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**PATHWAYS TO THE KNOWLEDGE ECONOMY:
Knowledge Processes and Regional Economies**

Working Paper

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KNOWLEDGE IN THE ECONOMY

Knowledge has always been an essential part of economic activity, but the current epoch – beginning with the inception of the PC during in the 1980s and consolidating through the expansion of the world wide web in the 1990s – seems to be qualitatively different in its reliance upon economic knowledge. The kinds of trends that can be identified to support this view include:

- intensified expression of technological knowledge in products and processes on all levels, from organic chemicals to aircraft, from robots to cars,
- intensified demand for knowledge embodied in the workforce and extant amongst service providers,
- the automation of knowledge storage, processing and mediation through digital (and other) means in for instance production management systems.
- intensified formalisation and commodification of knowledge, as a product itself, and attendant concerns about intellectual property rights.

Real changes may be occurring in the economic contribution and importance of knowledge, but as yet we do not have an adequate understanding of these changes and of the ways in which they are impacting spatially across Europe. In particular, *(1) we do not have a good grasp of the ways in which knowledge is contributing differentially and unevenly to the development of regional economies; (2) we do not have a good understanding of the ways in which the regions of Europe are contributing to the development of the knowledge economy.*

The present background paper reviews some of the main literatures on knowledge in the economy by reference to the writings of economists, sociologists and geographers. It then offers a preliminary conceptualisation of the knowledge processes of the economy, including the knowledge value-chain and the knowledge circuits, and generates some hypotheses. Finally, it suggests how this conceptual framework can inform the design and structure of the sixth framework proposal.

The study is thematic in nature, and is intended to address this deficiency by examining the different conditions under which European regions are moving towards the knowledge economy. Conclusions will be drawn regarding the methods that can be used by policy-makers to identify not so much ‘best practices’ but more specifically ‘appropriate practices’ that are available for different regions given their respective starting points and economic bases.

RESEARCH QUESTIONS

The purpose of the study is to understand the temporal dynamics of economically-relevant knowledge in the economies of European regions, in order to inform policies that are seeking to promote the transition of Europe towards a knowledge-based society and to reduce disparities between regions in this transition. The specific policy questions to be addressed are as follows:

1. What different types of economic knowledge are found in different types of regions, and in what ways – as products, as processes, as contextual factors – does this knowledge function in these economies?
2. What are the different trajectories – what starting points and what possible destinations – of regions across Europe towards the knowledge economy?

3. through what generative and communication pathways does knowledge 'flow' into regional economies? Which are the more important, and which are the less important, of these pathways?
4. Under what conditions – intra-regional and extra-regional – have these 'knowledge trajectories' and 'knowledge pathways' been established in the regions concerned, and how have differences in these conditions between regions?
5. What steps can be taken to strengthen the 'flow' of knowledge into regional economies through these pathways? Under what policy conditions (at different levels of government) can the economic contribution of knowledge to European regions be enhanced?

Whilst undoubtedly important, 'the knowledge economy' has been subject to much exaggerated discussion in recent years, leading to potentially misleading claims regarding its nature and significance (see for example Leadbetter 1998). Likewise much current discourse on economic change and policy is – despite the progress of globalisation – couched in terms of the re-emergence of regional economies through intra-regional linkages whether these are in the form of 'new industrial districts', 'clusters', or 'innovative milieux'. The academic purpose of the study proposed here is therefore threefold:

- to critically examine the emergence of the knowledge economy by assessing the diversity of this, the different forms it is taking and different trajectories involved in the different regions of Europe;
- to critically examine the emergence of the knowledge economy by determining the actual nature and dynamics of economically-relevant knowledge in relations between different agents in and beyond Europe;
- to critically examine the significance of physical proximity and intra-regional linkages to this process by determining these dynamics in the context of determinate regional economies across Europe.

We have developed the research theme in a broad way to allow scope to address the topic from different regional and sectoral contexts. An example case study is discussed in Appendix 3.

DISCOURSES ON KNOWLEDGE

Economic approaches to knowledge have generally focused around an examination of the contribution of knowledge and innovation to economic growth, of the conditions under which knowledge production is maximized, and the degree to which knowledge is (or can be constituted as) a public or private good.

Economics of Knowledge

In traditional growth theory it was assumed that increased worker output was governed by increased use of capital. But in the 1950s Solow showed that technological change rather than sheer capital intensity was the key factor in worker productivity and economic growth. During the 1980s this insight was extended by new or endogenous growth theory by arguing that ideas should be treated as making an independent contribution to economic growth and so as an independent factor of production. This reflects a growing awareness that in the case of, for instance, East

Asia the rapid rates of growth experienced reflect less the accumulation of large volumes of capital than the closing of the knowledge gap with the West. For Romer ideas are instructions that “let us combine limited physical resources in arrangements that are ever more valuable” (Romer, 1992, p. 64). Like many other writers Romer asserts an essentialist view of knowledge as existing somehow independently of the texts that ‘express’ the ideas concerned. Ideas cannot be reduced to capital (or human capital) because they are – Romer claims – ‘non-rival’ in the sense that they are immaterial and can be used simultaneously by unlimited numbers of people, with each additional user not reducing the amount available for use by others. Human capital is rival because inseparable from people, “any non-rival good that [a] person produces – a scientific law; a principle of engineering ... a blueprint – lives on after the person is gone” (Romer, 1990, p. 74).

Likewise Stiglitz argues that knowledge is ‘non-rivalrous’: “once knowledge is discovered and made public, there is essentially zero marginal cost to adding more users” (Stiglitz, 1999, p. 8). He acknowledges that: “any material embodiment or encoding of information is still strictly speaking rivalrous”, but asserts that “it is only immaterial ‘disembodied’ knowledge, information, ideas, concepts, functions, and other abstract objects of thought that are purely non-rivalrous. It is the process of embodying knowledge in people (learning) and things (application) that is costly in time and resources” (Stiglitz, 1999, p. 8). Unfortunately, whilst the assumption of immateriality is fundamental to their analysis, neither Romer nor Stiglitz explain how knowledge subsists in the pure or disembodied form.

Drawing on Schumpeter, Romer argues that benefits go to firms because of their temporary monopoly in the ideas they generate. For Romer ideas differ from labour and capital in that they produce increasing returns to scale, giving rise to particular problems of lock-in and path dependency. Stiglitz likewise argues that “knowledge, almost by definition, gives rise to a form of increasing returns to scale which may undermine competition. These concerns are reinforced by the large network externalities, such as those associated with the use of computer ‘languages’. These network externalities have further consequences: they give rise to positive feedback and locked-in effects, which have profound consequences for both equilibria and dynamics...” (Stiglitz, p. 1999, p. 11; see also Arthur 1994). We can agree that a lead in knowledge in a particular field can generate sufficient supernormal profits that the company can secure further knowledge inputs which lead to a circular process of self-reinforcing growth and market power. But whether or not knowledge generates increasing returns to scale depends upon the quality or value of the knowledge concerned. In many settings knowledge has perhaps diminishing returns, in that the more knowledge that has to be waded through in reaching a decision the less efficient the decisions that are made.

