The Knowledge-based Economy: A Sisyphus Model[1]

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ABSTRACT *The current fashionable emphasis on the knowledge-based economy is missing the real significance of the dichotomy between tacit and codified knowledge. A continuing input of tacit knowledge is essential to sustained innovation and growth. Without this, the modern thrust towards codification based on IT can lead to an economy with plenty of processing capacity but no new knowledge to process.*

Keywords: tacit knowledge, codified knowledge, knowledge-based economy, taxonomy of information.

My objective in this paper is a very limited one, i.e. to suggest that the current fashionable emphasis on the knowledge-based economy is missing the real significance of the dichotomy between tacit and codified knowledge. Had I been able to follow Michael Kirby's dictum that a good paper should try to make only one point, that is the point I should have striven for—although I should have reserved the right to make that point in several ways.

It may help if we avoid the wasted words and hours that can so easily be devoted to purely semantic issues—to the different meanings of information and knowledge. If we can be broadminded enough to extend our thinking from economics (whatever that is) to the study of information-processing, why should we not take in knowledge-structures as well? After all, it has been said that "as a rule, information is designed to effect or affect knowledge".[2] So let us reject the claim that "the narrow focus is science and the wide lens is speculation".[3] There is also a very practical reason to adopt this stance. As Arrow remarked, "information is a descriptive term for an economically interesting category of goods which has not hitherto been accorded much attention by economic theorists".[4] Attention has shifted in the quarter of a century since he wrote those words but not enough to invalidate his assessment.

Who/what is Sisyphus? Sisyphus was a legendary king of Corinth. It was his punishment in Hades to roll a heavy rock up a hill. As he neared the top, the rock was subjected to some exogenous force and rolled down again. The process went on endlessly.

Let me sketch the content of this paper. First, I shall look to the dichotomy between tacit and codified knowledge, as reflected in the work of some recent contributors: Nelson and Winter, Eliasson and Abramovitz and David and then, turning the clock back, as discussed by one of the pioneers, scientist philosopher Michael Polanyi.[5] Then I shall examine some recent versions of the knowledge-based economy: Eliasson, Abramovitz and David and the recent study of the Australian case commissioned by ASTEC and CSIRO.[6]

Next, I shall suggest as a starting point a simple model in which there are two kinds

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of knowledge, tacit and codified. Finally, I enter a plea for a taxonomy of information based on a characteristics approach as a possible means of building more complex models which might depict successfully the role of knowledge in the processes of economic growth.

Tacit and Codified Knowledge

Nelson and Winter start from Polyani's observation: "We know more than we can tell". They assign a "central place" to "knowledge that cannot be articulated". They reason from cases like the skills of swimming, driving and landing a plane to the case of the researcher attempting to model human psychological processes. In each, they say, "language is an imperfect tool for conveying the information they need". They sense ambivalence on the part of both learner and researcher: "Both hope that words will smooth their individual paths to achievement; both know that there is no distinction in the achievement if the path is *too smooth*" [Italics added].

They try to identify the determinants of the degree of tacitness: "much operational knowledge remains tacit because it cannot be articulated fast enough, because it is impossible to articulate all that is necessary to a successful performance, and because language cannot simultaneously serve to describe relationships and characterize the things related".

Difficulties begin to arise when the skills change to those of the businessman—and here Nelson and Winter are on common ground with some of the old debates. They contrast orthodoxy which stresses choice and deliberation with their own approach which emphasizes "the *automaticity* of skillful behavior and the suppression of choice that this involves". We might note that others have levelled just this indictment against orthodoxy, e.g. "Conventional economics is not about choice, but about acting according to necessity".[7]

The Nelson and Winter approach goes on to make a valuable contribution through the concept of organizational routine—as organizational memory, a truce among organization members, and as a target. It does not seem to me, however, that they succeed in so broadening the tacit part of the information activities that it could deal with what they admit is "fundamental ambiguity" shrouding the set of innovation alternatives.

They wish to emphasize the evolutionary aspect:

> Real search processes take place in specific historical contexts, and their outcomes clearly depend in part on what those contexts contain in the way of problem solutions that are available to be "found". What there is to be found consists in large part of the fruits, by-products, and residues of information-processing activities elsewhere in the society. The flow of general social history thus impinges directly on the firm through its search activities, and searching at t is not the same thing as searching at $T > t$.[8]

The general social history, especially of the firm and the members of that organization, can open the way for real innovation, for the crossing of many different kinds of borders, for the solution that comes before the problem. These activities involve tacit knowledge; and that tacit knowledge can be viewed as either used as such, perhaps secretly; or, more probably, used as an input to organizational routines that in effect require that the tacit knowledge is converted to codified knowledge.

