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Towards a dynamic (Schumpeterian) welfare economics

Wilfred Dolfsma*

Erasmus University Rotterdam – FBK and Maastricht University (MERIT), P.O. Box 1738, 3000 DR Rotterdam, The Netherlands

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Abstract

Knowledge plays an increasingly important role in shaping the dynamics of an economy. A static Paretian welfare economics is therefore inadequate, and needs to be supplemented by a dynamic (Schumpeterian) welfare theory. A dynamic welfare economics acknowledges the role of knowledge and communication. As knowledge develops cumulatively in a social environment, knowledge may not be readily diffused or exchanged. Different costs of communication need to be considered, each affecting the creation of new knowledge. Recent developments in Intellectual Property Right (IPR) law are evaluated to determine the extent to which they affect communication costs and thus future economic welfare.

Keywords: Knowledge economy; Communication; Communication costs; Welfare economics; Intellectual Property Rights

In chapter 17 of his *Capitalism, Socialism and Democracy*, Schumpeter (1943, p. 190, italics in original) has introduced some fundaments for a dynamic welfare economics. One passage is especially worth noting:

"we shall call that system relatively more efficient which we see reason to expect would *in the long run* produce the larger stream of consumers' goods per equal unit of time"

In this paper, I will start from the perspective that the newly emerging reality of our economies today is that they are knowledge economies (OECD, 1996). Baumol (2002), for instance, claims that over 60% of the labor force in the United States are knowledge workers. This is recognized in diverse strands of thought in the economics discipline after the puzzling findings in the growth accounting literature (e.g. Denison, 1967). Romer (1986, 1993) has been developing ideas about how knowledge impacts on economic growth, better known as *New Growth Theory*. The work of Baumol (2002) relates to this. Studying a dynamic, knowledge-based economy requires that a conceptual understanding of knowledge and its role in society is developed and used in economics. The first section discusses this in some measure. My argument is that a welfare economics for the knowledge-based economy requires different, partly additional concepts that would allow one to evaluate developments in society or government policy. A second section will give a brief and admittedly

* Tel.: +31 10 408 1948.
E-mail address: w.dolfsma@fbk.eur.nl.

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incomplete outline of the welfare economic perspective that is now mostly adhered to, following Pareto. A dynamic, Schumpeterian welfare economics would emphasize the development of knowledge and its use in the economy. To wit, the argument in favor of competition in the market and dynamic efficiency is emphatically *not* based on Paretian considerations of perfect competition (Baumol, 2002, Blaug, 2001, Mokyr, 2002, Nelson, 1981, 2004). The third section suggests some elements for a welfare economic perspective. A much debated policy issue that is very relevant for the knowledge-based economy is subsequently looked at to evaluate some measures governments are currently implementing. How would a dynamic welfare economics evaluate changes in the system of Intellectual Property Right (IPR) law?

1. Knowledge and the dynamics of an economy

In recent years, it has come to be acknowledged that development of new knowledge is an important source of dynamics for an economy. Knowledge is, however, a very much heterogeneous entity and thus difficult to come to grips with – using the metaphor of capital to do so may, for instance, be criticized (Dolfsma, 2001). Knowledge has distinct features that are worth discussing in light of this article.

To paraphrase Isaac Newton, knowledge is developed by people who could see further because they stand on the shoulders of giants. This, of course, is a well-established observation about the cumulative nature of development of knowledge, but at the same time was a derisive remark against Newton's opponent in a discussion about the nature of gravity in Newton's letter in 1776 to Robert Hooke. Hooke was a short, hunchbacked man on whose shoulders one would not want to stand. Even if one did stand on his shoulders, one would not see far. Knowledge thus develops as much in a social context as it is cumulative. The literature on the sociology of science has made this clear (Mäki, 1993). There are at least two other characteristics of knowledge that entail that in assessing welfare effects, one needs a perspective that takes dynamic processes by which knowledge develops into account. The development of knowledge involves tacit dimensions, and requires coding and decoding. These four characteristics are at work at the individual, the organizational,[1] the regional[2] as well as at a societal level (Mokyr, 2002). As at the latter three levels the knowledge development essentially involves individuals too, I will discuss this at some length. In addition, as the welfare perspective introduced below will take social welfare of a community (society) as a touchstone, the implications of the characteristics of knowledge development for the dynamics at the societal level are discussed as well.

