Knowledge and Learning
in the
Information Age

W. Edward Steinmueller
INK (Information, Networks, Knowledge)
SPRU – Science and Technology Policy Research
University of Sussex

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1. Introduction

As Kuznets observed, the distinguishing feature of modern economic growth is the application of scientific knowledge to productive activities.¹ For Kuznets, 'modern' economic growth involved progress since the Industrial Revolution rather than from the Information Revolution. The gathering momentum of the Information Revolution has, however, led many authors to conclude that it represents a qualitative departure from the accumulative and distributive processes involved in 'science-based' economic growth and therefore a new 'epoch' or 'paradigm' for the process of economic growth.² Most recently, the examination of the contribution of knowledge to economic growth has focussed upon systemic features of the production and distribution of knowledge and the relation of these features to economic performance.³ This intellectual trajectory, originating from empirical investigation and a sceptical view of received theory to which many 'heterodox' economic scholars have contributed, has also been the subject of 'revisionist' works in mainstream economic theory.⁴ The co-evolution of revisionist and heterodox mainstream theory reflects a common concern with the features of information as an economic commodity and the growing importance of knowledge in productive activities.⁵

¹ (Kuznets 1973)
² (Freeman and Perez 1988; Freeman and Soete 1987; Perez 1983) are the seminal contributions establishing this viewpoint.
³ (Edquist 1997; Lundvall 1992; Nelson 1993)
⁴ Mainstream economic theory may be defined as the effort to systematise the understanding of market functions along the lines of investigation specified by Walras and Pareto at the beginning of the 20th Century. Familiar examples of 'revisionist' contributions within the mainstream include (Krugman 1979) and (Romer 1986). A representative sample of this work including Krugman and Romer's articles is compiled in (Buchanan and Yoon 1994).
⁵ The current use of the English language to construct terminology like knowledge-based economies or economic growth bears the unfortunate connotation that prior economic formations were steeped in ignorance. In the present context, the proposition that knowledge is of growing importance role in economic activity is simply a reflection of two facts: 1) natural resource endowments, per se, have comparatively little explanatory value in explaining levels of economic welfare or rates of growth and 2) although capital and labour endowments have greater explanatory power, most of this power stems from making 'quality' adjustments reflecting the embodiment of improvements in knowledge in workers and equipment, and the transformation of organisations accompanying these improvements. The evidence for these propositions may be found in (David and Wright 1997), (Abramovitz and David 1996) and (Abramovitz and David 1999).
A popular manifesto of heterodox scholars such as those in evolutionary economics or science, technology and innovation studies is that mainstream economics treats technological change as exogenous to the economic system. It may be argued that this position has been more useful as a means for intellectually differentiating research approaches than as an accurate reflection of frontier research within the mainstream. It can also be said, however, that taking full account of the implications of information and knowledge into mainstream economic analysis introduces dissonance and perhaps bears with it the seeds of a fundamental transformation in economic analysis. This transformation has not yet occurred despite efforts to define one or more branch points that would support the growth of a comprehensive alternative. There are a host of reasons for the so-far still-born efforts to revise the scientific paradigm of economic analysis. The purpose of the present paper is to examine one of the mechanisms responsible for the resistance of economic analysis to fundamental transformation. At its core, mainstream economic analysis reflects a very simple collection of assumptions about the ways in which social processes may be decomposed for the purposes of analysis. It is not only a physics of social interaction but also a physics where social particles operate without the influence of fields. These assumptions are robust in the sense that their \textit{a priori} assertion or implicit incorporation is normally the conditional premise for economic analysis. These assumption are reinforced by the fact that most of the investment devoted to taking social measurements has been organised around the models that can be logically derived from them.