Knowledge differs from other goods in that “by definition, each piece of information is different from every other piece of information: intrinsically, information cannot satisfy the essential property of homogeneity that characterises competitive markets” (Stiglitz, 1999, p.13). Once again we have an essentialist concept of knowledge as something immaterial that lies in abstract behind the products which express it. Books or films that contain knowledge or information may after all be similar to each other – each book called ‘The Competitive Advantage of Nations’ is similar to every other book with the same title, and different in similar ways to every volume called ‘The Critique of Pure Reason’.

For Arrow knowledge was viewed as a public good that could not be produced efficiently in markets by profit-seeking agents given its non-excludability, indivisibility, non-appropriability, and therefore non-tradeability (Arrow, 1969). It is therefore down

to public agencies (such as universities), together with subsidised private companies and large corporations with oligopolistic power and barriers to entry supported by intellectual property rights, to generate most new knowledge. Stiglitz likewise argues that knowledge “has many of the central properties of a public good, indeed a global public good” (Stiglitz 1999, p.1). The view that knowledge is a public good was gradually questioned, however, on the basis that it does have a degree of natural appropriability and excludability. In this context it was argued that a major source of knowledge within the economy is bottom-up learning which takes place particularly within the firm and is supported by universities and others (Loasby, 1999; Antonelli, 2003, p.3). Agents learn from their experience in daily routines involving specific contexts, and develop new knowledge in specific domains where they have sufficient competence.

Stiglitz argues that tacit or non-codified knowledge is vital to a company's or an economy's competitive advantage and that it is precisely the quality of this tacit knowledge that informs the appreciation and take-up of codified knowledge in the form of technical manuals and blueprints when these are presented. Hence implementing a new technology in a new environment can be particularly problematic given the absence of tacit knowledge that would render this new technology intelligible and practicable. Furthermore, tacit knowledge in this background sense is difficult to transfer into a new setting, and may represent a major stumbling block to the assimilation of new techniques into developing countries. Likewise the institutional framework of a capitalist economy may need to be transferred into some developing countries, but in the absence of a tacit understanding of this institutional framework great difficulties may be encountered. So tacit knowledge is just as important to governance and institutional change as to business innovation: “economic agents act in a whole matrix of economic, political, and cultural factors, many of which are tacit factors not apparent to the ‘visiting economist’. A quick transplant of a ‘textbook model’ will very likely not take root in the local soil. Instead a longer process of transplanting or grafting is required” (Stiglitz, 1999, p. 5).

Knowledge is available externally to organisations through interactions between firms and other players within and beyond the market, and these external sources have come to be regarded as an important input into the production of knowledge. This appreciation is, for instance, reflected in the “systems of innovation” approach, where the co-operative behaviour of firms and other agents is seen as an important source of the production of new knowledge (Nelson and Winter 1982). On this basis it was recognised within economics that there may be a ‘knowledge trade-off,’ whereby the excludability provided by various constraining factors (from intellectual property rights to barriers-to-market-entry) which give firms the incentive to produce knowledge by preventing uncontrolled leakage, may diminish the beneficial spill-over of knowledge into a public pool from where it can be drawn into production, and so diminish the efficiency of the economic system as a whole: “Excess appropriability, both ex-ante and ex-post, based upon barriers to entry or on intellectual property rights, may slow down if not impede the working of knowledge complementarity, accumulability and fungibility” (Antonelli, 2003, p. 4).

The ‘indivisibility’ of knowledge means that each component of a body of knowledge is highly complementary with all the other components and provides a context that is necessary to the evaluation and use of new pieces. Hence co-operation between knowledge holders is useful as a way of maximising contextual knowledge and exploiting complementarity (Antonelli, 2003b). At the same time this implies barriers to entry for new actors without the background body of knowledge required to contribute. Antonelli argues that firms must achieve an appropriate ratio of internal and external knowledge in order to maximise their output. Localized knowledge

requires not only complementarity between external and internal knowledge but also complementarity between the stock of existing knowledge and the flows of new knowledge. The concept of knowledge as localized means that, with the interdependence of internal and external knowledge, market transactions are unstable and both positive and negative self-reinforcing mechanisms can be established.

The more cumutable technological knowledge is, in relation to the products and processes of a firm, the greater the incentive to internalise knowledge generation. Complementarity between the knowledge required for downstream and upstream activities again strengthens the incentives for in-house knowledge generation (to make rather than sell). When knowledge is embedded in the learning routines of firms, and cannot easily be separated from their organisational structures or human capital, then the value of this knowledge can be realised through selling property rights in the company concerned into the financial markets, a process which Antonelli refers to as the use of financial markets as a governance mechanism (Antonelli 2003a, p. 8).

The establishment of effective property rights system can lead to the creation of markets for disembodied technological knowledge rather than goods embodying it. The weaker the intellectual property rights the stronger the incentive for firms to integrate vertically in the production of new goods when they share complementary items of knowledge, and to rely upon industrial secrecy as a way of reducing knowledge leakages. Antonelli speculates that knowledge is an “essential facility” on a par with the telecommunications infrastructure network, in that it is indivisible, dispersed and fragmented in a variety of uses, and complementary so that “the exclusive access to each bit of knowledge can prevent others from cumulative undertakings” (Antonelli, 2003a, p. 11). He suggests the need to adjust intellectual property rights regimes in order to reduce the rights of exclusive use by introducing mandated right of access to intellectual property for third parties combined with a liability rule which ensures the judiciary will support ex-post payment of fair royalties to the owners of the intellectual property rights. This will enable knowledge interactions to coincide more closely with normal market transactions and increase the scope for valorisation of knowledge complementarities.

Sociology of Knowledge

A concern with the social determinants and social functions of knowledge was built into social science by the nineteenth century founders of political economy and sociology – by Marx and Engels in their discussion of ideology, by Weber in his investigation of the protestant ethic and of the role of ideas in shaping historical events, by Durkheim in his Kantian deployment of the ‘conscience collective’ as the source of intellectual categories and moral authority. The sociology of knowledge sub-discipline stems in particular, however, from the work in the 1950s of Karl Mannheim, who sought to explain cultural meanings by reference to *weltanschauung* and their social and historical context: “the key to the understanding of changes in ideas is to be found in the changing social background, mainly in the fate of the social groups or classes which are the ‘carriers’ of these styles of thought” (Mannheim 1952, p.36).