Knowledge differs from information (data) in that it needs to be interpreted to make sense of. Polanyi (1983) has developed a theory of knowledge acquisition that should also be of interest to economists (see Scitovsky, 1977, but also social psychologist Bandura, 1986). Polanyi (1983, p. 7) argues that (tacit) knowledge is acquired in a process he calls 'subception.' Any piece of information to be transplanted from one person to somebody else is 'recepted' (ibid., p. 5) by this other person and integrated or 'subsumed' into a larger framework of knowledge in which meaning is given to this new piece of information (ibid., p. 19). To the extent that information is subsumed (and it has to be subsumed if it is to have any meaning) into a larger framework of knowledge, it is interiorized (ibid., p. 29), as it were, to become a part of the body (cf. Douglas, 1986, p. 13). From this, it follows that man cannot always accurately state what it is that he knows about a certain topic. Such knowledge is typically "fraught with further intimations of an indeterminate range" (Polanyi, 1983, p. 23), constituting what might be called a 'mountain of experience' (Dolfsma, 2002). Where knowledge relevant to the particular subject becomes irrelevant is difficult to ascertain; there is a difficulty of separating relevant from irrelevant knowledge. Veblen (1961, p. 74) goes even farther than this in asserting that man *is* "a coherent structure of propensities and habits" (cf. Dolfsma, 2002). Prior knowledge is thus needed to acquire knowledge, but additional information does not necessarily increase one's knowledge: there are costs involved in storing knowledge. Knowledge building is not automatic, but involves being able to discern patterns. Despite having the same information, people might hold different views of the world, which can make communication difficult (costly) as decoding

[1] See Hansen (1999), for instance, and similar research.

[2] See Saxenian (1994), and Van der Panne and Dolfsma (2003), and references therein.

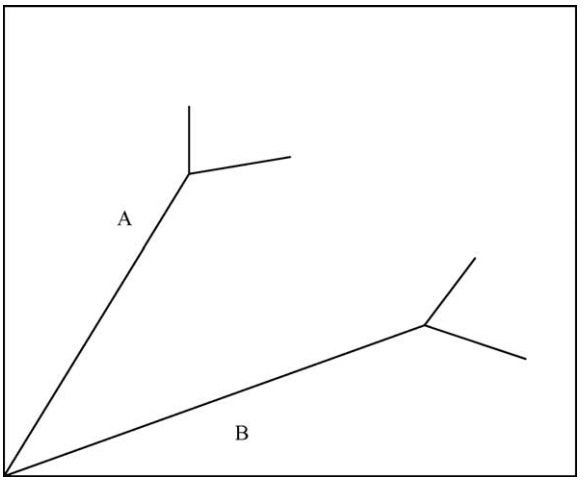

Fig. 1. Different learning paths. *Source:* Dolfsma (2002).

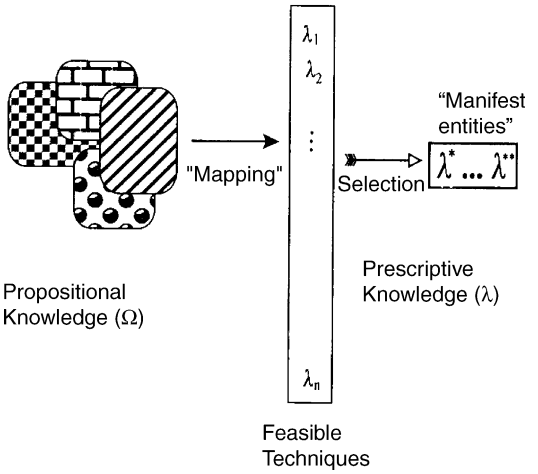

Fig. 2. Types of knowledge. *Source:* Mokyr (2002, p. 17).

needs to occur. In addition to any decoding that might be necessary, communication (transfer of knowledge) is costly in itself as well. Separating the knowledge one needs to communicate can be costly, while the means used to communicate can also involve costs for the sender. Such a view of knowledge and information differs from the one generally subscribed to in economics. Here, the idea is that additional knowledge will reduce noise (see Denzau and North, 1994). Persistently diverging learning paths, such as those between A and B in Fig. 1 are excluded. The analogy between the view of the process by which an individual learns that would allow for persistently diverging learning paths and the view on the development of technological paradigms (Dosi, 1982; van de Poel et al., 2002) is striking. This certainly holds true when discussed in the terms 'body of practice' and 'body of understanding' suggested by Nelson (2004) when analysing the 'advance of technology.'

