***, **, and * respectively indicate that the estimated coefficient is statistically significant at the 1%, 5% or 10% confidence level.
All regressions also include *14 industry indicators* and *7 firm size indicators*.
Scope: manufacturing companies with 20 employees or more (excluding the food industry), not weighted
Source: Sessi, CIS3 Survey

Table 5: Test of the Regression Model with Knowledge Management Intensity Against Regression Models with the Four Indicators Alone and Fully Interacted

Test against the regression model with the four KM indicators	Propensity to innovate	Propensity to patent	Innovation Intensity	Patent intensity	Productivity
Alone					
- Chi2(n)	6.2 (3)	1.3 (3)	2.5 (3)	3.0 (3)	13.9 (3)
- P-value in %	10%	74%	48%	40%	00%
Fully interacted					
- Chi2(n)	23.4 (14)	12.5 (14)	15.7 (14)	15.1 (14)	20.7 (14)
P-value in %	5%	57%	33%	37%	11%

Definitions: See table 4.
Lecture: Two other models are tested against the model presented in Table 4. The first one introduces a dummy for each of the four KM policies, instead of the KM intensity. The second one adds all the interactions possible between these four dummies.
Number of degrees of freedom are given in parentheses.
Scope: manufacturing companies with 20 employees or more (excluding the food industry), not weighted
Source: Sessi, CIS3 Survey

Chart 5: Impacts of Knowledge Management Practices on Innovation Performances, "all other things being equal"

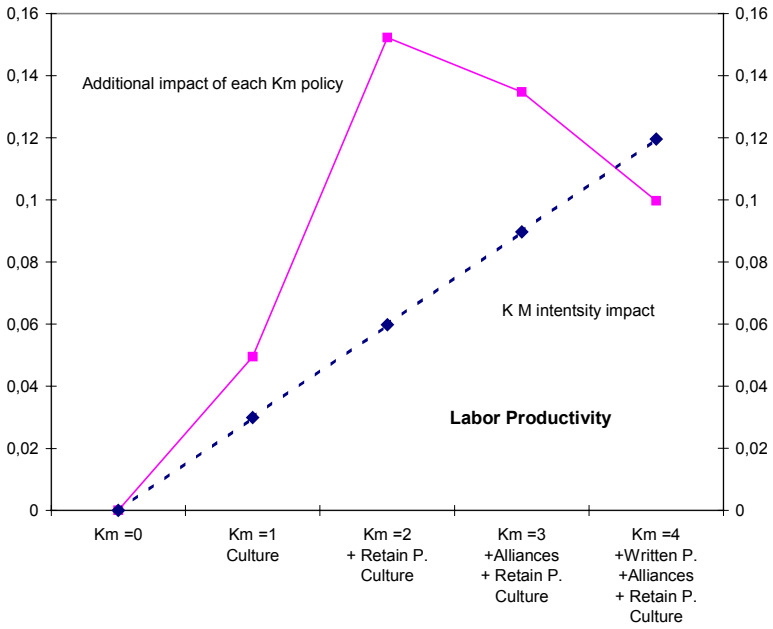


Definitions: See Table 3.
Lecture: The chart illustrates, for each innovation performance variable, the estimated impacts of the adoption of the KM practices,

- in the case of regression model using the KM intensity variable, varying from 0 to 4: **see dotted straight line** (results from Table 4),
- and in the case of the regression model using the four KM indicators, going from 0 to 1, in the following order: KM Culture (C), KM Retention policy (R), KM Alliance policy (A), KM Written policy (W) -where this order is in fact irrelevant: **see continuous line**.

Scope: Manufacturing firms with 20 employees or more (excluding the food industry), not weighted
Source: Sessi, CIS3 Survey

Chart 6: Impacts of Knowledge Management Practices on Labor Productivity, "all other things being equal"



Definitions: See Table 3.
Lecture: The chart illustrates the estimated impacts of the adoption of the KM practices on labor productivity,

- in the case of regression model using the KM intensity variable, varying from 0 to 4: **see dotted straight line** (results from Table 4),
- and in the case of the regression model using the four KM indicators, going from 0 to 1, in the following order: KM Culture (C), KM Retention policy (R), KM Alliance policy (A), KM Written policy (W) -where this order is in fact irrelevant: **see continuous line**.

