

Enriching the indicator base for the economics of knowledge¹

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This paper addresses the issue of indicators development that aims at providing a broad and deep measurement base on which research in the « economics of knowledge » can prosper. While initial quantification attempts in the area of the knowledge economy proceeded from both national accounting (Machlup, 1962) and growth accounting (Abramovitz and David, 2001), the use of indicators that have a direct bearing on knowledge (Jaffe and Trajtenberg, 2002) is becoming progressively the dominant approach. There is no summation (or composite value), as in accounting, but a collection of available statistics on several dimensions of knowledge, such as scientific and technological knowledge, innovations' inputs and outputs or organizational practices². The strength of this latter approach is that, conditional upon the quality of the indicators, it allows a true grasp of the phenomena of knowledge and innovation which are being considered.

Economics of knowledge is now exactly at the point where it can become a strong empirically disciplined science depending upon whether enough progress can be made on developing the underlying data and ensuing indicators. This paper argues that the economics of knowledge is at the crossroads and uses the development of knowledge management indicators as an example.

The pre-history of knowledge management indicators

Knowledge management (KM) is generally considered as a set of new organizational practices, which seems to be of wide relevance in the knowledge economy. Knowledge management deals with any intentional set of practices and processes designed to optimize the use of knowledge, i.e. to increase allocative efficiency in the area of knowledge production, distribution and use.

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² - See Godin (2007) for the development of this classification regarding different approaches to “measure knowledge”

Our knowledge about KM is extremely limited (or was limited at the time when some statisticians, economists and analysts started to be interested in studying the phenomenon). This knowledge mainly consisted of anecdotal evidence, success stories and a few business studies done by consulting companies.

I am quoting here some of the success stories that first started to attract attention as they were diffused through the publication of articles in business journals and some emblematic books, such as the famous “Working Knowledge” by Davenport and Prusak (1998):

“At Hoffman-Laroche a knowledge management initiative in 1993-1994 reformed the process of developing new drug application, the voluminous, complex documents that must be submitted to the FDA before any new drug can be approved and brought to market. In significant measure because of the initiative, applications and approval for several new products now take many months less than the usual time to complete, at a savings of \$ 1 million per day.”

“At Hewlett-Packard, the amount of product knowledge required to effectively use and support complex computer products has exploded. So in 1995, the company implemented a knowledge management tool called “case-based reasoning” to capture technical support knowledge and make it available to personnel around the world”

In their introduction, Davenport and Prusak claim that KM is a great source of competitive advantages, enhancing both the efficient allocation of this precious resource and the innovation capacities of companies. May-be they are right, may-be not! Who knows? There is a lot of money on the table to be made by consultants and gurus who are very quick to say that KM is the unique solution to all problems you meet in the daily operations of your company³!

Economists usually like to know a bit more about a new practice or a new technology which starts to be widely diffused in the economy. Since many firms are spending money on KM, one would expect that they are getting something in return. But spending money on “something” is hardly a good predictor of the returns of this “something”. How do economists know if KM is more than a fashionable social technology when there is no evidence that implementing KM is efficacious? Is KM no more than a new managerial discourse used to renew the grounds for motivation and commitments for those who participate in the capitalist enterprise (Boltanski and Chiapello, 1999) or is it an effective organizational innovation that has the potential to increase labor productivity?

As Wittgenstein wrote in one of his most famous books: *“the atmosphere surrounding this problem is dreadful and horrifying. Thick and dense clouds shade the crucial points. They are almost impossible to reach”*.

³ - This is of course not a reference to Davenport and Prusak who have written a useful book; that articulates very well their deep knowledge, experiences and practices in this area.

To answer these questions, economists have to design an applied research program involving obviously the building of indicators. The quest for a broader and more systematic empirical material relating to knowledge management is proceeding from step one to step four:

- preconception: it is necessary to look at the literature in order to see whether there are economic reasons to manage knowledge. The idea is to search for and articulate stylized facts about knowledge as a commodity to see whether there is a good economic case for a rationale private agent to invest in KM;
- data collection: we need data to highlight the various dimensions of the phenomenon. This is a crucial issue: one special feature of the economics of technical change, innovation and knowledge is that – as M. Trajtenberg (1990) put it very well – it calls for large amounts of data, much of it rather unconventional for economists. This feature reflects both objective econometric requirements and the conviction that if we truly want to grasp the phenomena of knowledge and innovation, we have no choice but to seek data that have a direct bearing on such phenomena. This is less obvious than it sounds: economists are reluctant to engage in raw data collection, trying instead to overcome the scarcity of data with econometric ingenuity (incentives in the profession are set accordingly); the prevailing conception of legitimate economic data is rather narrow and conservative. This may be justifiable in other areas of economics, but it is not in the realm of innovation and technological knowledge;
- we need to answer the big question: whether an increase in inputs and resources in KM would lead to more output. Is there any relationship between inputs and outputs? Unless this question is answered, there is no point in proceeding toward the fourth step, which is..
- ..the usual prescription of economics, that is the manipulation of incentives and inputs to achieve particular goals (Griliches, 1962).

Stylized facts

Clearly, there are a lot of economic arguments about knowledge that can be learned from the literature! Several of these arguments can be used to build an economic case for implementing KM practices.

Learning by doing: this refers to a particular locus of innovative activity: massive innovative activities occur “on the floor” or on line (as opposed to off line), through the mechanism of learning by doing. In learning-by-doing, innovation is not the main goal but may nevertheless occur as a joint product of “doing”. This process can even entail an experimental approach (people plan experiments on line and draw conclusions, new options are spawned and variety emerges). However, since it is a joint product and the main goal is to deliver a service or produce a good at the end of the day, the learning process can conflict with the normal performance which is expected from the worker. Thus, we have a case here for knowledge management as organizing proper conditions to

manage this tension and to promote experimental learning in the daily operational context of a manufacturing plant or a service operation.

Knowledge as a fixed cost: a piece of knowledge does not need to be produced more than once. The same piece can be used over and over by as many people as wish to do so. The production of knowledge is like a fixed cost in the production of goods and services. Now fixed costs are by definition a source of scale economies in production raising a set of problems in the field of strategies and policies. Again, this makes an economic case for KM as a method seeking for some kind of “optimal use” of knowledge.

Knowledge is weakly persistent: evidence in the psychological literature show that people forget. If the practice of a task is interrupted, forgetting occurs. Hirsch (1952) found that when performance was resumed after an interruption it was lower than the level achieved prior to the interruption. The knowledge derived from learning by doing quickly loses its value and if the stock of knowledge is not replenished by continuous production, it depreciates rapidly. This is a case for knowledge management as methods organizing explicit mechanisms to memorize and maintain the existing knowledge and minimize accidental “uninventions”.

Knowledge is not easy to transfer: It is sticky to borrow the word of E. von Hippel (1994). Stickiness raises a number of issues in terms of the organization of knowledge production and the integration of pieces of knowledge that have been produced in different places.

Knowledge is tacit: typically, knowledge and expertise have a broad tacit dimension, meaning that they are neither articulated nor codified. Tacit knowledge resides in people, institutions or routines. Tacitness makes knowledge difficult to transport, memorize, recombine and learn. One solution, and this is again an economic case for KM, is to codify knowledge: the knowledge is made explicit with a view to inscribe it on a medium. This entails high fixed costs but all knowledge management operations can then be performed at a very low marginal cost. Codification, as a KM procedure, increases memory capacity of an organization and creates learning programs for the new workers.

The last stylized fact we can find in the economic literature does not articulate any characteristic of knowledge as a commodity. Rather it points out the very limitation of the simple story of computers’ impact on the economic growth. The Solow paradox suggests that it was only a matter of time before sufficient IT capital accumulation would have a substantial impact on output and output growth. In fact, there is now considerable evidence that “organizational complements” – such as business processes, decision making structures, incentive systems, human capital, corporate culture and knowledge management – play an important role in the ability of a firm to realize value from its IT instruments (Brynjolfsson and Hit, 2005). Acquiring and maintaining these organizational complements is a real cost to the firm but also a potential source of significant value when combined with appropriate technology investments. *KM practices appear thus as an important complementary organizational capital* playing a key role in increasing private and social returns from IT investments. Or to put it in the words of

Milgrom et al. (1991), the deployment of IT and the adoption of KM practices are mutually complementary with each makes the other more attractive.

We have, thus, plenty of economic motivations and arguments for private companies to design, implement and develop KM practices. The economic literature dealing with the main features of the economics of production and transmission of knowledge builds clearly an economic case for KM. We can infer from this preconception step that KM is probably not just a fashionable managerial discourse but, above all, a social technology that is likely to have a positive impact on static efficiency, innovation and productivity. It is therefore worth it to proceed to the next step.