In a recent book Mokyr (2002) has argued that the industrial revolutions need to be explained by the development, but mostly by the diffusion and use of new knowledge. There are a number of noteworthy observations Mokyr makes about the role of knowledge for economic development. A first one is that there have been striking macro inventions before the first Industrial Revolution in England. None of these inventions gave rise to sustained economic growth, however. Another observation is about the way in which bodies of knowledge relate to one another. Fig. 2 is a framework that Mokyr suggests to understand the role of knowledge in the economy and in society. Propositional knowledge is knowledge about 'how to manipulate nature' (Mokyr, 2002); this includes more than what we would now call academic knowledge. Savants posses this type of knowledge. Prescriptive knowledge contains concrete directions about how to solve a particular problem; it is useful knowledge possessed by fabricants. Developments in both types of knowledge may stimulate one another. Mokyr explains this by pointing out that the knowledge base of economies (propositional knowledge) then can be too limited, the knowledge available can be not 'tight' enough to convince people to invest in the creation of new products or processes based on prepositional knowledge. Simply adding to what is known in a field will not result in a 'tightening' of the knowledge base.

Thus, it can be considered a coincidence, in a way, that England around 1780 was the first country where sustained economic growth based on the use of newly developed knowledge could be observed. England was by no means the most technologically advanced country, and indeed it used knowledge developed in countries such as France extensively. Mokyr points to the institutions of English society that lowered the costs of communication about new knowledge. The result was that knowledge was much more readily exchanged among savants, among fabricants, and between these two groups. Thus, new knowledge was more easily created, but most importantly existing knowledge was put

to good use faster, even if the knowledge would be of a tacit nature (cf. Cowan et al., 2000).

Communication then, in Mokyr's argument, will both broaden and tighten the knowledge base of propositional knowledge, and stimulate the development of techniques (prescriptive knowledge) that find an immediate application in society and stimulate economic activity. Central in Mokyr's analysis is his concept of the 'access costs' people face when in need of 'useful knowledge'.

Knowledge may affect a firm's processes in other ways too. Knowledge can be recognized as immaterial assets in a firm's financial accounts, acknowledging its importance as productive factor. Introducing knowledge in a firm's financial accounts allows it to use it as collateral in capital markets. Accounting rules to be implemented in 2005 in Europe, following the American example, clarify this hitherto murky situation (Lev, 2001). Intellectual property (knowledge made exclusive) also plays an increasingly important role in strategic manoeuvring between firms (Lev, 2001; Shapiro and Varian, 1999, Granstrand, 1999). IPRs may make a firm an inevitable player in a network, and it may allow a firm to exclude others from a network. This does not only hold for IPRs, but also for trade secrets and tacit knowledge, as long as access or use of such knowledge can be restricted. Economists have argued that agents need incentives to be persuaded to develop new knowledge. If such incentives – primarily in the case of a system of Intellectual Property Right (IPR) laws – would not exist, there would be an undersupply of new knowledge and basic knowledge in particular (Nelson, 1959). This argument is made both in case of patents, as well as in the case of copyrights (Landes and Posner, 1989). Without incentives, agents would not develop new knowledge, or would not make it publicly available. Nevertheless, it is known that firms do engage in fundamental research and have good reasons for doing so (Rosenberg, 1990), even when they know they cannot receive a patent to legally prevent others from commercially exploit the knowledge. In addition, not all firms find it worthwhile to apply for a patent (Arundel, 2001; Levin et al., 1987). Increasingly, the arguments legitimising a system of IPRs have shifted to emphasizing the need for these institutions to offer protection so that investments in production facilities can be recouped before copycats who had to spend less in developing a product than the innovator enter the market (Hettinger, 1989). The discussion is a heated one, both in academia and beyond. Economists approach this discussion using Paretian welfare theory.