Subsequently there developed a strongly phenomenological emphasis to the sociology of knowledge, with Berger and Luckmann (for instance) arguing that ‘reality’ is an ideational construct on the part of society, and applying Husserl’s method of reduction to the analysis of social provinces of meaning (Berger and Luckmann 1967). At a micro-sociological level ethnomethodology in particular was interested in the way that the commonsense meaning of everyday activities are

produced in 'accounting practices': "Social phenomena are 'real' because we organize out activities in such a way as to routinely confirm their real existence" (Silverman, 1972, p. 5). There is furthermore a strongly hermeneutic flavour to this work, whereby the 'reality' that social phenomena constitute depends upon the interpretive work of social agents drawing upon their stock of taken-for-granted and tacit knowledge: "our knowledge of the world is organized in a series of typifications which structure our understanding of settings and actors by allowing us to infer the unknown parts of others' motives" (Silverman, 1972, p. 7). At a meso-sociological level Parsons' investigation of value-orientations provided a way of explaining the differential response of people with different values to the same experiences, an approach that was taken up by Goldthorpe and Lockwood and applied to industrial behaviour. There were examinations of educational curricula as bodies of socially-organised knowledge that favour certain understandings and discourage others, and that may be 'culturally selective' in favour of white middle class masculine cultures and against the worlds of ethnic minorities or women. There were also examinations of scientific knowledge as a social construct that bears the imprint of its social origins (Barnes 1974).

At a macro level the investigation of ideology and culture was developed through the work of neo-Marxists such as Raymond Williams, Louis Althusser, or Jurgen Habermas. French structuralism and post-structuralism flourished especially under the influence of Claude Levi-Strauss, has given rise to an analysis of the cultural codes that constitute our worldly understanding, and has informed the development of a specifically cultural politics of difference – of race, gender, sexuality – in the hands of post-colonialist and feminist critics. Here cultural and discursive practices are viewed as sources of knowledge and understanding that reinforce prejudices and inequalities. Post-structuralisms shaped by Foucault, Derrida, Lacan, Lyotard and Baudrillard, and then again by Irigaray, Butler, Spivak, Haraway and Bhabha now dominate the cultural theory of knowledge (in the present context Baudrillard 1975, Lyotard 1991, Haraway 1991, Gibson-Graham 1996, and Spivak 1999 are perhaps the most relevant).

Geography of Knowledge and Innovation

Entrepreneurship and innovation are accepted as the key factors of economic growth. The former, in a narrow definition, drives the major factors of risk and capital investment in classical economics. The second, innovation, defined as the introduction and exploitation of change, has become accepted as the major input to productivity growth (Solow, 1957). Innovation, thus defined, can be viewed as the process through which economic knowledge is exploited for gain. Related to the knowledge value chain, information is converted to knowledge and, via innovation, is exploited. Given its central importance as an economic driver the understanding of innovation and innovation processes has become essential.

Early approaches considered innovation as an end point of a linear process where inputs of capital, in some form, led to an output in the form of some change such as business growth, start-ups or patentable inventions. This approach suggested innovations were 'events' occurring at particular points or places in organisations' trajectories and which caused market or organisational disruptions. In classical economics, such events were seen as being followed by market adjustments that would allow a return to stasis. However, most of recent thought has concentrated on an evolutionary approach focussing on a broad base of interactions and changes where innovation is dependent on a series of interactions and feedback loops between actors. (Kline and Rosenberg, 1986). In such an approach innovation is dependent on previous knowledge and is influenced by accumulated or embedded

knowledge from a multitude of sources – e.g., trading partners, academics, consumers etc. In other words innovation has a strong path dependency and its on-going development depends on the surrounding ‘environment’.

Innovation has therefore been analysed within the context of a systems approach where the system is “all elements and relationships that interact in the production, diffusion and use of economically useful knowledge” (Lundvall 1992). Given the concept of a systems approach, and the clearly observable differences in economic performance of different places, analysis of innovation systems had to have a spatial dimension. Initial comparisons of place led to the ideas around “national systems of innovation” encompassing networks and modes of interactive learning (Freeman 1987, Lundvall op cit, Nelson, 1993) which would include such institutional factors as the public organisation, and financing, of research and education, the private sector capacity, and practice, to provide venture finance and the operation of labour markets.

Other authors, (e.g., Braczyk et al 1997, Cooke and Morgan 1998, often taking particular case studies, concentrated on more localised networks and knowledge interactions under the term “regional innovation systems”. This was not to deny the importance of national frameworks but recognised that many inter-firm and firm-agency interactions were locally based. Secondly, that some types of knowledge, particularly tacit knowledge, seemed ‘sticky’ and inseparable from locality. There was also the obvious point that economic performance could be differentiated at a lower level than the national state in many instances. Sectoral case studies have also indicated that different degrees, and quality, of interaction occurred in different places. (e.g., Carrincazeaux, Lung, Rallet, 2001). Interest in innovation, and the idea of a systems approach at regional level, led to lines of enquiry that sought to identify the characteristics of successful regions and frame these into policy recommendations.

A new body of work, loosely called regional science, emerged at a time of up-set to the global order and the end of the Keynesian economic consensus. There was an expansion in the internationalisation of business; increased power of global corporations; the emergence of supra-national blocks plus increased open-ness of trade rules with restrictions on individual nations’ ‘anti-competitive’ practices. The ‘decline of power’ of individual nations led to regions becoming identified as the level at which detailed policy could be implemented - with the nation state, or the supra-national block providing the overall architecture. National industrial policy found expression at a regional level and concepts were developed to put a tangible and predictive perspective on the ‘something in the air’ concept of local proximities. (Marshall, 1919). Knowledge, and learning, as the base processes of innovation are central to the regional economic model. If innovation depended on the use, or conversion, of existing knowledge and the assimilation and feedback of new knowledge then the ways in which this might happen became central to the enquiry. The innovation system, which interlocks at regional, national or supra-national level, provides the social and institutional framework through which economic knowledge flows.

Feedback loops improve the knowledge (learning) and lead to further innovations. Interactive learning and the social context in which it occurred were seen as key elements in economic success. The GREMI Group considered local production systems and interactive learning and developed the concept of the ‘milieu innovateur’. Such a milieu operated through networks and cooperating institutions to deliver a series of un-traded interdependencies (Storper, 1995), in other words knowledge exchanges which would lead to regional advantages, and embedding of

firms, that would not be easily lost to market forces. Porter's (1990) clusters model identified the factors of successful interaction. Though based on inter-firm competition rather than cooperation, and referring to the national level, Porterian clusters were seen, in policy terms, as tangible and supportable expressions of networks for knowledge creation, transfer and conversion to economic good (innovation). Terms such as social capital and relational capital (Camagni, 1999) were used as metaphors for the system of knowledge exchange at local level.