Data, data, data

Good economic research depends on the generation of appropriate and reliable economic data. If economists want to say something about the economics of KM, there is no way but to provide a measurement base on which research on the economics of KM and innovation can prosper. The OECD KM survey was the result of an intense collaboration between Statistics Canada and the OECD. It was developed in 2001 and 2002 in order to:

- create a systematic base of evidence about the diffusion of KM in some OECD countries,
- get some leverage effects in terms of international comparisons by using the OECD mechanism – consisting in contracting with national offices to do the work within a common framework of statistical guidelines,
- contribute to the stabilization/standardization of the conceptual categories and terminologies of KM, and
- create an international public good, if you like, that is some infrastructural knowledge related to the survey (terminology, categories, questions, test results), so that more countries and researchers can use it to undertake further studies and analysis.

The survey – which is extensively described in the OECD book (2003) (including methodological chapters, country studies and topic studies) – produced a lot of important results:

- it demonstrated the possibility to produce some aggregate measures about KM implementation and diffusion and to build indicators of firm behaviors vis à vis KM;
- it generated a series of results about the diffusion process of KM, size and technology effects, the priorities of firms in terms of KM practices and purposes (sharing, acquiring, human resource management, etc.), the complementarities between KM and other innovative practices, etc.. (see in particular, Earl, 2003, 2006, Earl and Gault, 2003, Edler, 2003, Kremp and Mairesse, 2003).

The big question: does it matter in economic terms?

We know from the second step that KM practices are adopted massively within the private sector. There are plenty of cases of innovations in social technologies that have

been massively adopted during a short period of history while no clear evidence have never been produced about their economic impacts (Nelson, 2003).

Kremp and Mairesse (2003) used the French data to study whether there is a relationship between KM intensity and outputs (either innovation or productivity). As we know, the evaluation of the economic impact of a new practice or a new technology is a difficult question since we cannot observe simultaneously the same firm with KM and without KM. If we study a firm having implemented some KM practices, we cannot observe the counterfactual and therefore cannot directly answer to the question: what would have been the outcome of the company if it had not implemented KM? There are several ways to estimate the counterfactual: for instance matching approaches are based on the assumption that as long as two groups of firms share the same characteristics, it is consistent to compare the treated group (with KM) and the untreated group (without KM). Kremp and Mairesse, however, used the opportunity offered by a very large data set (6000 firms) to search for statistically significant correlations between an indicator of KM intensity and output and outcome variables (innovation, patent, labor productivity) in a cross section econometric study. They showed statistical and economic significance of the estimated impact of KM intensity (*ibid.* p.158): regardless size, industry, R&D effort and whether they belong to a group, firms do tend to innovate and patent more extensively, if they have adopted KM policies. All else being equal, when KM intensity increases by one, the propensity to innovate increases significantly; as well as innovation intensity, patent propensity and patent intensity. The estimated impacts are quite substantial and in spite of all usual reasons of econometric misspecification that potentially apply here, they claim that these results remain statistically informative. At the minimum they reflect significant underlying positive correlations conditional on a fair number of relevant factors. Their tests and results about the relation between KM intensity and labor productivity provide the same kind of picture about the positive effect of the new organizational practice on economic variables. As Kremp and Mairesse argued, all these results do not mean causality, although such causal link seems a priori more likely than unlikely.

These results are important and some of the Wittgenstein “thick and dense clouds” start to be dissipated! They provide some detailed evidence related to the general idea that intangibles like KM and other organizational complements play a crucial role in explaining the recent surge in productivity in OECD countries. They also invite economists to extend the research further toward incentive mechanisms and the social private arrangements that would be most conducive to increase KM intensity as an important driver for innovation and productivity.

Incentives

The next step deals with the existence and identity of factors and incentives affecting the level of KM activities. It is for example interesting to address the issue of employees who are encouraged – through some kind of reward mechanisms - to write, codify and share documents. Employees have therefore to undertake two different tasks (the normal production task and the KM task) and have to choose an effort level for each of these

tasks. The firm's problem is to offer incentives to elicit the optimal level of effort. Incentive's theory in a multi-task setting shows that there is need for optimally balancing incentives across tasks; otherwise people will inefficiently allocate too much effort towards those tasks with the highest marginal return to them. From this general result, one can model optimal incentive structures for an effective implementation of KM practices.

