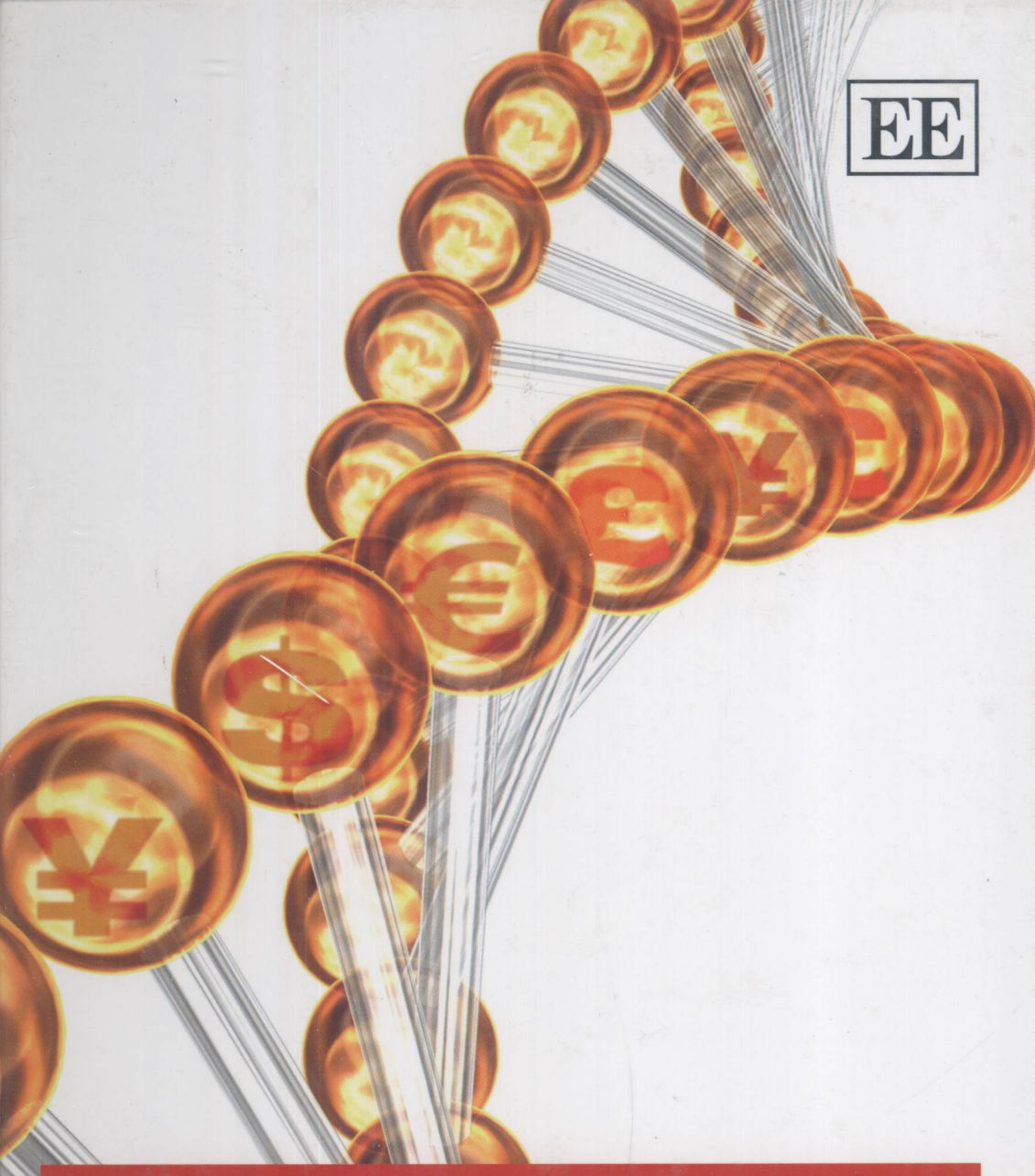

Public or Private Economies of Knowledge?

Turbulence in the Biological Sciences

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M.H.
A.M.