There are considerable literatures on both innovation and knowledge yet despite the close relationship between them there has been relatively little seeking to connect the two (Howells, 2000). Innovation, being more tangible, is easier to deal with and is, therefore, often used as a proxy for knowledge, i.e., knowledge must flow around the innovation system – but what sort of knowledge. The innovation approach fails to account for the complexity of knowledge (see Allen, 2000) taking into account only certain types and making artificial spatial divisions between them. The geography of knowledge and its provenance and flow is more complex since it involves inter-relationships between people and a wider range of proximities – shared understandings – than just physical locations.

In addition, a political dimension has accompanied social and economic aspects of regional science. In Europe, in particular, the growing influence of the EU as a supra-national body has been accompanied by a debate on devolution, subsidiarity and multi-level governance. These bring an additional dimension to both enquiry observation and understanding of knowledge and innovation, in the first instance, and framing policy to 'make a difference'. Inevitably, consideration of governance issues makes us consider the relationships and influences at multi-level rather than in disembodied regions. (Cooke, Uranga and Extbarria, 1998). Thus we need to combine a sectoral and regional approach that examines innovation and knowledge in a broad geographical context, seeks to include the governance and societal parameters that influence knowledge processes and considers in more depth the different kinds and representations of knowledge.

THE MEANING OF 'KNOWLEDGE'

According to Allen "the field of economic knowledge has been delimited largely to that of cognition..." (Allen 2000, p.18). The result is that in much economic discourse it is the work of engineers and scientists, technologists and innovators, in telecommunications and information-based services such as banking that is most readily acknowledged. On the other hand "outside of the scope of knowledge, on this reckoning, are those activities which appear to possess few, if any, of the qualities of reason, analysis and judgement" (Allen, 2000, p. 18). The formal, cognitive view of knowledge is reflected in the writing of Daniel Bell from the 1960s and 1970s, and subsequently in Castells' work on the network society, and is contrasted with Storper's and Salais' analysis of intimate worlds of tacit knowledge production based on convention and custom (Castells 1996; Storper and Salais 1997). Reich has argued that the manipulation of symbols in one form or another is central to what professionals do in order to add value to the economy, and Reich coins the term "symbolic analysts" to refer to their activities. But Allen points out that symbolic analysis is involved in engineering as well as finance, design as well as marketing, traditional as well as so-called creative industries. The production of any good or service is likely to involve a mixture of expressive and analytical symbolism, so that creative industries for instance involve not just aesthetic judgements about the product but also technical and financial ones.

Drawing upon the work of Ernst Cassirer, Allen proposes three different forms of knowledge – expressive, representational and abstract symbolic – which were intended to show that abstract theoretical and technical knowledge is not the only type:

- expressive knowledge is a non-discursive and tacit mode of experience (“a structure of feeling”) akin to the Aristotelean ‘poesis’, involving the manipulation of symbolic codes (such as music) for aesthetic or affective purposes;
- representational knowledge involves languages or quasi-languages that produce cultural meaning and may (or may not) stand for the real world;
- symbolic abstraction involves numerical and other kinds of scientific conceptualisation as used in mathematics or physics, for cognitive manipulation (akin to Aristotelean ‘techne’)

As we have seen, mainstream economics tends to assume an essentialist view of knowledge as an ideal object that subsists purely in abstract behind any particular expression, is therefore ‘non-excludable’ and is ‘the same’ in whatever medium. But just as there can be no detachment or gulf between the mind and body, so it is unhelpful to regard knowledge as immaterial and residing in some disembodied realm of ‘ideas’, detached from ‘labour’ or from ‘capital’ or indeed from texts of various sorts (as is assumed by Romer and other endogenous growth theorists)¹. On the contrary, knowledge subsist always and only as an attribute of ‘matter’ – a differential attribute – whether this is sentient or non-sentient, labour or capital.

Allen’s contribution is important because it extends the concept of ‘knowledge’ to include more than simple techné. But he cites Castells’ definition of ‘knowledge’ (“a set of organised statements of facts and ideas, presenting a reasoned judgement on an experimental result, which is transmitted to others through some communication medium in some systematic form” (Castells 1996, p.17)) without discussing its implications, and questions only its cognitive focus but no other aspect. For Allen: “if knowledge amounts to more than streams of data, flows of images or reams of information, then the faculty of judgement ... is central” (Allen 2000, p.25). Without this qualification knowledge apparently shades into culture more generally and its specificity is lost, but precisely the degree to which judgement is distinct from knowledge is not examined, and surely all culture is involved tacitly in the process of judgement?

The conceptualisation and definition of ‘knowledge’ is decisive in determining our understanding of how and where this subsists – how it is produced, communicated and used – and so how it can be treated within the social sciences. There are several considerations here:

- The coexistence of a plurality of different meanings of ‘knowledge’ between the social sciences (between economics, sociology, cultural studies, linguistics), whilst a source of creativity in the short term, is ultimately a weakness that needs to be addressed if a cross-disciplinary approach is to be established.
- The development of ICT, and the contribution of this to knowledge generation, means that we need to find a way of addressing knowledge that does not presuppose a radical discontinuity between people and machines.

¹ Rather than opposing the mind to the body it may be more fruitful to regard this as another side ‘of’ the latter: “Merleau-Ponty’s favored depiction of this ‘side’ of his ontology seems to be in terms of ... a folding space or a hollowed-out space ...” (Cataldi 1993, p.65).

- At the same time, it is important not to equate knowledge to information technology – whilst knowledge in various formats is built into computers (e.g. as codes), and computers support knowledge in various formats (e.g. pictures on the screen), computers per se are not sign systems. Items that specialise in knowledge production and storage do not necessarily *comprise* knowledge themselves – computers are not texts or pictures even if they do present these.
- Human knowledge should not be conceptualised as somehow disembodied, ideal and mysterious, but equated to its ‘presence’ as systems of signs sustained in various contexts.

One approach that may be helpful to cross-disciplinary working is to define knowledge as a set of symbols that evoke meanings of one sort or another, from *affective states* (in the case of, say, music) through *mental or sensory images* (in the case of novels or films), to *analytical or practical understandings* (in the case of science reports and technical capabilities). Following Saussure we can argue that signs produce meanings (including ‘ideas’), and that they do so in the first instance not through the process of referring but through their articulation with one another in systems of differences. In an economic context ‘knowledge sectors’ or activities may be defined in terms of their products, as *economic activities the primary product of which is a configuration of signs or symbols that can be traded as a commodity*. Just as it is through the differences between signs that meaning is produced, so it is in the composition of these systems of differences that knowledge goods are produced, that they signify, and that they may operate to yield surplus value. Knowledge goods feature both as final products and as inputs to production. Indeed the circulatory model of the economy reminds us that final products are inputs to what we might call reproduction, including not only factors of production but also the production of these and of the ground rules and institutional frameworks that constitute the capitalist economy. But (contra new growth theory) as knowledge subsist always and only through material objects it cannot function as a ‘separate’ factor of production but must be regarded as an attribute of such factors.