2. Paretian welfare economics

Historian of economic thought Blaug (2001, p. 39) has lamented on several occasions the "replacement of the process conception of competition by an end-state conception [which] drained the idea of competition of all behavioural content", where not the existence of an equilibrium but rather the stability of that equilibrium state is analyzed (cf. Vickers, 1995). Blaug traces the origins of this approach to Cournot, Walras, and blames Samuelson, Hicks and Robbins for establishing it as the mainstream.

Every first year student of economics is presented with the picture of perfect competition between large groups of suppliers and consumers of homogenous products. The Pareto optimum welfare conditions to attain a first-best situation are well known and need not be reproduced here. The thinking about welfare economics in the 1930s up to the 1950s has moved from discussing cardinal utility functions, to the Hicks–Kaldor compensation criteria, to the Lipsey and Lancaster second-best theorem, and to Arrow and Debreu's impossibility theorem (Cowen, 2000).

Central assumptions in Paretian welfare economics are, among others, three postulates: "consumer sovereignty, individualism in social choice, and unanimity" (Blaug, 1980, p. 148). Every individual (agent) is the best judge of his own welfare, welfare of individuals may not be compared but simply needs to be aggregated (by the market), and social welfare is defined only in terms of the welfare of individuals. These, together with assumptions about parties' objective functions and motivation (profit and utility maximization) allow one, for the analysis for instance of a world where two goods (A and B) are offered to determine the optimum situation at the point of tangency *T* in Fig. 3 where marginal costs of production equals marginal utility. At the same time, the relative price ratio between the two goods equals marginal utility, constituting a Pareto-optimal situation. Changes in either the supply or the demand curve in Fig. 4, for whatever reason, will be evaluated in terms of welfare triangles. In the figure, a movement of the supply curve is shown (from S to S′), leading

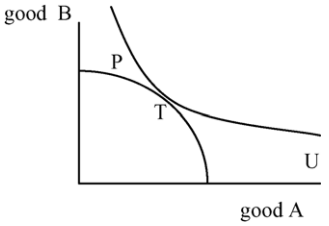

Fig. 3. Utility maximization.

to a 'deadweight welfare loss' of the size of triangle ABC.

To date, Paretian welfare theory dominates, while a characterization made in a 1960 survey of welfare economics still holds as well (Mishan, 1960, p. 198):

"No growth or innovation takes place, no uncertainty exists and individual tastes remain unaltered. In addition, the working population is fixed and is, in some sense, fully employed. Within this framework it is further assumed that individual behaviour is consistent, and (. . .) that the individual is the best judge of his own wants."

For my purposes, the first part of the quote is especially noteworthy. As Romer (1994) argues, the conditions that are here placed under the *c.p.* clause are far from rare conditions. The kind of analysis that needs to posit these assumptions may thus not be as relevant as one might assume: "to keep things simple, set aside the niggling disputes about consumer surplus as a welfare measure" is what he suggests (Romer, 1994, p. 15, cf. Blaug, 2001, p. 47).

3. A dynamic welfare perspective

A more appropriate (additional) welfare theory would be acknowledging the dynamics in today's knowledge economies. The comparative static foundations of a Paretian approach are less appropriate in such circumstances. Indeed, as Cowen (2000) has argued, there have been more attempts at suggesting different theories to the established welfare economics of Vilfredo Pareto. Cowen (2000, p. xiii) distinguishes "three dominant yet incompatible strands": ordinalist Paretian welfare theory, applied cost–benefit analysis used in practical policy, and cardinalism of which Amartya Sen is a representative. The latter "returns to the purely theoretical realm but rejects Paretianism"; it "is less systematic and unified than the other two strands".

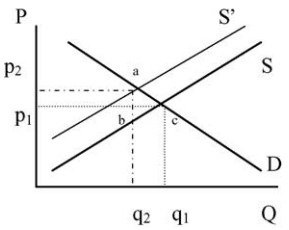

Fig. 4. Welfare triangles.

The public interest in the creation of new knowledge has been long established, mainly due in more recent decades to Nelson (1959, 1990). In a dynamic economy, a static approach to welfare, emphasizing the end-state kind of competition is not very appropriate, however. Thus, "welfare loss triangles are admitted and downplayed" as Nelson (1981, p. 106) has expressed it, following Schumpeter (1943). A welfare perspective emphasizing the dynamics in an economy will need to combine insights from a diverse set of related fields as such a perspective has not been developed to date (cf. Mokyr, 2002, pp. 21–27).