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1. Making knowledge public and private

TURBULENCE IN KNOWLEDGE, TURBULENCE IN ECONOMY

> The genomic sequence we were producing and dealing with is more than a commodity. It is the essence of biological heritage, the instruction book for living things. . . . The only reasonable way of dealing with the human genome sequence is to say that it belongs to us all – it is the common heritage of humankind. (Sulston[1] and Ferry, 2003)

> Strains on basic scientific values are exemplified by the public–private competition that arose during the sequencing of the human genome. While this competition accelerated initial availability of the genome sequence, it did so at considerable cost to the health of the interface between science and society. (Olson, 2002[2])

> Our actions will make the human genome unpatentable. We expect this primary data will be used by us and others as a starting point for additional biological studies that could identify and define new pharmaceutical and diagnostic targets. Once we have fully characterized important structures (including, for example, defining biological function), we expect to seek patent protection as appropriate.
>
> In effect, this new venture is the private sector recognition of the importance of the Human Genome Project. By working closely together, NIH, DOE and other public and private institutions can help meet the goal of having a complete map and sequence of the human genome sooner than anyone ever imagined.
>
> I hope that after this hearing you view both our announcement and the federal program for which you are responsible as not an 'either/or' proposition, but instead focus on how these two activities working in tandem can ultimately improve our lives and those of the generations to come. (Venter, 1998[3])

> Anything that drives science forward is good. We're all better off because we have access to the [rice] genome data today instead of waiting for some 15-year public program. (Bio-IT World, 2002)

Over the past few decades, we have witnessed an outburst of debate over the acclaimed revolution in biological science (Zweiger, 2000; Gilbert, 1991; Strohman, 1997) and, at the same time, as the above quotations demonstrate, intense controversy over what kind of economic good this

new biological knowledge is or should be. We do not think this is a coincidence. Upheavals in production of knowledge (scientific–technical) generate upheavals in the economic order of knowledge too. This contributes to the unceasing 'restlessness of capitalism' (Metcalfe, 2001, 2002, 2007). Economic instability stimulates us to a fundamental questioning of what is property when it comes to knowledge. In what sense is knowledge public? How is knowledge exchanged and reproduced? What kind of knowledge constitutes tradable 'products'? We address these questions particularly in order to problematize conceptions of the 'public' and 'private' knowledge that has provoked – and confused – much recent discussion.

The most high-profile example of this coincidence between scientific revolution and turbulence in economies of knowledge has undoubtedly been the race to sequence the whole human genome (Sulston and Ferry, 2003; Cook-Deegan, 1994; Balmer, 1996), paralleled by many other genome races, including some with more complex economic processes (Harvey and McMeekin, 2004). There was certainly a race for a landmark scientific achievement (we shall ask what kind of knowledge is involved in that achievement), but there was at the same time a race to 'make public' or 'make private' some or all of the resultant knowledge. Huge resources, either from public funding or from private financing, were dedicated to the race, and the nature and governance of financial resources are clearly significant for any knowledge production.

Earlier, one of the main public funders in the US, the National Institute of Health, had vigorously promoted the patenting of those keys to genes, Expressed Sequence Tags (ESTs), and also single base mutations identified as being related to particular diseases (Single Nucleotide Polymorphisms, or SNPs/'snips'). But later the NIH reversed its position, partly in response to the outcry about the balkanization of the human genome (Doll, 1998; Dworkin, 1997). Then, as an economic intervention that defies normal categorization and many assumptions about economic behaviour, Merck, a major pharmaceutical company, in collaboration with the Washington University, St Louis, created a public database for ESTs – a prime genomic resource for eventual commercial exploration – and, at great speed and expense, deposited as many ESTs in the public domain as it could, so pre-empting private property rights (Marshall, 1994, 1999; Venter and Adams, 1998; Caskey and Williamson, 1996; Goldman, 1998; Eisenberg and Nelson, 2002).[4]

Another sign of turbulence – which we will be analysing in some detail – raised the question of what is public and private in another way, namely, as a national or global public or commercial good. A European protein database that had dual public and commercial characteristics was subject to a novel type of 'takeover' by the NIH in order to reglobalize (Americanize?)

it, as distinct from re-'nationalizing' it, making the new database a solely public good, ostensibly a world-public database. At least, US firms now have access to that database on a non-commercial basis.