The kinds of semiotic formats or products that are important economically include *texts* (news stories, policy papers, horoscopes, ‘instructions for combining limited physical resources’ (Romer’s ‘ideas’)); *numbers* (digital codes or bank statements); *sounds* (speech or music); *still images* (drawings or photographs); *moving images* (TV programs, feature films and computer games); and combinations of these. These items may subsist as ink-on-paper, notes in the air (e.g. a concert performance), coloured marks on canvas (paintings), in electrons-on-pixels in machines, electric charges on disks and tapes, or chemical processes in people’s heads (memories and imaginations). Knowledge is ‘stored’ in various format, such as hard drives or grey matter or textbooks, and ‘flows’ across formats through ‘translation’ processes involving ‘reading’ and ‘writing’ (the file in the hard-drive is ‘read’ to the screen, the book or the unconscious memory is ‘read’ to the conscious mind; the hard-drive ‘writes’ to the screen or the printer, the unconscious ‘writes’ to the conscious mind). Many types of product are dedicated formats (such as the book, telephone, computer network), whilst others do this as an ancillary part of their main purpose (such as the words written on control buttons).

Like any ‘good’, knowledge varies in value from positive through to negative. Not all knowledge is equally valuable, and some is of negative value – people want to avoid the ‘cost’ of having to acquire certain laborious and extraneous types of knowledge (such as those involved in overcoming product failure). In a business context the value of knowledge lies in its contribution to the realisation of profits and the expanded reproduction of capital. In a leisure context the value of knowledge lies in

its contribution to pleasure and to consumption. The production and circulation of knowledge is therefore animated and occurs only in so far as it is thought likely to contribute to these ends, and is organised and selected according to this. The difference between 'useful' and 'useless' knowledge is key, yet the costly process of distinguishing and separating these is often overlooked.

Knowledge is *embodied* in all goods, and is *engendered* by all goods in their operation. But perhaps knowledge need not be contained in all goods (despite the words written on them, or their styling symbolism, or their radios, cars are not primarily symbol systems)? Perhaps knowledge is only delivered to the user when the good is a knowledge or semiotic product? But it may be argued that, given the symbolic nature of our worlds, every good whatever its function (e.g. a car for driving to work) always also performs a semiotic function (e.g. conveys a message about – e.g. – safety or virility or taste), and so that there is no such thing as a non-semiotic good. Likewise, every semiotic good functions in a practical way for the achievement of various goals – whether these are emotional, cognitive or physical – and so every semiotic good is simultaneously practical (on this point see Staten 1984).

Knowledge is an economic factor that is at the disposal of capital like any other factor and product of labour, and will be created in whatever forms and magnitudes contribute to expanded accumulation. It will therefore be reorganised, penetrated and moulded, to suit the needs of capital, and only 'reflect reality' to that extent. Other words for 'embodying' from economics are 'designing' and 'innovation' as well as 'production'. Other words for 'learning' are 'creation', 'invention' and 'enskillings'. Other words for 'composing' are 'writing', 'designing', 'crafting', 'composing', 'appreciating', 'interpreting', 'reading'.

MICRO-PROCESSES OF ECONOMIC KNOWLEDGE

Knowledge is implicated in every economic activity and in every economic good. But if we are to clarify the special characteristics of the economic role of knowledge during the current period, and the ways in which this is working itself out at different spatial scales including the regional level, then we must begin by describing how knowledge participates in the generality of economic activity. It is possible to identify three basic forms of the engagement of knowledge (defined as above) in economic activity:

1. *Embodiment*

Every economic good (in the widest sense including land, raw materials, capital equipment, skilled and unskilled labour, finished goods and services) presupposes the knowledge used in its production. Indeed production may be viewed as the process of expressing or embodying this knowledge – both its strengths and limitations – in the form and content, and indeed the value or utility, of the goods concerned. Coal, which can be extracted from the ground, may be said to 'embody' the knowledge required for its extraction and preparation, from the knowledge of geologists and financiers to the knowledge of managers and coal hewers. Likewise episodes of 'Big Brother' may be said to embody the knowledge required for their planning, staging, recording and editing, the knowledge of programme producers as well as the knowledge (and ignorance) of participants. Even services, such as a taxi-ride, embody the knowledge of their production, of the taxi-driver and of the customer. Indeed whether skilled or unskilled, the workforce embodies the knowledge used in its education and training (the 'know-how' of parents, teachers,

the workers themselves). 'Human capital' – which is really an attribute of labour – is itself therefore (re)produced through a circuit involving knowledge.

The knowledge that is embodied in goods is distinct from the knowledge required for their use and is not generally required by the user – it is not necessary to know how to make a computer in order to know how to use one. The knowledge involved in production (whether of coal, TV programmes, workers or spy-planes) is therefore not necessarily shared by the user or consumer of the products, or by the 'products' themselves (where these are other people). Although knowledge used in production is not 'coded into' the goods concerned, it is usually possible to deduce something of a perhaps limited nature about its contents by analysing the items concerned (through for instance the disassembly of a crashed US spy-plane in China).

Just as each good embodies the knowledge used to produce it, so succeeding generations of equipment – and of workers – may be said to embody the knowledge (and other goods) involved in producing preceding generations. The 'Solow residue' (the role of better as against more capital in production and growth) reflects a belated acknowledgement amongst economists of this knowledge accumulation process.

- Generally speaking it may be argued that there has been a long-term trend towards the expanded and intensified accumulation of embodied knowledge, with each generation of technology and skills to some degree building upon and embodying the knowledge of previous generations (hypothesis 1).
- However it may equally be argued that this process is not linear, but involves 'punctuated equilibria' of creative destruction in which paradigms embodying certain knowledges are established, operate effectively for years, and are then superseded by new paradigms that displace older ones and the knowledge they embody (hypothesis 2) (Schumpeter 1994; Kuhn 1962).
- One of the ways in which the current epoch may be conceptualised is in terms of a paradigm shift in the nature of culturally defined 'normal knowledge' since the 1980s, towards computers and DNA, language and signs.