So I was led to look elsewhere. Gunnar Eliasson[9] likewise builds on the Polanyi contribution. For him, "information . . . [means] coded and communicable knowledge,

that can be articulated and understood if the requisite receiver competence exists". So here a new element seems to be introduced—competence in information-handling.

Of course, competence in some general sense had been widely assumed in conventional theory and much effort has gone, especially on the part of management experts, into persuading business and governments that it can be identified and created in return for an appropriate consultancy fee.

Eliasson argues that communicating knowledge is more than a matter of transaction costs.

> There are various ways of demonstrating the existence of tacit knowledge beyond the notion of prohibitive costs to communicate. If individuals in teams or organizations exhibit sufficient heterogeneity in competence or talent there will always be significant knowledge that cannot be communicated due to lacking receiver competence . . . It is "tacit" to those who don't understand.[10]

So here tacitness seems to come about simply as a consequence of specialization; and it can emerge also because there is learning-by-doing with a variety of learning experiences.[11] It still does not address the possibility of new knowledge. So I suggest that there are two problems here for economics; first, it is unsatisfactory to assume that all knowledge is codifiable; and, second, even when tacitness is introduced into the analysis, we have to be careful about the source of the tacitness.

Another comprehensive exploration of these matters is contained in the report of an OECD conference in 1994.[12] Foray and Lundvall note several propositions: first, the production and distribution of knowledge has special characteristics which are not compatible with mainstream economic theory; second, knowledge plays an important role in the economy; third, the importance of that role may have been increasing; fourth, investment in knowledge and capabilities is characterized by increasing returns; fifth, there has been a proliferation of new disciplines and sub-disciplines, e.g. economics of intellectual property rights, standardization and information technology.

They then argue that fundamental principles of economic analysis are not easily applied to knowledge activities; that there have been major changes in the mode of production and distribution of knowledge—"a new dynamic between the formation of tacit versus codified knowledge"; and that "the most pertinent political issues of the present era", e.g. globalization, underdevelopment and environmental sustainability, "[c]annot be understood and tackled adequately without a rethinking of economics, where the focus is on knowledge and learning".

Abramovitz and David contributed the opening paper to this OECD collection. In their first paragraph, they concede critical roles for tacit knowledge but then focus attention on codified knowledge and "the impetus imparted to investment in intangible, knowledge-intensive forms of wealth". As befits the computer age, the codified component is compact and standardized and easily transmitted, stored and reproduced, and, more contentiously, transferable "over long distances and across organisational boundaries at low cost".

While they concede further that the growth of codified knowledge is not all there is to the story of the rise in intangible investments, their failure to deal explicitly with *tacit* knowledge means that the contribution of that component cannot be acknowledged fully. I shall return to this later.

Now consider the pioneer's views:

> The declared aim of modern science is to establish a strictly detached, objective knowledge. Any falling short of this ideal is accepted only as a temporary imperfec-

> tion, which we must aim at eliminating. But suppose that tacit thought forms an indispensable part of all knowledge, then the ideal of eliminating all personal elements of knowledge would, in effect, aim at the destruction of all knowledge. The ideal of exact science would turn out to be fundamentally misleading and possibly a source of devastating fallacies.[13]

This does, of course, point to a self-contradiction in the advice I have been in the habit of giving to STEP and other research students: "Find a good problem. Ask a question". Polanyi's comment follows Plato: if you know what you are looking for, there is no problem; if you do not know what you are looking for, you cannot expect to find anything. A solution lies in the role of tacit knowledge of "as yet undisclosed, perhaps as yet unthinkable, consequences". Perhaps this links with Don Aitkin's comments about serendipity, although I personally think the role of tacit knowledge is far removed from accidental discovery.[14]

So we are left, according to Foray and Lundvall, with skills, shared beliefs and modes of interpretation (which I suggest may or may not be able to be articulated). I read of late that "facilitated monitoring" is being recommended by consultants as a way of maintaining skills and passing them from one generation to the next.

The Knowledge-based Economy

The difficulties in the way of implementing the tacit *vs* codified dichotomy are considerable. There is a well-established effort to gather information relating to an information sector and this stands in contrast to analytical efforts that see both tacit and codified knowledge activities as integral parts of all economic activity. One approach that hints at what we now seek dates back to the 1970s OECD work which sought to distinguish routine information activities from non-routine.[15] These same difficulties surface again in the more recent knowledge-based studies.