These are just some striking examples of how the emergence of the new science raised some equally new economic questions. It poses science policy questions about what components of the new science governments should fund, and how they should set priorities. For example, what should be the balance between supporting the production of new knowledge vis-à-vis new infrastructures for distributing knowledge? It also poses questions for regulators. While the 1980 Bayh–Dole Act in the USA, allowing and encouraging university scientists to seek patents for their federally funded research, was not specifically directed at new developments in biology, it no doubt had an impact. But what sort of impact has it had on advancing biological knowledge and its applications? Significant questions have been asked about patent law and practices too. The new knowledge resources emerging from genomics and bioinformatics have challenged patent rules determining what can be patented and what can not, especially in relation to the issue of utility. Furthermore, there have been questions over the desirability of allowing patents on genomic sequences on the grounds that creating restrictions to use would seriously impede progress. There are also important questions for those involved in industry. Where should firms place their bets in the emerging biology knowledge base? Should they seek patents on their knowledge, keep it secret or distribute it publicly? For which types of knowledge resource can markets be established and what value can be placed on tradable knowledge resources?

These questions give a good indication of the importance of the issues at stake, but they imply a far more fundamental question concerning the development of capitalism. If the growth of knowledge is central to the growth of the economy, and if *increasingly* that growth is sustained and promoted by the growth of non-market, public knowledge (and education), what does that imply for our understanding of capitalism as essentially or predominantly a market-driven economy? The question is one of how economies are organized to advance knowledge and make use of it for economic ends, and at their core is the issue of how the public and private aspects of knowledge become instituted. This book aims to tackle the issue head on, developing a novel theoretical framework and using it to make sense of the ongoing informatics revolution in biological science and technology. We will argue that capitalist economies create divides between public and private knowledge. The specific characteristics of public and private knowledge, and the divides and interactions between them depend on how economies of knowledge are instituted. There is immense variety in this, both synchronically and diachronically. Furthermore, there can be

significant fluidity in how the public and private parts of knowledge interact: there are tensions, some fruitful and some not. So it is a dynamic picture, where the evolution of economies of knowledge depends in large part on the co-evolution of public and private knowledge. The dynamism is within and across both the public and private domains, and it is this that we aim to capture in our analysis of multimodal economies of knowledge.

The core thesis of the book recalls and revives some old themes of political economy in a new guise of economic sociology. At its simplest, we believe that new divisions of labour are constantly being created between production and use of knowledge. Once differentiation occurs between groups of producers and groups of users of knowledge, there is an issue of how that knowledge is distributed and exchanged between them. As with all divisions of labour, there is an interdependence between those now differentiated in their relation to knowledge as it is created and applied. At the broadest level, the division between public and private knowledge can be seen as a societal division of labour. In capitalist economies, there is a perpetual tension between different modes of distribution and appropriation of knowledge, and thereby a source of contestation concerning the place of knowledge in economy and society. We pitch our research camps at the fissure points between public and private knowledge.

PUBLIC AND PRIVATE KNOWLEDGE: KEY DEBATES

Quite a lot has been written about the public and private characteristics of knowledge. Our objective here is not to provide a comprehensive review, so much as to point out how different dimensions of knowledge have been explored to uncover directly or indirectly some of its public and private attributes. In this respect, we have identified five prominent dimensions in the literature: knowledge as an *economic good*, the *embodiment* of knowledge, different *types* of knowledge, *institutions* of knowledge, and, *ownership* of knowledge. We discuss these five dimensions to provide some key building blocks for the development of our own analytical framework. In doing so, we want to draw attention to a common pattern that permeates the way that each of the debates has been structured. For each dimension, public and private characteristics have initially been conceptualized as contrasting and opposed binary categories. Subsequently, empirical realities have shown the sharp divides to be significantly overstated, and perhaps increasingly so. As the debates have matured, the initial dichotomies have largely been replaced by notions of hybridity, blurring and interdependence. Our other objective in this section is to consider some consequences of the

different cuts at the public and private characteristics of knowledge. The problem is that the debates often appear to be at odds with one another: the public or private of one dimension does not sit easily with the public and private of another. The terms are used in conflicting and confusing ways, sometimes referring to organizations, sometimes to sectors and sometimes to knowledge itself. The following discussion attempts to tease out some of these meanings.