2. Composition

Knowledge is produced when people (or machines) draw upon their experiences to create knowledge through a process of 'composition'. This occurs in the process of perception, for instance, when 'raw experience' may be reflected upon and used to produce 'texts' whether written or spoken or in some other format. But at another level it also occurs in report writing, where previous texts are reflected upon, assimilated and woven into new texts. It is therefore possible (at least to begin with) to distinguish two kinds of 'composition' depending upon the sources used – from direct or non-semiotic experience (such as using a car or other 'primary-sources'), and from indirect or semiotic experience (such as reading books or viewing films or other 'secondary sources'). The former is sometimes referred to in the literature as *learning* and is based on 'first-hand experience' (usually interactive), whilst the latter is referred to here as *translation* and is based upon 'second-hand experience'.

a. 'Learning'

Every economic good requires the knowledge needed for its use, and will over time engender this knowledge by stimulating users and encouraging *learning*. Each new car that is driven, just as each new colleague that is worked with, stimulates

knowledge production peculiar to the interaction, and also probably reinforces skills of a more general nature and contributes to more abstract knowledge production. This knowledge will often take the form of tacit 'know-how' – inarticulate capabilities and techniques 'learned-by-doing' for the most effective ways of working with the item or person. But it may also be codified to varying degrees in manuals, user-guides or office opinion. The knowledge that is produced during learning is not necessarily shared by the producer. A violin may enable someone to become a virtuoso without the violin-maker being a virtuoso, and the reader of a book may derive things from it that were not intended or even known by the author.

People are highly selective about the types of knowledge they want to have produced, given the labour-cost involved. In 'learning' knowledge is engendered through 'consumer' labour as well as producer, and this labour may be positively or negatively valued. A particular skill which is required by producers is to strengthen a product's appeal by understanding and moulding the experience of use, simplifying this by reducing the amount of learning required for effective use, or increasing its rewards.

- Goods are intended to engender some kinds of knowledge labour – the desirable kinds – (e.g. video games) and to avoid others. There is a broad trend towards 'managing' the amount that needs to be known and must be engendered in use in order to reduce the 'knowledge-labour costs' of use and therefore strengthen the appeal of products (hypothesis 3).
- Each new generation of technology is informed by learning stemming from previous generations, and from subsequent discoveries, and this learning contributes to the accumulation of knowledge embodied in technology. The production of knowledge like any other economic good generally requires (for the time being) some input from both 'labour' and 'capital', and is costly in terms of each of these. But over time the proportion of 'capital' in relation to 'labour' – human labour – in knowledge production has grown, and this process has been given a significant boost by the expansion of ICT. The current era differs in that machines ('capital') can embody and learn and translate with diminishing inputs from labour. Capital accumulation has always captured not just the products of human labour but also the capacities of labour-power itself. Each advance in ICT 'liberates' knowledge production from human labour, taking not just the products of embodying and learning but also the capacity of embodying and learning into machines and 'capital' themselves (hypothesis 4).

b. 'Translation'

Some economic goods comprise knowledge in one format that has been composed by reference to knowledge in other formats through the inter-textual process of 'translation'. These goods – semiotic goods – require the knowledges that translations are composed from as well as the knowledge that is 'embodied' in their production (knowledge for instance of writing or of printing or of business). An example would be the translation of literature – an 'original' poem in French is required that can be translated to become a 'new' poem in English. A different example might be the telephone system, where spoken words generate electrical signals that are divided into labelled packets, dispersed throughout the network, and reassembled at the other end as a sequence of electrical signals that can generate similar words. A third example, however, would be the very process of reading itself (where text is interpreted and assimilated and perhaps remembered) and of writing (where text is 'translated' from thoughts).

Rather than thinking of these examples as 'one meaning' that is first encoded then decoded (which involves an essentialist view of meaning, and down-plays the creativity involved in reading and remembering) it is better to see these as forms of 'composition'. The process of taking knowledge in one format (in Japanese, or in grey matter) and producing 'the same' knowledge in another format (e.g. English, or computer text) is by no means simple. The changes that occur during the translation – in format, setting, personnel etc – mean that the knowledge in one format is similar to, but never the same as that in another format. 'Translation' is therefore not to be understood as passive transliteration or mere copying, but more generally as an active process of reception and conceptualisation, of production of knowledge in a way that always echoes but also escapes the 'original' (see Bhabha, 1990; Benjamin, 1982). We cannot therefore treat knowledge as an essence that is detachable from its format and unconstrained by material scarcity issues – even knowledge 'in our heads' is stored there and called up as required.

Where the product is itself an item of knowledge, the knowledge needed to produce this knowledge (e.g. typing) is still embodied in it whatever else is written there as well. 'Translation' differs from 'embodying' because the knowledge that is written there differs from the knowledge of writing itself (or of typing or printer) but embodying is always involved in translation. Likewise 'translating' may always also be a 'learning' process, but 'translating' differs from 'learning' in that the knowledge learned from the process of translating (e.g. about format characteristics and differences) will be wider than the knowledge that is actually created or composed by the translation. When knowledge is stored it may be supported by a code that can generate the knowledge but differs from this knowledge itself. Hence the computer language that sustains the storage of the text now being written is not itself English, and neither are the electrical signals in the telephone system that generate messages. The storage – or more accurately 'generative' – language may not (and perhaps will not) be the language of the knowledge itself.

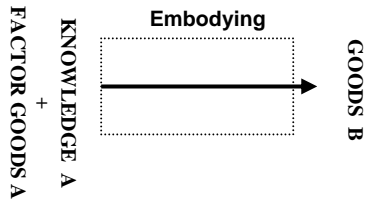
c. 'Learning-and-translation'

Some 'goods' – usually workers and machines combined – are employed to respond to situations (problems and opportunities) in specific fields by learning from these and producing knowledge in the form of rules of thumb, designs, manuals, research reports, news bulletins, TV clips, fictional pieces or paintings (e.g. war artists). But all workers and machines learn all the time in other less conscious ways. Here we have the production of knowledge.

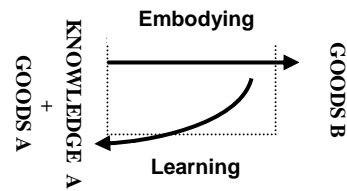
Not all learning is derived from first-hand or 'primary' experience. Some – perhaps most – learning is 'secondary' in nature, and mediated through translation of other forms of knowledge by such as reading literature or conversation. Indeed the interpretation and even the constitution of first-hand experience is deeply influenced by prior understandings and knowledge, and is therefore 'grounded' in the second-hand. But this secondary learning itself relies upon first hand experience of these 'secondary sources' and is itself 'grounded' in a different way in the first-hand. 'Translation' involves 'first-hand experience', the experience of perceiving or reading and of composing, and knowledge can be generated – by learning – about this experience which is not the same as the knowledge produced by 'translation'. All learning is therefore at one level secondary (or 'non-local') just as at another level all learning is also primary (or 'local'). All learning is therefore learning from 'use' of one kind or another, and all knowledge is generated through a learning/translation process of one sort or another. Knowledge is implicated in all goods, whether semiotic products or otherwise. Translating involves a kind of learning, and learning involves a kind of translating.