As the scholars following heterodox economic approaches have suggested, however, many of the economic issues presented by information and knowledge cannot be easily digested by economic analysis and some may not be digested at all. Unfortunately, it is difficult to establish that alternative approaches to these economic issues fare better. By attempting to delineate these issues somewhat more sharply, the aim of this paper is to provide a partial map of our ignorance and thus, perhaps, to have some influence in defining future research directions.
2. Information is Not Knowledge

Much of the knowledge relevant to economic activity may be defined as an integrated and articulated ability to utilise information in ways that are generative and adaptive.6 A person who has knowledge is capable of generating both new information and new knowledge from their pre-existing knowledge. It is also a characteristic of having knowledge that a person’s knowledge generating capabilities adapt both to the receipt of new information and to the feedback provided by the generative process of using that knowledge.7 A serious definition of knowledge, and the one offered here is only one example of such a definition, must encompass the fact that knowledge cannot, itself, be directly exchanged. If such an exchange were possible, the problems of learning and education, as well as many other processes designed to reproduce knowledge, would be enormously simplified.

The words associated with knowledge are particularly imprecise in the English language, and often require further qualification. For example, 'to know' may refer to capabilities ranging from simple recollection ('Do you know the phone number?') to very complex collections of capabilities ('Do you know how to perform an open heart surgical procedure?'). The more interesting distinctions between information and knowledge involve the second rather than the first example. Nonetheless, the economic analysis of knowledge is largely based upon the assumption that knowledge can be reproduced through the exchange of information. This is an example of the process of analytical decomposition at work.

6 This definition draws upon the issues of articulation and expression developed in (Polanyi 1962), the developmental theories of Piaget, see (Gruber and Vonèche 1977), and the relations between linguistics and knowledge elaborated by (Chomsky 1988). Each of these sources presents dramatically different theories of the origin of knowledge acquisition abilities, but they share the view that, once begun, the elaboration and extension of knowledge can and will be carried forward by the individual, alone or, more likely, in interaction with others.

7 This interpretation is based upon the close relationship between knowledge and language, an issue that has become central to many recent social studies of science, see (Galison and Stump 1996) and (Galison 1997). A particular focus of these discussions is the particularity of the multiple languages used in scientific discourse.
If we observe the social process of learning we see individuals consulting information resources such as textbooks, instruction manuals, or Websites, listening to lectures or trying to explain what they know to others, performing practice exercises, writing for themselves or for others' review, and similar types of activities. All of these activities involve the exchange of information. It would seem quite reasonable to conclude from these observations that knowledge is derived from information exchange. When we ask individuals to demonstrate their knowledge through examination or the solving of problems, however, we find markedly different results among individuals. One possible explanation of these differences is that the level of effort devoted to receiving information varies across individuals. Perhaps those individuals that applied themselves more thoroughly to receiving information perform better than the individuals who made less effort in receiving information.

A second possibility is that some individuals have greater cognitive capacities to receive and recollect information than other individuals. Differences in performance therefore may reflect innate talent or 'intelligence.' A third possibility is that the alignment between information and individual capacities is better for some individuals than others. In a particular or 'situated' context, one individual may be more successful than another individual in demonstrating their knowledge, while in another the order may be reversed. A fourth possibility is that the process of integrating information into knowledge involves a 'hidden step' that is particular to the individual and also involves each of the other three possibilities. Educational and social psychology have, for the most part, found it necessary to move towards the latter, more complex, explanations of the learning process in order to account for the experience and performance of individuals and groups in learning.

If learning is a highly situated or individualised experience, then the process of knowledge reproduction is one that can be aided by the availability and quality of information, but the predictability of the learning or knowledge reproduction outcome is, at the level of the individual, uncertain. The same observations made about the individual may be applied to groups of individuals so that teams' or organisations' capacities to reproduce knowledge will be idiosyncratic and uncertain.
When we attempt to translate these elementary insights into economic theory we confront what appear to be relatively minor problems. The value of any particular piece of information in enabling the reproduction of knowledge will be uncertain. This means that the 'production function' for reproducing knowledge will be stochastic and the output, a 'level' of knowledge, somewhat elusive. These issues do not represent indigestible problems for economic analysis. It is not unusual to consider production processes in which the application of inputs produces a distribution with some outcomes of greater economic value than other outcomes or that, strictly speaking, are unobservable. Generally speaking, economists argue that the market will select the most successful outcomes.