With these results we close the pre-historical episode of the KM indicators to turn now to their uncertain career!

2 – Failures on the market for indicators

The OECD survey offered some good results to the international economic and policy audience about KM:

- there is a strong economic case for implementing KM in private companies;
- the production of aggregate measures are possible on various aspects of KM diffusion as well as on firm behaviors vis à vis the management of this precious asset;
- some statistical tools have been tested, improved and are publicly available (Earl and Bordt, 2003);
- estimated impacts of KM on innovation and productivity are quite substantial; and
- it is useful to proceed further toward the manipulation of incentives and inputs to achieve particular targets in terms of KM intensity.

However *the proof of concept* – i.e. the demonstration that the questions are relevant (steps 1 and 3) and aggregate measures are possible (steps 2 and 3) – is by no means sufficient to impose internationally new indicators and therefore routinize the data collection. We would like now to turn to what resembles strongly to some “failures on the markets for indicators”.

The KM indicators (i.e. KM intensity), as they exist now, are by no means ideal. An ideal indicator has to pass successfully the tests of precision, absence of bias, stability over time, comparability across different environments, difficulty to manipulate, aggregation, and last, but not least, cost (Jaffe, 1999).

It is obvious that a new indicator will get improved over time if enough time is given to it to be used and tested, to get people using it in a routine way both for data collection and data interpretation, improve it and so forth. While R&D intensity is now close to some types of ideal indicator (at least for those who believe in the importance of R&D in innovation and economic growth), the first generations of works based on R&D indicators were terrible!

This means that the first phase of building and using a new indicator, which has demonstrated its relevance and some practical virtues, is extremely perilous, involving obstacles which are very often impossible to overcome. This is a selection phase,

characterized by a lot of market failures that mostly derive from some kind of “increasing returns” problems:

- the creation and initial use of an indicator entail high fixed costs (research, initial tests, survey design and implementation), which are difficult to bear by the small group of pioneers;
- the wide diffusion of it is characterized by strong network externalities: the higher the number of “users” (statistical offices), the more attractive and interesting the indicator, the more it will attract further users;
- the successful implementation of a survey involves strategic complementarities at the institutional level between researchers, statisticians, policy makers and the business community, which exist only partially from the start (this is a different part of the business community which has to be mobilized as a source of information about KM, as compared with the business people who provides the information about R&D for example);
- there is a time series effect: “old indicators” create a double-value for the corresponding survey done at time n : the value of collecting data at time n + the value of not discontinuing the time series. This second value is, of course, 0 in case of a new indicator;
- last, but not least, a successful indicator is a “code”, which enhances efficiency of communication and information-processing procedures among a large number of economic agents. But a code represents an especially durable form of capital and the learning of a code by individuals is an act of irreversible investment for them (Arrow, 1974, David, 1992). The need for codes that are mutually understandable within organizations causes individuals and groups to become specialized in the information capable of being readily transmitted by the code and to ignore other kinds of information that would require a different code to be absorbed. Since the code is part of the organization’s capital, it will be modified only slowly over time.

All these features correspond to some forms of increasing returns in the development and consolidation of new indicators; meaning that it is likely that an indicator will never be adopted by the international community even if the *proof of concept* has been produced. As in any case of technological competition in presence of uncertainty and increasing returns, the best will not necessarily win the game. The winners will be those that succeed in getting enough momentum, so that they will benefit from the increasing returns dynamic, while excluding some other good candidates from the market.

A further complication deals with a problem of scarce resources, which includes not only money but also attention from policy makers (to interpret new indicators that might change their policy perspective) and time from the business community (to complete the questionnaire). This means that very often a new indicator will be imposed at the cost of some existing ones. This makes the case more difficult since the new indicator is far from being close to its ideal state while the existing ones are somewhat closer to the ideal form.

It is obvious that there is very little room to correct these market failures. The initial phase of implementation is a decisive one. It should involve multiple interactions between researchers, statisticians and official survey administrators, policy makers and of course the business community as the source of information. This phase operates as a sort of filter that very little new indicators will pass successfully. Success stories of new indicators entail the creation of a coalition of stakeholders that will succeed in recruiting rapidly new members of strategic value, a process that resembles to the creation and (eventually) the domination of an “epistemic community”.