Chart 1: the Micro-processes of Economic Knowledge

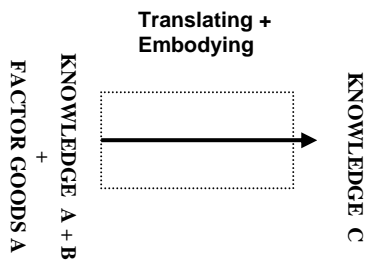
1. *Simple-good Production*



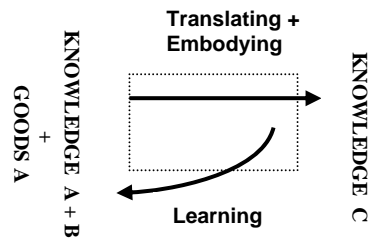
2. *Simple-good Production with Learning*



3. *Knowledge-good Production*



4. *Knowledge-good Production with Learning*



3. Dissemination

Knowledge items in various formats may be disseminated through outlets as a commodity, or exchanged informally, or given away. Hence a film is disseminated when it is put into a cinema, a book when it is sold through a bookshop or provided through a library, a play or concert when tickets for performances are sold or given away. The dissemination process – as we shall see below in the discussion of the value chain – is distinct from the reception, reading and appreciation of the product.

MACRO-PROCESSES OF ECONOMIC KNOWLEDGE

So far we have suggested that knowledge is produced through a combination of 'learning' and 'translation', and that it is 'embodied' in the goods whose production it permits and informs. The four basic micro-processes outlined above attempt to describe the involvement of knowledge in the economy. Their micro-character means that they will probably occur throughout the economic cycle at a day-to-day level. But they also seem have a kind of fractal character that enables them to be used to generate an account of the macroscopic role of knowledge in the economy, in which there is the production of knowledge items, their circulation and consumption, as well as the governance process that tries to hold the ring together. Our starting point here is the knowledge-value chain. This section provides the basis for the work programme.

Knowledge Value-Chain

So far we have suggested that knowledge is produced through a combination of 'learning' and 'translation', and that it is 'embodied' in the goods whose production it permits and informs. The four basic micro-processes of knowledge outlined above attempt to describe the participation of knowledge in the economy. Their micro-character means that they recur throughout every stage the economic cycle from production through circulation to consumption and reproduction. It also means that they recur at every social scale from the firm to the market to the system, and at every geographical scale from local through regional and national to the global.

But nevertheless these categories may be used to inform the development of a macroscopic account of knowledge in the economy, in which knowledge goods are produced, circulated and consumed in the expanded reproduction of the means of knowledge production. A starting point here is provided by the notion of 'knowledge value-chains'.

Chart 2: the Creative Industry value-chain

1	2	3	4	5	6
Creation	Making	Dissemination	Exhibition/ Reception	Archiving/ Preservation	Education/ Understanding

Source: Naylor et al 2002, p. 18-22

In a useful contribution Naylor et al have produced the schema set out in Chart 2 to describe the value-chain in creative industries. The utility of this is that it helps to move us away from a manufacturing-based concept and can be adapted to the production of knowledge. Where knowledge is concerned the 'value-chain' (in the widest possible sense) involves the composition of texts of various sorts through the stringing together of episodes of learning-and-translation as follows:

- I. items of knowledge are **composed** during informal learning-by-doing as well as by formal research and 'translation'. These items may be composed in formats that are more or less ephemeral or inaccessible (e.g. people recalling memories; images being produced on a small screen);
- II. these items form the basis for new compositions that are **(re)produced** as knowledge items in other formats that are more durable or accessible than the

- 'originals' (e.g. computer systems 'writing' material from the screen to hard-drive; events on TV or radio or 'live', objects such as cds or newspapers);
- III. these reformatted items – events or objects – are **disseminated** by being sold as commodities in shops or exchanged informally in networks or given away (e.g. knowledge externalities);
 - IV. the items concerned are received and **read** by people – applied by them to compose another item of knowledge, a 'reproduction' in yet another more personally-useful format (such as a played cd, a personal experience or memory, a saved PDF document);
 - V. reception-knowledge on the part of knowledge-users – reading and using skills – are part of the value-chain without which there can be no translation and embodiment, no **reception** and so no circulation of knowledge items; these must therefore be produced through schooling – itself the interactive composition of reception knowledge through the combined efforts of teacher and student – through the operation or the wider culture or 'knowledge-commons', or through 'programming' of some other sort.
 - VI. they may also be **used** in a further stage of production, either embodied in a service or good (if the designs for – say – a house) or used in translated-and-learning to compose new knowledge in another format (such as a book or a film).
 - VII. Knowledge-items may be amenable to being stored, and the **archiving** process often involves second order composition of taxonomies into which other knowledge items can be categorised (such as the Dewey decimal system in libraries).

Knowledge Economies and Nested Socio-Economic Scales

The value-chain approach – at least as set out above – details a circular model of the production, dissemination, consumption and reproduction of knowledge which views this one integral strand in the circuit of capital accumulation. The next step from knowledge micro-processes towards macro-processes involves simplifying this value chain sequence and adding in some more economic and institutional realities. In particular, whilst the value-chain sequence addresses the production, dissemination (or circulation), consumption and reproduction of knowledge, it ignores critical processes of governance (which establish the conditions of circulation through for instance IPR regimes, and the supply of knowledge from public sources such as Universities). It also ignores or down-plays the contribution of the stock of taken-forgranted knowledge held in the culture or knowledge-commons:

1. *Production* – knowledge embodied in goods and services knowledge of different sorts is embodied in the workforce and in other means of production (land, equipment, buildings etc), and is applied in the combining of these in production processes. The enterprise – every enterprise – entails labour and management processes involving interaction between people and means of production in which knowledge plays a crucial part. Knowledge is a fundamental component of 'labour' (both reflected in this and contained within it), whether this is white-collar or blue-collar, skilled or unskilled. The 'knowledge' involved will be implicit or tacit – 'know-how' in which activities are 'grooved' and technologies acquire a ready-to-hand invisibility. And it will be explicit or reflective – 'expertise' in which activities involve directed cognition and technologies gain a present-at-hand facticity. The labour process involves the *informing* of labour by learning, including knowledge and understanding of both sorts, by the means of production – here labour learns from the machine or the system. It also involves labour *reforming* and revising these means of production out of its experience and learning. And finally it involves labour *embedding* its knowledge in the goods or

services it produces. As each generation passes so the quantity of knowledge embodied (e.g. in technology, systems, institutions, or workers) grows.

2. *Circulation* – knowledge is a key factor in the operation of markets amongst agents, and in other allocation mechanisms through which goods and services circulate – from learning and translation – knowledge is embodied in economic transactions and derived through learning from these transactions. Networks, markets. But to capital formation, labour reproduction we may add the knowledge production process – a dimension of the circuit of capital, that is intensifying. Between the public sphere and the private, or the community and the private, knowledge is extracted into a privatisation process (e.g. Genome project). This involves commodification. Between the private sphere and the others, knowledge diffuses and informs hegemonically our world and our tastes.
3. *Governance* – knowledge is contained and embodied in institutional and cultural frameworks that sustain and regulate business and market activities. IPR regimes, public support or the emphasis upon the privatisation of knowledge. Regimes of knowledge codification according to Mode I or Mode II architectures. Can knowledge be regarded as a separate factor of production given that each factor already ‘contains’ knowledge in the above ways? Role of governance in the commodification or diffusion process.
4. *Society and Culture* – the tacit or codified stocks of knowledge extant within the knowledge-commons represented by the wider cultures of society. The characteristics and qualities of this environment are critical in determining the ability of the society to use and to generate knowledge.