Schumpeter (1943, especially Chapter 17) indicates that the effects of choices made by private or public parties should (also) be evaluated in terms of their long-term effects: which alternative leads to the most attractive outcome in the future? Schumpeter seems to indicate that both measurable effects in the market as well as more immeasurable effects inside and outside of the market should be taken into consideration, although he is not very clear about how to develop these ideas into more operational terms. In line with Schumpeter's work, and prompted by a number of other scholars, I would suggest that 'communication' between agents plays an important role in shaping the processes through which an economy evolves from one stage to the next. To be more concrete, it would seem that there is a positive association between the ease with which communication may occur and economic development (see, e.g., Dudley, 1999, Mokyr, 2002).

In this contribution a main starting point will be to use a Cobb–Douglas type function for the production of knowledge. The use of this kind of function to model the production of knowledge is far from unique (Audretsch, 1998; Dudley, 1999), despite the use of production functions being questioned in general

(Shaikh, 1990), in part due to the failure of the efforts at growth accounting (Denison, 1967). I start from the idea that communication between parties can be more or less difficult, and that these difficulties can be translated into costs. The extent to which communication is difficult (costly) relates directly to the technology used, to the established (cultural) mores about communication (cf. Mokyr, 2002, Nelson, 1990), as well as to more formal institutions. The costs can be direct or more mediated, and the effects are both on levels of welfare as on the ways organizations take shape (Milgrom and Roberts, 1988). Certainly when "more than 60% of the labor force in the United States is engaged in activities in the 'information sector' of the economy" (Baumol, 2002, p. 2) it is important to analyze the circumstances for the creation of new information and knowledge, to be in a better position to assess the effects on the economy.

In line with what Dudley (1999) suggests, three kinds of costs are related to communication – the level of the costs involved determines the kind of communication that one may expect.[3] One may distinguish storage (*s*), decoding (*d*) and transmission (tr) costs of communication.[4] Communication is an input that would lead to the 'output' of newly used and created knowledge. As it can often only be determined ex post if the knowledge involved signifies an incremental or a radical development, the discussion here applies to both these situations.[5] When all of these costs are high, no communication occurs.[6] When transmission costs are low but the others remain high, communication will be centralized, much as Fig. 5a presents. As storage costs decrease, like in Fig. 5b, a decentralized communication structure emerges. When finally decoding costs are low, a distributed kind of communication will be observed (Fig. 5c). It would seem that these three different

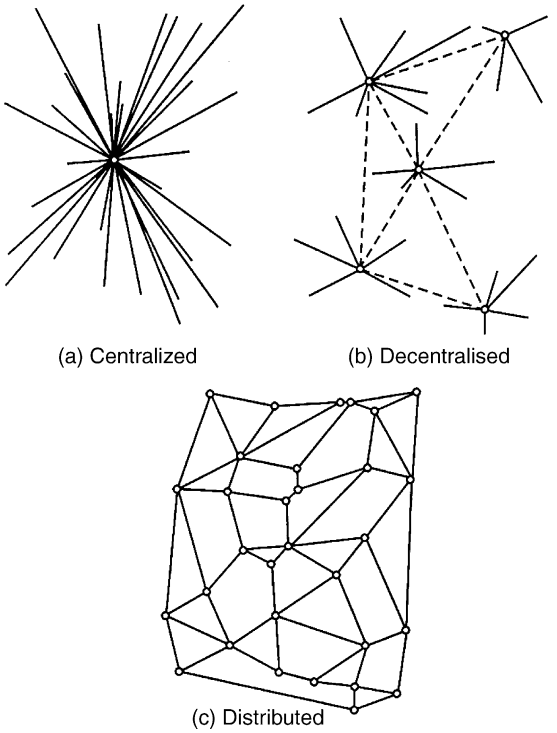

Fig. 5. Communication structures. *Source:* Dudley (1999).

communication costs capture what Nelson (2004) calls 'the communitarianism of scientific knowledge.' The suggested sequence for decreases in these communication costs seems to match with what may be observed when one considers developments in the use of techniques involved in communication. Table 1 summarizes this discussion. Communication that is distributed (Fig. 5c) is to be preferred from the position of the public interest, as knowledge and information is exchanged most readily and conditions for economic and societal development are most conducive.