The more serious problems occur when we recognise that knowledge 'outcomes' are not determined by any single application of inputs. Precisely because knowledge is generative and adaptive, the knowledge 'outcome' resulting from the application of inputs will differ over time and as the result of interactions that the individual or group has in using the capacities provided by knowledge. Certain contexts will result in 'virtuous' cycles in which knowledge is successively improved while other will result in 'downward spirals' in which pre-existing knowledge proves inadequate. The conditions supporting positive outcomes will be difficult to specify ex ante. While the market selection hypothesis can still provide some certainty that ineffective courses of development will be rejected, admitting these additional characteristics of knowledge to the analysis implies that organisational success takes on an uncomfortably idiosyncratic and stochastic character. Moreover, the factors determining successful outcomes are becoming 'internal' to the economic actors, and thus even less observable.

In economic processes where knowledge is a significant determinant of performance, the micro-foundations of industrial performance are stochastic rather than deterministic. This creates some rather large problems for 'textbook' economic theories of the 'representative firm' which have already been noted by (Nelson and Winter 1982). Industrial composition is likely to be a stronger explanatory variable.

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8 For example, human capital accumulation models have been successful despite our inability
than observations of the inputs to particular firms, an approach now generally accepted by the emerging economic discipline of industrial dynamics. This conclusion is strengthened when knowledge is rapidly changing and when other sources of competitive advantage (such as increasing returns in other intangible assets like advertising or distribution networks) play a smaller role than the capacities to acquire and utilise knowledge. Mainstream economic theory, however, is able to encompass these considerations, although in doing so the predictive or deterministic conclusions of analysis move from the level of the firm to the level of the industry, and new problems of market definition are introduced (see (Sutton 1998) and (Sutton 1991)).

The issues discussed in this section reveal a sharp division or cleavage between approaches that would equate information and knowledge and the alternatives that recognise the difficulties of transforming information into knowledge. In the former approach, there is no reason, in principle, for treating information differently than other goods and the only fundamental problem of information as a commodity are the peculiarities of its reproduction costs (which, by assumption of the equation of information and knowledge, adhere to knowledge as well). In the latter approach, the production of knowledge is intermediated by additional processes such as the cognitive capabilities of actors and their use of acquired knowledge to extend and adapt actors' capabilities to new contexts. Following the latter approach leads to three basic propositions to be taken up in the following sections:

1. The structure of an organisation can fundamentally influence the effectiveness of learning. (intra-organisational systems of learning).

2. The division of labour between organisations is enabled by either the ability to 'compartmentalise' learning processes or to develop effective methods of joint learning (inter-organisational systems of learning).

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9 As Sutton explains 'Within this setting, we cannot predict actual outcomes; rather, we can place some bounds on the form that market structure can take. While this constitutes a limitation of the theory, it is inherent to the present approach and cannot be avoided.' (Sutton 1998), p. 478. Sutton does suggest, however, that one means of increasing the structure of models similar to his own is to examine how specific and critical capabilities are constructed, *ibid.*, p. 489.
3. A fundamental question about the evolution of knowledge-based production is whether trajectories in demand and production technology are the source or consequence of intra- and inter-organisational learning systems (the causation question).

These three propositions are not the only ones that are implied by taking into account the distinctions between information and knowledge, but they are particularly salient for a number of contemporary discussions in the economics and business studies literature.

3. Intra-Organisational Systems of Learning

The larger patterns of change in intra-organisational learning are best observed by taking a very long run view. With respect to the technology for fabrication of machines such as farm equipment, for example, we may consider the evolution of intra-organisational learning over almost two centuries. During this period of time, the location of learning shifts within the organisation in ways that re-emphasise the significance of the relatively recent onset of the Information Revolution and its potential implications.