Scope: Manufacturing firms with 20 employees or more (excluding the food industry), not weighted
Source: Sessi, CIS3 Survey

Appendix

Table A1: Diffusion of Knowledge Management Practices by Industry

Industries by NES36 classification	% of Firms per industry having set up Knowledge Sharing Culture	Incentives Policy to Retain Employees	Alliances for Knowledge Acquisition	Written Knowledge Management Policy	Knowledge Management Intensity
Consumer Goods Industry	**21**	**23**	**19**	**11**	**0.73**
Clothing and Leather Products *(LT)*	8	14	8	4	0.34
Publishing, Printing and Reproduction *(LT)*	23	21	17	9	0.70
Pharmaceuticals, Fragrances and Cleaning Products *(MH & HT)*	40	39	37	28	1.46
Home equipment *(LT, ML, MH & HT)*	21	26	22	12	0.81
Automobile Industry *(ML & MH)*	**33**	**32**	**20**	**24**	**1.08**
Capital Goods Industry	**31**	**32**	**27**	**18**	**1.07**
Shipbuilding, Aircraft and Railroad Construction *(ML & HT)*	46	28	34	28	1.37
Mechanical Engineering Products *(ML & MH)*	25	29	21	14	0.89
Electric and Electronic Components *(MH & HT)*	44	40	40	27	1.50
Intermediate Goods Industry	**29**	**26**	**23**	**9**	**0.96**
Mineral Products *(LT & ML)*	27	27	18	13	0.85
Textiles *(LT)*	25	19	19	12	0.75
Wood and Paper Industry *(LT)*	27	20	18	15	0.79
Chemicals, Rubber & Plastics *(ML & MH)*	36	31	30	27	1.23
Metal Processing & Metalworking *(LT & ML)*	27	24	21	19	0.91
Electric and Electronic Equipment *(MH & HT)*	32	33	31	22	1.18

Definition:
This table is based on the NES36 classification. The classification of industry by technological intensity is mainly based on the average ratio of R&D to output of the industry at the CITI rev2 level (OECD, 1997). A approximate correspondence to the NES114 is possible but not to the NES36, the NES36 industries containing sub- industries of different technological intensity. To give a hint of the degree of technological intensity of the NES36 industries, the existence of sub-industry of different technological intensity is indicated in parentheses.
Scope: Manufacturing firms with 20 employees or more (excluding the food industry), weighted results.
Source: Sessi, CIS3 Survey.

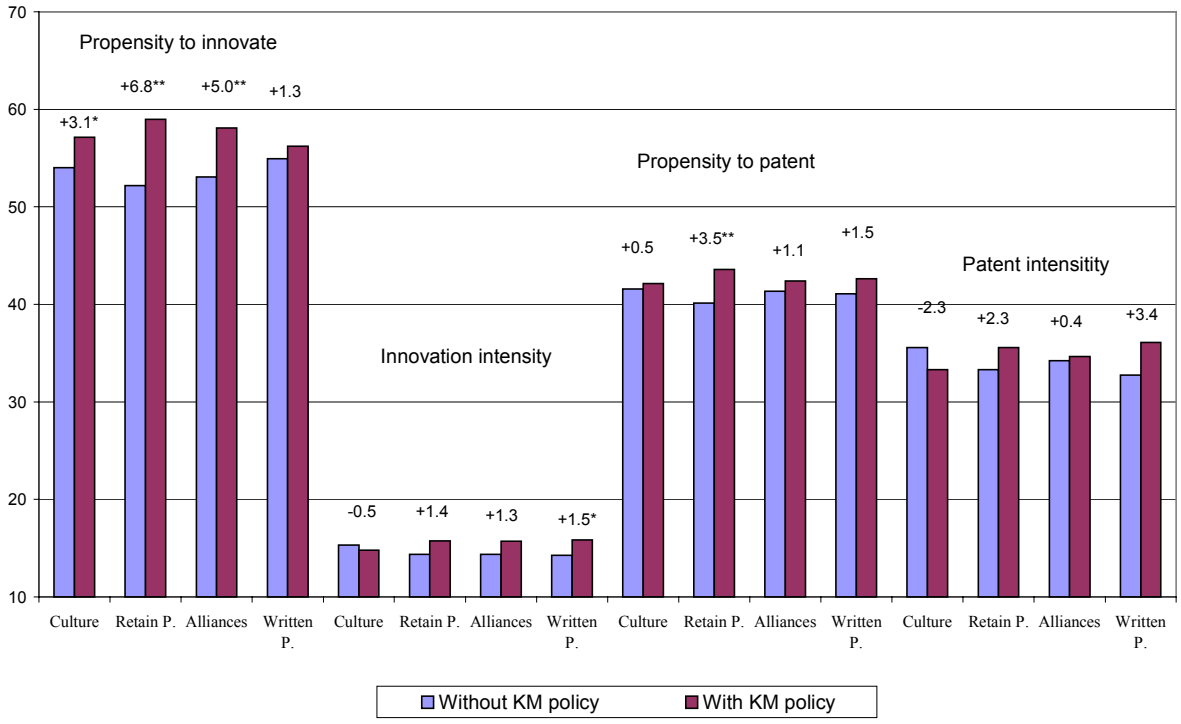
Table A 2: Complementarity of Knowledge Management Practices