The basic insight that centralization of communication raises costs which is not beneficial for society was also argued for by Nelson (1981, p. 101): "the argument that centralization imposes high information and calculation costs carries considerable weight in a dynamic context". Indeed, for him it is a central argument for favoring capitalism over socialism, as it was for Hayek as well. This view contrasts with "the standard theoretical analysis [which] implies that only zero spillovers [of knowledge] are compatible with optimality in innovative activity" (Baumol, 2002, p. 121). Rather, extensive

[3] Casson (1997, p. 279) argues that transaction costs are a special case of communication costs. His is a plausible argument that needs to be pursued further, but that will not be undertaken here.

[4] Mokyr (2002) seems to lump these together in his category of 'access costs'. In what follows, costs of communication are emphasized rather than the benefits on the assumption that the level of these costs shape the circumstances under which the benefits will come about.

[5] In addition, as Levinthal (1998) has argued, technologies (knowledge) may be introduced from one context into another; in the latter context they may be perceived as radically new when in the former it had been developing incrementally.

[6] For the sake of clarity, I assume that communication costs is a binary variable; it is either 'high' or 'low'.

Table 1
Communication and communication costs

Costs of	Type of communication			
	None	Centralized (a)	Decentralized (b)	Distributed (c)
Transmission (tr)	High	Low	Low	Low
Storage (*s*)	High	High	Low	Low
Decoding (*d*)	High	High	High	Low

dissemination of new knowledge benefits society and it is of course this argument that is one fundament for the system of Intellectual Property Rights. In exchange for a temporary exclusive right to use of newly developed knowledge, a party is to make this knowledge publicly available in order for others to build on it. Many firms, however, even consider it directly beneficial for themselves to disseminate their newly developed knowledge (Baumol, 2002, p. 73), for instance because network effects can kick in more readily (Shapiro and Varian, 1999). Knowledge might also transfer inadvertently between firms, and it is for this reason that firms cluster geographically (Saxenian, 1994). Indeed for firms in high-tech sectors there is reason to assume the existence of a *causal* link between the decision by a firm to set up shop in a particular location and the knowledge infrastructure already present in that vicinity (van der Panne and Dolfsma, 2003).

Pace Dudley (1999) one could include the three different communication costs in a Cobb–Douglas production function in order to assess the effects of changes in communication costs for economic welfare (equation 1). The main purpose of this production function is to evaluate *changes* in communication costs in terms of their effect on social welfare, and less so to study the affect of the absolute size of these costs. For my discussion here issues of returns to scale are irrelevant. A Cobb–Douglas production function makes most sense when the analysis is at an aggregate level, while there is also support for the use of this function at a disaggregate level (e.g., Gurbaxani et al., 2000). Given the nature of the exogenous variables involved, there is no point in assuming constant elasticities of substitution and hence adopt a CES production function. The Cobb–Douglas production function is the most readily interpretable production function and is used most often in the literature (cf. Audretsch, 1998). The suggested Cobb–Douglas production function primarily provides a heuristic tool here, certainly in light of Rosenberg's (1994, p. 53–54, italics added) assertion that "[i]nnovation is the creation of knowledge that cannot, and therefore should not, be 'anticipated' by the theorist in a *purely* formal manner." Nonetheless, it seems plausible to assume that a community of size (n)[7] will, in period ($t+1$), experience a social welfare (q) generated by communication in period (t) that can be represented as:

$$q_{t+1} = A\left(\frac{n_t}{s_t}\right)^{\alpha}\left(\frac{1}{\mathrm{tr}_t}\right)^{\beta}\left(\frac{n_t - 1}{d_t}\right)^{\gamma} \quad (1)$$

where $0 < \alpha$, β, and $\gamma < 1$, $n \gg 1$, and s_t, tr_t, and $d_t > 0$[8].