Conclusion

The economics of innovation and technological knowledge is mainly an empirically disciplined science. The example of the KM survey (but many other examples are relevant to this discussion⁴) shows the need for applied economists to gather and learn the fact of technology and organization themselves. Data based on remote proxies are not enough. A restless challenge for applied economists in the area of innovation is to enlarge the scope of empirical material that economists will come to regard as legitimate and perhaps even routine in applied research. This is a necessary effort since we want the economics of innovation and technological knowledge not to remain at a purely abstract level but able to “re-enter”, to “land” in order to link abstraction back to the practices so as to inform properly both managers in the private sector and policy makers about what are the aggregate economic impacts of new organizational and human resources practices, new business methods, new discovery technologies, etc.

However, the case of the development of KM indicators shows that this is a difficult process. The production of a proof of concept – the questions considered are relevant and the production of aggregate measures is possible – is by no means a guarantee for imposing the indicator considered on the international scene. As a result the KM indicators’ development has been discontinued and the emerging coalition of interests (involving some national offices and the OECD) almost disappeared.

This is a shame since KM practices, as systematically used by private firms, are clearly a central organizational concept in the knowledge economy, so that it is important to measure firm’s behavior in this area. Also, KM and other new human resources practices are complementary investments which are larger than investments in the IT itself. However they go largely uncounted and the task to better measure those intangibles that are increasingly important to knowledge-driven growth and firm performance remains by far uncompleted.

The challenge of developing a measurement base to study knowledge management at the firm level is, therefore, still ahead and there is a need for stronger political commitments as well as stronger interactions between statisticians, economists, policy makers and the business sector to enlarge the scope of empirical material that economists will come to regard as legitimate and perhaps even routine in applied research.

⁴ - The measurement of user innovation is another case in point that my colleague E.von Hippel will discuss at the Conference

However, there are obviously some elements for hope to be found in the great success of the development of indicators based on enterprise-based surveys of innovative activity, as implemented in a number of countries in Europe and elsewhere (including Canada). The success of the CIS is easy to explain. Innovation is an old and prestigious economic concept, familiar to economists (not only the Schumpeterian). It was easy to attract the interest of policy makers, all aware of the importance of evidence about innovation performance and it was equally easy to find the part of the business community in charge of innovation management in firms. Thus the network of potential users was initially quite large and was strongly supported by powerful institutions. The strategic complementarities between the various stakeholders already existed, since they are quite similar to those existing for R&D data collections. Only the fixed cost of launching the survey could have been a problem but it was not a great one since a large number of institutions were willing to share them.

Another element for hope is that the most recent revision of Oslo Manual (OECD-Eurostat, 2005)– which is the “codebook” for innovation indicators – extends coverage of innovation to new types, including “organizational innovation”. This category is obviously broader than KM but clearly related to it. Most examples of organizational innovation in business practices are actually KM practices (p.51). Also the four questions about KM practices adoption, used in Kremp and Mairesse (2003) to estimate a KM intensity indicator, have been lodged again in CIS4 at the European level.

A final element for hope in the future of a rich indicator’s base related to the knowledge economy is that, even in the absence of a large international survey using standardized procedures for data collection on KM, empirical studies on the economic impact of knowledge management (as well as of other new human resources practices) are proliferating (see Hall and Mairesse, 2006); all studies converging toward conclusions that such new practices raise performance (see Shaw, 2004 for a survey). Of course all these studies are based on partial surveys, ad hoc data sets and data sets not specifically designed for this purpose. Hence these studies are extremely costly and have a poor potential for international comparisons and benchmarking. However, even though each of these studies seems fragile and open to criticism on many counts when taken on its own, the overall convergence of the results is quite convincing.

The success of the CIS, as well as the increasingly large body of empirical research about KM and organizational innovation, based on data from firms, show that the objective of enriching the indicator’s base for the economics of knowledge is not inaccessible and that its future as a strong empirical discipline is promising.

Appendix

Empirical papers based on the OECD-StatCan survey

L.Earl and M.Bordt, “A word to the wise – advice for conducting the OECD knowledge management survey”, in D.Foray and F.Gault (eds.), *Measuring knowledge management in the business sector*, OECD, 2003

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L.Earl and F.Gault, “Knowledge management: size matters”, in D.Foray and F.Gault (eds.), *Measuring knowledge management in the business sector*, OECD, 2003

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