	in % of firms having			
	Knowledge Sharing Culture (28%)	Incentives Policy to Retain Employees (27%)	Alliances for Knowledge Acquisition (23%)	Written Knowledge Management Policy (17%)
% of Firms Having				
Knowledge Sharing Culture	100	64	60	73
Incentives Policy to Retain Employees	62	100	58	53
Alliances for Knowledge Acquisition	49	49	100	48
Written Knowledge Management Policy	45	34	37	100

	In % of Firms NOT having			
	Knowledge Sharing Culture (72%)	Incentives Policy to Retain Employees (73%)	Alliances for Knowledge Acquisition (77%)	Written Knowledge Management Policy (83%)
% of Firms Having				
Knowledge Sharing Culture	0	14	18	18
Incentives Policy to Retain Employees	13	0	17	21
Alliances for Knowledge Acquisition	12	13	0	17
Written Knowledge Management Policy	6	11	11	0

Lecture: Among the 28% of firms having a culture of knowledge sharing, 62% have an incentive policy to retain employees ,49% have alliances for knowledge acquisition, and 45% a written policy of knowledge management.
Among the 72% of firms NOT having a culture of knowledge sharing, 13% have an incentives policy to retain employees, 12% have alliances for knowledge acquisition, and 6% have a written policy of knowledge management.
Scope: Manufacturing firms with 20 employees or more (excluding the food industry).
Source: Sessi, CIS3 Survey.

Chart A 1: Impact of each Knowledge Management Policy on Innovation Performances "all other things being equal"