The initial development of manufacturing industries involved a strong 'localisation' of learning activities in the craft workers responsible for manufacturing operations. Before the concept of 'interchangeable parts' and the technologies needed to implement this idea became widely available, manufacturing operations required individual skills in specific operations which would result in intermediate outputs that could be 'fitted' into complete artefacts. Adam Smith's division of labour within the 'pin factory' required individual craft skills that supported the eventual assembly of the pin. The production of early mechanised agricultural equipment such as the McCormick mechanised reaper was based upon a similar requirement for craft skill in reproducing

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10 See (Steinmueller 2000) for an attempt to do this specifically with regard to the issues discussed in this paper and (Beniger 1986) and (Hounshell 1984) for much more detailed accounts of the historical processes involved.
components from patterns and proto-types. The result was that each piece of finished equipment was sufficiently distinct as require the further services of mechanics to interchange parts between equipment. Within the organisation, knowledge accumulated in the craftsmen carrying out these operations and every effort to develop new designs and equipment required the active collaboration of these craft workers with designers.

The development of mass production fundamentally altered the locus of knowledge accumulation within the organisation. The key enabling development for this change, however, was external to most manufacturing companies. The development of the machine tool industry involved a progressive division of labour and a dis-integration of machine tools production from user industries (Rosenberg 1976). Specialisation not only spurred technical advance but the growing scale of demand for the resulting products fostered 'convergence' toward machine tools with broader functionality that could be adapted to a growing range of user needs (ibid). Machine tools allowed sufficiently accurate reproduction of individual parts that the work of 'fitting' of component parts could be transformed into the operation of 'assembly'. The operations of the shop floor and the very discipline of shop floor operations were then transformed by the development of control systems requiring a panoramic oversight into the relative rates of production of different operations.

During the 20th century, the logic of mass production was successively employed to virtually every activity where tight specifications of component parts (either human or artefact) could be achieved (e.g. franchise food, insurance, war, and office machinery). During the 1920s, however, mass production diverged from Henry Ford's original vision of 'power, accuracy, economy, system, continuity and speed' with the addition of Alfred Sloan's interest in stimulating new consumer demands through the creation of new fashions in artefacts. This change further reinforced the role of the central co-ordination and design within the enterprise even as Sloan's principles of financial organisation supported the divisional structure of the modern corporation. The introduction of variety and diversity established a different trajectory from that

See (Hounshell 1984).
imagined by Ford, one in which economies in the process of product changeover became as important to the success of the enterprise as scale in production.

The key observation to make about these developments is that many of the processes of knowledge production and reproduction became a specialised function within the enterprise, creating the need for an intermediate bureaucracy to gather, filter, and present information to decision-makers and designers. In many respects, developments during the second half of the 20th century have been the result of efforts to mitigate or bypass the problems introduced by Sloan’s model of mass production.

Information and communication technologies, originally the instrumentality supporting the ‘control revolution,’ have become a tool for decentralisation within the organisation and a means for bridging different organisations. Paradoxically, these developments have only become possible through the creation of the largest standardised system in human history, the Internet. The Internet provides the means to embed or re-distribute organisational control at will, limited only by the creation of institutional norms and standards needed for the prevention of opportunistic behaviour and the co-evolution of technological and social systems. The social laboratory is open and thousands, perhaps millions, of experiments are underway. Their outcome will determine the shape of institutional organisation during this century.

In this context, what should be the role of the social sciences, and economics in particular? Understanding the structure of transactions within the organisation has never been more important. We urgently need to know what the barriers and limitations to ‘virtual organisation’ are; how these are influenced by human cognitive limits augmented using information and communication technologies, new institutional rules and norms for constructing trust and facilitating exchange, and the consequences of communication across social groups of diverse constitution.

Within economics, the problems of resource allocation within the firm are becoming more complex. A familiar problem for telecommunication economists, the allocation of costs and revenues across activities subject to joint economies, will become a generalised issue in the governance of the firm. Another difficult problem will be the problem of establishing a valuation for intangible assets, particularly when these assets
can be configured in a multiplicity of ways, each with different implications for addressing rapidly changing constellations of user requirements and final demands.

4. Inter-Organisational Systems of Learning

Networked information and communication technologies of which the Internet is the paradigmatic example have major implications for inter-organisational co-ordination generally and the division of labour in specific. In recent years, the growth of inter-organisational agreements beyond transactional contracts has been a conspicuous feature of business life. The sheer volume of these transactions has largely defeated systematic efforts to interpret their meaning. Many of these agreements are a consequence of the growing inter-dependence of national economies and the paradoxical rise in intra-industry international trade. Agreements organised under headings such as technology exchange, marketing development and strategic partnership agreements no doubt mean many different things, including different things to the participants as these arrangements evolve. They certainly encompass efforts to co-operate as a substitute for competition as well as efforts to co-operate for the purpose of enhancing competition, although no government has devised an adequate method for distinguishing which of these aims any particular agreement serves.