Knowledge as an Economic Good: Public or Private

Over 180 years ago, Thomas Jefferson made the following observation about some special characteristics of knowledge that has been subsequently marshalled (for example, David, 1993; Stephan, 1996; Stiglitz, 1999) in support of a view that knowledge has certain inherent properties that make it a public good:

> If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of everyone, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it. He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening mine. (Jefferson, 1967 edn, p. 433)

Formalization of this view of knowledge as a public good, developed first by Nelson (1959) and Arrow (1962), and then further explored by the likes of David, Dasgupta, Stiglitz and Foray (Dasgupta and David, 1994; Stiglitz, 1999; David, 2004; Foray, 2004) can be summarized by two inherent characteristics of knowledge:

- Knowledge is non-rivalrous in use: once produced, there is no marginal cost in another individual making use of the knowledge. Furthermore, even if exclusion was possible, it would be undesirable, since the spread of already existing knowledge is costless, at least relative to the costs of producing it again. Knowledge does not get used up in use, so there is no rivalry between different agents availing themselves of it.
- Knowledge is inherently non-exclusive: once produced, and especially when intentionally disseminated, knowledge is difficult or impossible to appropriate privately through excluding others from using it.

Establishing the public good credentials in this way has been persistently used as a 'market failure' argument for government support of knowledge production, principally on the grounds that firms will underinvest because appropriation is difficult. Markets simply do not work well, so the argument goes, in stimulating the production and circulation of knowledge. Knowledge, by virtue of these inherent properties, is public by default – unless, as historically occurred, dedicated legal institutions are created, such as patents, which define what knowledge might be appropriated. These institutions, as will become evident, are central to the creation of the public divide within capitalist economies, and they are continuously evolving. But, even under such legal protection, knowledge is only partially and insecurely captured for private property, not only or even mainly because of legal requirements for disclosure and time limits of protection. It remains a *latent* or *quasi* public good in the sense that it is 'out there' especially for non-competing uses or uses that readily evade legal enforcement of private rights. But it is the reliance on *inherent properties* that has prompted the development of alternative viewpoints. We can present three distinctive criticisms to this view.

The first, most forcefully argued by Callon (1994), takes issue with the idea that the public status of knowledge should be defined by looking at inherent properties: 'There is nothing in science to prevent it from being transformed into merchandise' (ibid., 402).

Knowledge can always be bundled or packaged or embodied in ways that make it tradable, and enable rival uses. In this analysis, neither of the two inherent properties of knowledge hold with sufficient force even to make the claim that knowledge is a quasi and latent public good as the economic theory defines it. But Callon does want to retain the idea of science as a public good and as an enterprise that should receive government support. Public science produces public knowledge by creating new networks and these networks are emergent entities that require defence against tendencies that might close down the creation of variety in knowledge. It is a model of interdependency between public and private science, which seems right, but, in attacking the standard economic theory of public knowledge, much of the *economic* conditioning of the relationship is thrown out too.

The second type of opposition to the essentialist formulation involves studies of knowledge appropriation dispelling the idea that knowledge is inherently non-excludable and at least hinting at the idea that knowledge is rivalrous in use under certain conditions. Crucially, the attack on the non-excludability of knowledge rests on more than the observation that patents can be used as an instrument of appropriability. In these studies (Levin et al., 1987; Teece, 1986), firms in particular were shown to be quite effective in appropriating their knowledge through secrecy or strategies relating to

first-mover advantages (such as the development of complementary assets), even if only for a short period of time. Some, like Pavitt (2001) have presented an even stronger view, that it is actually very difficult and costly for industrial knowledge to be transferred between different organizations, and that knowledge can prove somewhat 'sticky'. These observations, combined with the opportunity to seek formal protection of intellectual property through patents, show that knowledge can quite readily be made private and in several different ways. There is also surely a strong sense in which knowledge does exhibit rivalry in use. Given the widely believed role of knowledge in economic growth and in competitive advantage, it seems obvious that access to knowledge for further knowledge production, or for the production of non-knowledge goods, grants those in possession an advantage over others. Thus the competitive context of knowledge production and use, within either university or commercial settings, clearly points to rivalry. That is why great efforts are frequently made to keep knowledge secret.