In the works cited earlier, Eliasson provides tables of labour use but these are in effect rearrangements of the information sector categories: New Knowledge Creation is the old Information Producers; Economic Coordination takes the place of Information Processors and Information Infrastructure; Knowledge and Information Transfer corresponds to Information Distributors.

Creation of New Knowledge breaks down into R&D and Design. But we are no closer to a separation of tacit from codified. R&D work and expenditure clearly takes in routine activities: maintaining the scientific enterprise, printing and publishing, updating observation records, and, dare we say it, meeting at conferences and seminars. Recent discussions about the effectiveness of R&D subsidies would seem to have accepted what many knew already that marketing and much else could be included if the incentive were great enough.

Abramovitz and David analyze investment in intangibles, primarily in education but also R&D and health, safety and mobility. But surely much of what is captured in these categories is well and truly codified.

A similar but more extreme treatment seems to emerge in the ASTEC/CSIRO study of Australia and the knowledge economy. As Engelbrecht observes this study (over) emphasizes R&D: "R&D is only one of the many growth factors. The role and importance of human capital in the growth process, and its formation through various forms of education and learning, is not even explored. Neither is the role of organisational capital and competencies, or issues concerning national and international knowledge spillovers. The national system of innovation is reduced to the R&D system.[16]

So I suggest we are not getting much help from the knowledge-based economy fashion with the empirical work. To date it has been very largely a renaming of the information sector initiative.

A Model of the Knowledge Process

I suggested earlier that we can begin with a two categories of knowledge model: tacit and codified. Keynes was content to assume that information/knowledge was part of all investment outlay—he hazarded a guess that it was about 5%. Perhaps we can as a start recognize the importance of tacit knowledge in a similar fashion—say, 10% of information outlays.

The process can be envisaged as one in which the tacit knowledge producing activity initiates an innovation process. Successive phases would be the creation of tacit knowledge, its application and conversion in part to codified form, in parallel with maintenance of a stock of tacit knowledge. Production, application and maintenance of both kinds of knowledge each require their supporting organizational capital. Modelling must avoid the linear thinking habits of scientists and science policy writers; there is much scope for feed-back loops.

Central to this process is the conversion of tacit to codified. This has been much affected by information technology developments.[17] It may well be that this brings a form of lock-in. Kenneth Boulding confessed, thirty years ago, to being worried about one aspect of these developments:

> The very power of the computer to simulate complex systems by very high-speed arithmetic may prevent search for those simplified formulations which are the essence of progress in theory. I have an uneasy feeling, for instance, that if the computer had been around at the time of Copernicus, nobody would have ever bothered with him, because the computers could have handled the Ptolemaic epicycles with perfect ease.[18]

I suggest that tacit knowledge may suffer the same neglect as those "simplified formulations". This points to a weak link in what is now being called the spiral process.[19]

A second weak link involves the crossing of boundaries, especially organizational ones. Much writing assumes that once knowledge is codified, the available information technology effects transfer. The reality would seem to be that codification, because it is not a purely technical matter but involves human and organizational capabilities, runs up against limits of affordability.[20] As a consequence, codification may be achieved only locally rather than extend more widely to regions and internationally. It is much more likely that the paths will be determined by preexisting networks which are part of organizational capital. And all this may be modified depending on how important are elements of secrecy and the erosion of private property rights in information. Arrow has drawn attention to the erosion of the informational advantage that is often the primary value possessed by the firm and to the possibly significant impact on the future development of firms.[21]

A Taxonomy of Information

Modelling of the knowledge process can begin with the tacit and codified dichotomy and proceeed along the lines I have suggested. However, a wider view is called for if the notions of the knowledge-based economy and the new growth theory initiative are to be fused together. Here, I suggest that the major task to be tackled is the development of

a taxonomy of information.[22] If, as sector studies have suggested, information-handling activities of all kinds together constitute the major claim on resources, the present statistical coverage of those activities must be judged completely inadequate by comparison with the richness of detail available for agricultural and manufacturing activities. Data problems with respect to some major activities are growing. For example, deregulation/privatization is reducing significantly the data available for the key telecommunications industry, the justification being protection of commercial interests.