Efforts to map the pattern of these agreements as indicators of new configurations of market power or influence have only been partly successful. The fluidity of these agreements suggests a different interpretation, one based upon the re-configuration of competencies as firms re-structure their intra-organisational systems of learning in response to new the opportunities presented by technological and organisational innovation. (Teece 1986) provides one of the most useful analytical tools for investigating and interpreting these developments. Beginning with the familiar concept of core competence, Teece makes an important distinction between generic, specialised and co-specialised competencies. The implications of the first two categories are straightforward. Generic competencies are best out-sourced assuming that the capabilities to integrate the results are retained and that there are no problems of monopolisation. Out-sourcing specialised competencies is a straightforward make or buy decision subject to the same considerations with the presumption that a variety
of strategic considerations may favour the 'make' decision. The third category, however, is particularly interesting in that it is created through joint investment of the producer and supplier.

Co-specialised competencies bind two organisations more closely together, creating a measure of bilateral monopoly (supplier monopoly and buy monopsony). If the buyer also has market power in downstream markets the standard economic result is that vertical integration is likely to be a more efficient solution. In many cases, however, the extent of the bilateral monopoly may be small and transitory and changes in vertical structure may be offset by the advantages each company achieves in specialisation. Under these conditions, sustained patterns of vertical specialisation are likely to prevail.

With regard to the issues of learning and knowledge accumulation, there are two distinct possibilities for this type of vertical industrial structure. The first is that the competence shared by the two companies is largely confined to the design and production of the supplied component or service. In this case, the two organisations may localise the learning process to their organisational interface bridging them. The more interesting possibility is that, under these conditions, the value of a particular co-specialised asset of one or the other partner will be influenced by interactions with their other products or services. The supplier may have a need to co-ordinate activities among several different customers or to take account of the 'externalities' arising from the co-specialised competence it is developing with its customer in other business activities. Correspondingly, the purchaser may need to integrate a number of its other activities with the specific product or service being produced using the co-specialised competency. Under these conditions, the relationship between the two companies will evolve over time in ways that are particularly difficult to predict because of the nature of knowledge production and reproduction discussed earlier.

As in the case of intra-organisational learning, the problems of establishing a valuation for particular activities is likely to represent a persistent problem in such arrangements.
Exchanges between the two companies, although formalised through agreements, may result in unanticipated positive or negative spill-overs requiring further managerial control. One possibility is that the intermediate structures characterising the 'old' system of the centralised control may begin to be replaced by new managerial structures designed to govern and control network relationships. Another is that the firms may choose to simplify their relationship in order to reduce the growth of such overhead but risk finding that other networks are able to effectively perform this coordination activity and thereby gain a competitive advantage. Research in this specific area is very much needed; there is little comparative knowledge of 'best practice' within industry and comparatively little empirical academic research in the area.

In some industries, such as electronics, these vertical relationships are simplified by the nature of the technology. Electronics technology is largely based upon the development of arrangements for inter-operability or inter-connection that permit the interfaces between sub-systems to be the locale for interaction between companies. Other types of systems, however, have much broader patterns of inter-dependency. In addition to the need for examining inter-organisational agreements and governance procedures there is a need to characterise the nature of the integration problems that firms face in particular technologies.

Finally, the implications of knowledge production and reproductions discussed in the first section include the potential value of 'recombination' of knowledge from different contexts, (Gu and Steinmueller 1996). Particularly under conditions of rapid market change, the potential for stimulating new types of learning through the reconfiguration of partnership arrangements appears to offer a substantial opportunity. Thus, one source of the inter-firm agreements may be the effort to discover if there are substantial advantages to be had in co-operating with firms having different capabilities or serving different markets. As opposed to the previous line of analysis, this would suggest that the level of inter-firm agreements is the consequence of search and

12 These advantages are further augmented by the possibility that vertical integration may result in loss of sales to the upstream partner as downstream customers (in competition with the downstream partner) find other supply arrangements.
'assortive' mating behaviour among firms seeking to develop new potentials for learning and knowledge creation.