The third view proposes that the more knowledge is generic the more it approximates to the essential knowledge characteristics defined above; and the more it is specific, and embedded in particular uses and objects, the easier it is to appropriate privately. But there are no sharp lines here, so no absolute inherent properties of generic-ness or specific-ness, a view most forcefully and persistently argued by Nelson (1989, 1990). Moreover the generic and specific are intricately interconnected, so further blurring boundaries.[5] The question then becomes one of how the boundaries between public and private knowledge are set, given that there are no naturally occurring distinct species of knowledge. The important questions become achieving a balance between establishment of incentives to produce knowledge and exploit it commercially, which can rest on the opportunity to make it private, against preserving the non-exclusivity of knowledge, so important for its cumulative advance. Depending on institutional incentives and rules, the balance can tip too far either way, although Nelson himself has been increasingly concerned about the risks of growing opportunities for private appropriation impeding cumulative advance. However, although now some distance from the earlier essentialist view, there still remains a tendency to treat knowledge as a public good unless it has been privately appropriated. It still draws on the idea that generic knowledge has inherent characteristics gravitating towards the public pole, unless efforts are undertaken to appropriate privately. Treating public knowledge in this default way implies a view of the capitalist 'engine of progress' with the private market mode as its dynamic component, for which public knowledge is only the fuel, somehow generated outside the central economic system.

The Embodiment of Knowledge: Tacit or Codified

The notion of tacit knowledge as proposed by Michael Polanyi (1967) rested on an empirical observation that people seem to know more than they articulate or are even able to articulate. The concept was further developed to provide a foundational component of Nelson and Winter's (1982) evolutionary theory of economic change, where tacitness here extended to groups of individuals within firms. But it was Dasgupta and David (1994) who most forcefully considered how the knowledge embodiment issue connected to the public–private question, by contrasting tacit knowledge with codified knowledge. Almost by definition, tacit knowledge is private to the individual or group by virtue of experience, codes and representations not shared by others, hence incommunicable or at least untranslated for a wider constituency. Codified knowledge, on the other hand, is 'knowledge that has been reduced and converted into messages that can be easily communicated among decision agents' (Dasgupta and David, 1994, p. 493). On this basis, the related dichotomy of 'information' and 'knowledge' is posited, with the former embodied in a 'codebook' or other material or electronic substrate (books, graphics, electronic data and so on), the latter embodied in the human bearers of knowledge. There are then different potentials for these two categories, respectively as either public information resources and private informational product markets, or public and private labour markets for bearers of knowledge.

Indeed, in a later contribution, Cowan et al. (2000) go much further by insisting that uncodifiable knowledge is not very interesting for the social sciences. Here, the focus is on understanding the process of codification in greater detail, promoting a view that enhancements in codification will facilitate progress in knowledge accumulation and that modern developments in Information and Communication Technologies (ICTs) represent significant opportunities in this respect.

Yet these mappings of different knowledge embodiments onto economic and organizational characteristics are rarely pursued to their logical conclusion. First, the dichotomy presumes that codified knowledge, once separated from the bearers of knowledge, is free floating in public or market space. Tacit knowledge alone is treated as residing in the bearers of knowledge, whereas codified knowledge circulates 'out there'. But if codified knowledge is both 'in there' (the heads of knowledge bearers) and 'out there' (knowledge products) then the dichotomy is far from straightforward. In particular, the tradability potential is not so straightforwardly dichotomized between knowledge markets for information and labour markets for knowledge. It is quite revealing that Cowan et al. consider the strong case for tacit knowledge as undermining the case for a 'public goods'