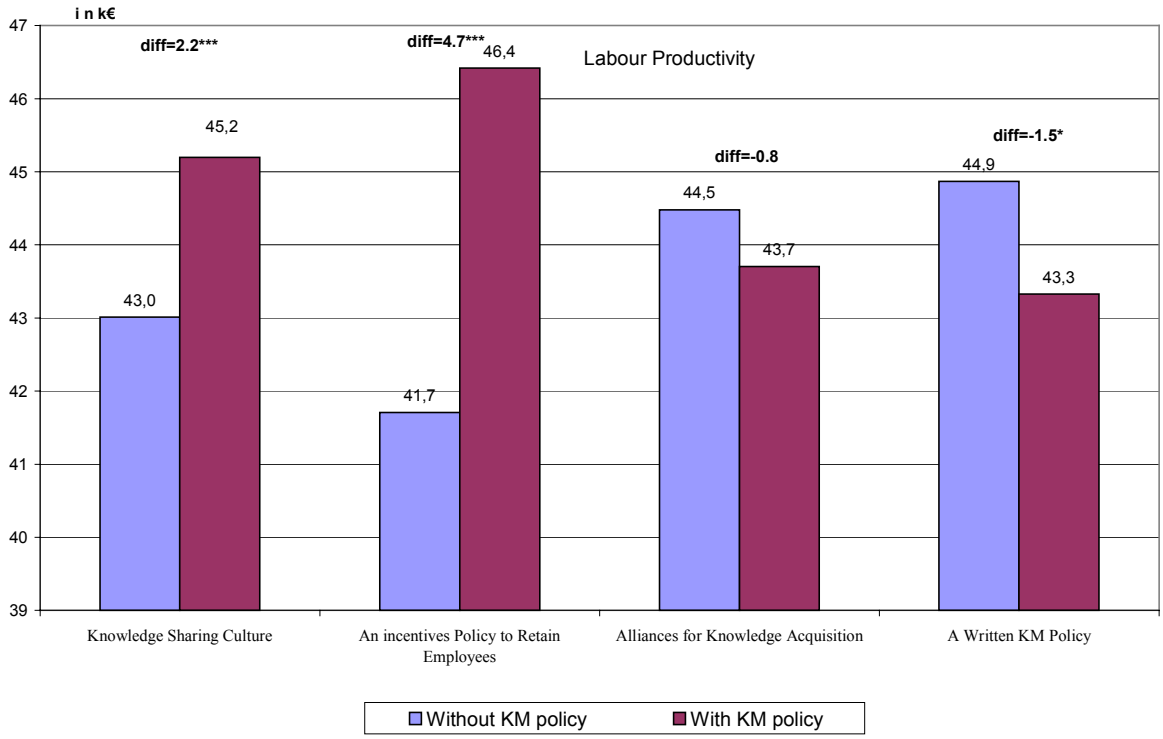


Definitions:
The propensity to innovate is measured by the proportion of firms earning a turnover from new or significantly changed products on the market from 1998 to 2000 (in %).
The propensity to patent is measured by the proportion of firms having patented products in 2000 (in %).
The innovation intensity is measured by the share, in the firm's total turnover in 2000, of the turnover from new or significantly changed products introduced on the market from 1998 to 2000 (in %).
The patent intensity is measured by the share, in the firm's total turnover in 2000, of the patented products sales (in %).
Measures: Means are computed "all things being equal", controlling for size, industry (French classification of activities and products (NAF36)), group belonging, R&D expenditure effort, new management methods indicator, Internet and ICT for external data sharing indicator and the four KM indicators.

The variance analysis makes it possible to calculate the average of each performance indicator for two sub groups based on the assumption of the equal distribution of firms per class for each of the variables controlled for.
Lecture: all things being equal, the companies without any knowledge sharing culture have a 54% propensity to innovate, while the firms with a knowledge sharing culture have a 57.1% propensity to innovate. This difference is significant at the 10% level.
** significant at the 5% level
* significant at the 10% level

Scope: manufacturing companies with 20 employees or more (excluding the food industry) , not weighted
Source: Sessi, CIS3 Survey

Chart A 2: Impact of each Knowledge Management Policy on Labor Productivity "all other things being equal"



Definitions:
The labor Productivity is measured by the logarithm of the firm's value added to the total number employees in 2000 (in K€ per person).

Measures: Means are computed "all things being equal", controlling for size, industry (French classification of activities and products (NAF36)), group belonging, R&D expenditure effort, new management methods indicator, Internet and ICT for external data sharing indicator and the four KM indicators.

The variance analysis makes it possible to calculate the average of each performance indicator for two sub groups based on the assumption of the equal distribution of firms per class for each of the variables controlled for.

The model is estimated with the log of the labor productivity, and the log of the capital intensity is introduced as an explanatory variable. For the graph purpose, it is then converted in K€ per person.

Lecture: all things being equal, the companies without any knowledge sharing culture have a labor productivity of 43.0 K€, while the firms with a knowledge sharing culture have a labor productivity of 45.2 K€.
** The difference are significant at the 5% level for firms having set up Knowledge Sharing Culture and Incentives Policy to retain Employees.
Scope: manufacturing companies with 20 employees or more (excluding the food industry) , not weighted
Source: Sessi, CIS3 Survey