Inter-organisational learning is likely to alternately be a substitute and a complement for the intra-organisational learning processes discussed in the prior section (Section 3). One of the most intriguing questions currently facing empirical research in this area is the detection of specific regularities in the configuration of intra- and inter-organisational structure that follow specific patterns of industrial structure, technological opportunity, or market development. Within the framework discussed so far, these regularities might be identified as stemming from supply-side opportunities for the configuration of learning processes. The message of the next section is that such regularities may also be co-determined by external influences, opportunities to further exploit the international division of labour stemming from trade liberalisation and the ongoing development of the variety trajectory established by Sloan's modification of the logic of mass production.

5. The Causation Question

The previous sections have largely emphasised the supply-side issues arising from changes in the learning opportunities represented by organisational and technological change. These changes are occurring, however, in a particular context. The international trade and financial system is continuing to evolve towards liberalisation allowing the further international division of labour and providing the financing to support this process. Moreover the trajectory of greater product variety is showing signs of further acceleration. Both of these developments may provide further impetus towards changes in intra- and inter-organisational structures for learning and some specific implications for the relative pace and direction of change between these structures. We will begin with the issue of product variety.

Table 1 indicates the recent pattern of change in consumer goods categories in the US market. The fact that this is a rather unusual table is an excellent example how statistical measurement follows prevailing economic models. What it shows is that long after Sloan established the new trajectory for mass production (such as the production of the consumer goods shown in the table) the extent of variety continues
to increase. Indeed, the relatively high rates of growth in several of these categories including the inclusive category of 'consumer packaged goods' suggest that in recent years growth in variety may be accelerating.13

Table 1  Indicators of Increasing Variety in the US Economy

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Number Year</th>
<th>Number Year</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Models</td>
<td>140 1978</td>
<td>260 1998</td>
<td>3.5%</td>
</tr>
<tr>
<td>Vehicle Styles</td>
<td>654 1978</td>
<td>1,212 1998</td>
<td>3.5%</td>
</tr>
<tr>
<td>Breakfast Cereals</td>
<td>160 1978</td>
<td>340 1998</td>
<td>4.3%</td>
</tr>
<tr>
<td>National Soft drink Brands</td>
<td>20 1978</td>
<td>87 1998</td>
<td>8.5%</td>
</tr>
<tr>
<td>New Book Titles</td>
<td>40,530 1978</td>
<td>77,446 1998</td>
<td>3.7%</td>
</tr>
<tr>
<td>Mouthwashes and Dental Flosses</td>
<td>27 1978</td>
<td>130 1998</td>
<td>9.1%</td>
</tr>
<tr>
<td>Levi's Jean Styles</td>
<td>41 1978</td>
<td>70 1998</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

Note: The number of consumer packaged goods is estimated from the shelf keeper unit code registrations, part of the uniform product code standard for standardised point of sale scanners. Sources of other figures are available in the source. In order to computer the CAGR (compound annual growth rate) the original sources approximation of the years of observation 'late 70s' and 'late 90s' have been fixed at 1978 and 1998 respectively.

Source: (Federal Reserve Bank of Dallas 1998)

The increasing variety of consumer goods does not, per se, indicate any bias between intra- and inter-organisational learning behaviour. In the first instance, this is because we are not controlling for the number of firms producing these goods. It is likely that industrial concentration is falling in the production of these goods. However, it is also likely that many of the leading firms are themselves introducing substantial numbers of new products to avoid being drowned by the flood of new entrants. For these firms, is there likely to be a bias between intra- and inter-organisational networks? One

13 Of course one cannot strictly conclude acceleration from observation of levels at only two points in time. However, if one extrapolates backward the growth rates experienced over the past 18 years, the category of 'consumer packaged goods' would have only 780 items in 1962, perhaps an implausibly low level of variety for that year.
possibility is that it is precisely because of the efficacy of such networks that larger firms are able to offer new products. Another is that in order to achieve these higher levels of variety, the larger companies must delegate responsibilities for product management to lower levels in the company and therefore foster intra-organisational decentralisation. Currently available statistics do not provide a broad enough picture to understand which of these two developments is occurring despite the potential significance of these developments for a wide range of public and private sector policies.