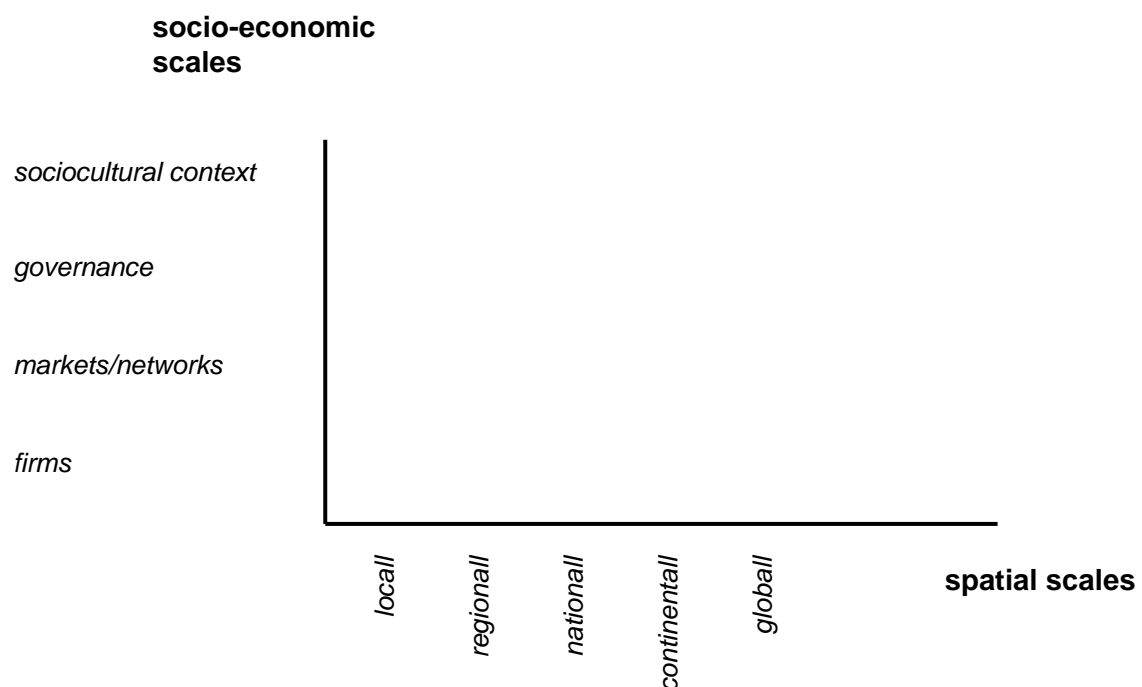
There is also second to n^{th} order cycles too, with ‘management’ and ‘policy’ knowledge observing these cycles reflexively and their institutional ordering embodying and learning knowledge at the removed orders. Leading to new management techniques and arrangements. A distinction has been drawn between technical and local ingenuity – or knowledge – as an addition to new growth theory (Homer-Dixon 2000, p.232). Social knowledge underlies institutional frameworks etc

Regional Economies and Nested Spatial Scales

The viability of each company, and of the economy as a whole, depends upon its ability to combine activities that are organised across a range of different spatial scales. There are a number of advantages to be gained by firms from larger scales of organisation. In particular, they give access to a larger pool of capital, suppliers and workers; a more differentiated spatial division of labour; larger markets and associated ‘volume’ economies; and links to more powerful governmental institutions. There are also, however, certain disadvantages attached to larger scales of organisation. These require, for example, the establishment of complex co-ordinational linkages to forge organisational cohesion within capitals at the scales concerned. Smaller scales of organisation may make businesses more responsive to the needs of a plurality of niche markets. Successful capitals will through trial and error tend to adopt a scale division of labour that is ‘optimal’ in the sense that it balances the merits of different scales for different activities (on the scale division of labour see Cox and Mair 1991).

The performance of any firm considered in isolation depends amongst other things upon the suitability of the scale division of labour which is established amongst its various activities (purchasing, investing, producing, selling) to the methods of

production it is adopting and to the opportunities it is attempting to exploit. The *optimum scale division of labour* for each sector is the one which is most suited to that sector's requirements given the prevailing technological, market and institutional conditions. Capitals that are able to change their scale division of labour, and thus maximise the advantages of a larger scale of operation for some functions and a smaller scale of operation for others, may gain access to a new realm of opportunities that permits these to displace or assimilate other capitals. As regards the performance of systems of accumulation, however, this depends upon the suitability of the scale division of labour which is established not only between capitals but more generally between the different moments in the circulation of capital (such as labour supply, finance capital, commodity supply, production, exchange, consumption). The optimum scale division of labour for the accumulation system – which represents the best combination of large, medium and small scales for different accumulatory activities – is also determined by the technological, market and institutional conditions associated with each regime of accumulation (Collinge 1992, 1999a, 1999b). Combining the two 'scale orders' we arrive at a framework that can inform the structure of the projects:



CONCLUSIONS

Knowledge has always been the principle ingredient in labour, however unskilled, and to operate a tool or a pen presupposes some level of knowledge on the part of the worker. So when labour power is purchased this necessarily includes the power of thinking and knowing. Likewise knowledge has always been embodied and engendered by capital equipment, however primitive, when this is produced and used. Knowledge has not, however, always been comprised within capital equipment. But knowledge has always been a product and therefore a capital item. What is new about the current era is the intensification of all these processes, the conversion of knowledge in a significant part of capital and its commodification capital equipment, and the extent of the commodification of this. In particular, it is the capturing of knowledge production capabilities within capital itself.

Despite the rhetoric of immateriality surrounding his work on knowledge Leadbetter does in fact recognise the costs associated with its distribution and its realisation as an economic good. "A recipe is just information; to bring it to life, the cook has to interpret and internalise it by making his own judgements... Information can be transferred in great torrents, without any understanding or knowledge being generated. Knowledge cannot be transferred; it can only be enacted, through a process of understanding, through which people interpret information and make judgements on the basis of it" (Leadbetter, 1999, p.29). Knowledge distribution is therefore dependent on a costly learning process though he does not fully explore these processes and their role in generating scarcity in knowledge.

His key focus is on the changing manner in which knowledge is distributed. He argues there has been a shift from inefficient tacit distribution to more efficient transfer through explicit or codified means.

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