I know there are serious conceptual and measurement problems but surely the statistical agencies can do better than at present. A first step would be to make a start with developments that have assumed some importance: computers, videos, VCRs, ATMx, etc. To do this runs the risk of recording the items of technology hardware and telling little about their use or about information activities in general. To illustrate, in the case of telephones, we are given statistics of sets and lines. An attempt can be made to ascertain the pattern of calls, their duration and purpose, e.g. different demand elasticities have been found for domestic calls that are work-related as opposed to those concerned with family matters or entertainment.[23]

Potentially important dichotomies have emerged. In addition to tacit/codified, consumption *vs* investment, private *vs* social are applicable. There is a need to identify characteristics that are economically significant. Weerahandi *et al.* of Bell Communication Research developed a framework for forecasting demand and new services using the characteristics approach.[24] Unfortunately, they focussed on the characteristics of the technology rather than of information. Examples of needed dimensions are the frequency of observation, the static or dynamic nature of the information, the degree of accuracy required, the promptness with which it must be made available, the complementary information needed, and the universality of its distribution.

Pieces, Batches or Flows?

I find it interesting that Arrow in his seminal 1962 paper formulated his influential propositions relating to divisibility and appropriability with respect to "a given piece of information" or "a given body of information".[25] Some time later Machlup, writing about optimum utilization of knowledge, tried to simplify matters by dealing with "some particular, specific batches of knowledge", although his view was that [k]nowledge is not a pile of homogeneous material, but a complex structure of heterogeneous thoughts, each available at zero marginal cost but usable only together with resources available only at positive, and often very high cost".[26]

Now both these authors recognized the flow nature of information. In fact, Arrow was later to define the firm as "an incompletely connected network of information flows" and Machlup always made much of the distinction between stocks and flows. But just as Arrow, as he developed his ideas about the economics of information, was led to question Jevons' slogan, "bygones are forever bygones", I should like to question some aspects of his 1962 paper.[27]

If pieces of information are not identical items in a pile but rather complement, or serve as substitutes for, each other—if they fit together in a developing "structure of heterogeneous thoughts", e.g. complementarity between tacit and codified knowledge, does this modify the reasoning about divisibility and appropriability?

A piece of information may be useless without the needed complements and those complements may be dated. In a sense, the flow may be divided into dated pieces but the prize goes to whoever secures all the pieces in the sequence. Perhaps the "building on the shoulders of giants" points to this line of thought. Perhaps data registration rights

are a good practical illustration: denial of access to data submitted to secure registration of, for example, a chemical compound, can, when the patent terminates, be a formidable barrier to entry by a generic producer.

When we move away from the well-defined piece of information, divisibility takes on a different meaning. We can even imagine situations in which a buyer may be willing to buy the same piece of information twice! We should therefore ask whether this modifies the standard conclusion about the creation of pervasive economies of scale. Similarly, appropriability is transformed. Strategic considerations enter and a technological leader may well be able to create unassailable informational barriers to entry.

Perhaps these ideas follow on from some of the perceptive comments we can find in discussion of decision processes. A. G. Hart long ago commented on decisions "taken in the consciousness that they are part of a developing chain",[28] and more recently Stiglitz pleaded for modelling of the economy "in which information is continuously being collected and processed and in which decisions, based on that information, are continuously being made".[29]

Tacit knowledge plays a major role in this shift of focus. Such knowledge is central to the "structure of heterogenous thoughts" and we need to find a place for it in our analysis.

Similarly, we need to find policy ways to foster the role of tacit knowledge. This means looking for the weak points in the process: the initiation of the creation of tacit knowledge, the converting of tacit into codified knowledge, and the maintenance of the stock of tacit knowledge. The danger is that IT carry the day and the knowledge-based economy find that it has plenty of processing capacity but no new knowledge to process. I am reminded of Norbert Weiner's comment about his colleagues' aspirations to extend to social sciences the method of the natural sciences:

> From believing this necessary, they come to believe it possible. In this . . . they show an excessive optimism, and a misunderstanding of the nature of all scientific achievement.[30]

The dangerous belief now is that all important knowledge can be codified. I am inclined to the view that it is neither necessary nor possible. The reality is much closer to the labour of Sisyphus.

Notes and References

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13. *Ibid.*, p. 20.
14. He adds: "In fact, had anyone sought money from us [the ARGC] on the argument that he or she would do some research in the hope that an accidental discovery would arise, we should have thought them barmy" ('The Australian Research Grants Committee: An Account of the Way Things Were', *Prometheus*, *14*, 2, December 1996, p. 189). Note, however, that the medieval Latin *invenire* meant accidental discovery while *ars* meant technological knowhow.
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