The growth of international trade under the expanding liberalisation that appears, despite some resistance, to be likely to continue provides further opportunities for the creation of inter-organisational arrangements of the types identified by (Teece 1986). It is, however, difficult to ascertain the extent to which increases in international trade are being accompanied by the types of division of labour that would involve substantial inter-firm exchange of knowledge. For example, many international co-operative agreements continue to reflect other motives such as market access. Although liberalisation has reduced trade barriers, the significant costs and risks of developing distribution networks and the uncertainties of contractual distribution arrangements suggest that market access agreements remain an important motive for international inter-firm agreements. Correspondingly direct foreign investment further obscures the extent to which networks of knowledge creation and exchange are being extended across firm boundaries or whether firms are being extended over national boundaries. These issues, which are fundamental to understanding whether the new international division of labour is one that is likely to perpetuate past patterns of technological dependency, are obscured by the way that statistics are collected which in turn is the consequence of the model employed for justifying particular statistical records.

Thus the roles of product variety and international trade suggest that substantial challenges lay ahead in the determination of causation. On the one hand, the reconfiguration of intra- and inter-firm arrangements for learning are a possible consequence of the new opportunities offered by information and communication technologies for decentralising or de-localising the primary locus of learning activities. On the other hand, the necessities for decentralisation imposed by increasing product
variety or the opportunities for de-localisation provided by a growing international division of labour suggest that the determinants, while perhaps enabled by information and communication technologies, are more proximately influenced by other factors. The answers to these questions are not likely to lie in 'business as usual' in the gathering or analysis of traditional statistical indicators but in some fundamental new approaches to measuring the influences of knowledge creation and distribution in modern economies.

6. Conclusion

The principal aim of this paper has been to better delineate the issues arising from knowledge in the information more sharply. Ironically, as one more precisely delineates the role of knowledge in the organisation, the greater is the blurring between boundaries between familiar objects of economic analysis. It becomes less clear, for example, that human capital theories can ignore the social context in which individuals live or that the fixed costs of investments in intangible won't have spillovers affecting the value of the firm's prior fixed investments.

The issues of boundaries are particularly important for evaluating the rapidly changing organisational configuration of modern business enterprises. After a prolonged period of 'down-sizing' and the creation of much more complex patterns of inter-firm linkage, the problems of re-localising learning activities within the organisation and managing network relationships between organisations is becoming a central feature of the 'new economy'. These issues are made increasingly salient by the advance of information and communication technologies that create wide latitude in organisational reconfiguration, constrained primarily by the problems of establishing new social norms to limit opportunism and the skills to take advantage of new opportunities.

Whether the new economy will require a new economics is still very much an open question. It is possible to identify many areas where analysing the interaction between organisational reconfiguration and the implications of knowledge reproduction leads into areas where mainstream economics is particularly weak. This paper has cited several specific examples. These include the problems of attributing values in distributed networks with joint economies of production, the valuation of intangible
assets that receive or produce spillovers affecting the value of other assets, and the synergistic affects of 'recombination' of knowledge influenced by dramatic changes in market structure. Approaches for dealing with these issues have been devised by both mainstream and heterodox economists, but generally sacrifice the ability to specify outcomes at the level of the individual organisation.

The contest between alternative approaches is, however, fundamentally influenced by the interactions between theory and measurement. The range of variables influencing organisational behaviour that fall outside of current accounting frameworks is growing. Fundamental changes that must occur at the level of individual organisations will be increasingly influential in reshaping how we view organisations. As companies grapple with the problems of valuing inter-firm agreements, investments in intangible assets such as organisational memory, and changes in business processes and organisation, new empirical information will become available to economists and other social scientists. Those societies that find ways to productively use this information are likely to prosper and the new economics is likely to rise from this new economic context.
References