In this function, A is the well-known efficiency parameter. The concrete shape of the production function makes economic sense. A rise in any of the communication costs will hamper economic activity and thus economic welfare – for this reason communication costs enter the denominator in the equation. Decoding communicated messages is proportional to the size of a population, but needs only to be done by the receiver of a message. On this, Dudley (1999, p. 602) further remarks that "the efficiency of markets depends on people's ability to negotiate and enforce contracts, output is decreasing in the cost, d, of decoding a unit of information. Owing to network effects, this transaction cost is offset by increases in the number of other people, $n_t - 1$, with whom each individual can communicate." Due to the impact of knowledge on productivity, output, q, increases with the amount of information stored. The relation between q and storage cost (s) is inverse under competitive market conditions in particular. There is, furthermore, a direct link between the size of a pop-

[7] A community need not be country, and is perceived here as relatively homogenous in term of the cognitive distance (Nooteboom, 2000) of its members towards each other and in terms of the knowledge that is tacit.

[8] Therefore, this production function is strictly quasi-concave, while its isoquants are negatively sloped and strictly convex.

ulation and the storage costs that need to be incurred. Transmission costs, tr, are not directly related to the size of a population; depending on circumstances (costs), a population of any given size can transmit knowledge extensively. Scale economies to joint production, for example because (co-) workers or partners need to be coordinated, however, increases in transmission costs will decrease q. Usually, in reality, any development that affects one type of communication cost is likely also to affect other communication costs.

A dynamic welfare perspective, for which some suggestions are brought forward in these pages, might favor policy measures that violate the Pareto criterion. This would then be for different reasons than possible violations of the Pareto criterion that Pigou, for example, suggests. Pigou (1924, p. 78) suggests that an income re-distribution from rich to the poor would be justifiable because that would allow "more intense wants to be satisfied". Indeed, for the dynamic welfare perspective suggested here utilitarian considerations play a less prominent role than for the Paretian view to which Pigou also subscribes in large measure. How the suggested dynamic, Schumpeterian welfare perspective suggested here fits in Cowen's classification introduced at the start of this section is not clear. In any case, I would not present this approach as necessarily incompatible with the other three kinds.

4. Changes in the system of IPR and welfare

Intellectual Property Rights are central institutions in a knowledge economy. The relevant legal and technological changes always are easily identified, even though not all of their effects are associated with IPRs clear. Evaluating developments in IPRs from a perspective of their effects on the dynamics of an economy is entirely appropriate given the objectives for this part of the system of law. Indeed, the purpose of establishing IPRs is twofold: first to stimulate the creation of new (useful) knowledge, and, secondly, to stimulate its dissemination. As Levin et al. (1987) observed among others, however, the positive effects of the presence and extension of IPRs is often assumed to be self-evident. IPRs are believed to be beneficial for both the firm that has obtained them as well as for society as a whole. There is, of course, some discussion in academic circles about the effects of IPRs and how to evaluate these (cf. Towse and Holzhauer, 2002), but these are mostly in comparative-static Paretian terms. The duration and scope of patents is one such a topic. A disregard for IPRs need not hurt the innovating firm. Other means to protect ones innovations might be preferred (Levin et al., 1987), or network effects might better kick in if the innovating firm strengthens or enforces its IPR position less (Takeyama, 1994). In what follows I will discuss a number of recent changes in particularly patent law and copyright law in terms of their effects on communications costs. The changes I discuss are not exhaustive, although they do include the most significant ones. Each of the changes in IPR discussed will have effects on all of the three communication costs.

The span of the system of IPR has grown over time. A law protecting legal rights in databases has come into being recently, while the protection under patent law of software or business models is now allowed. In addition, the (statutory) limitations on the commercial exploitation of the knowledge developed have decreased in number. This is no mixed picture: IPRs have grown stronger over time. Especially in the past decade a number of noteworthy developments can be mentioned. Often, the development in the United States is followed by changes in Europe. In this article, the differences between the two legal systems (US and Europe) are not so much discussed as the similarities between the two. The purpose of the discussion here is thus to evaluate the potential effects of *changes* a system of IPRs and not so much an analysis of the systems as they exist in a way that is relevant for economists.[9] A more standard welfare approach has also noticed the undesirable effects of changes IPRs in general and patents in particular. It is argued, for instance, that such developments possibly distort the direction of technological change (Adams and Encaoua, 1994), possibly slow down technological progress (Takalo and Kanniainen, 2000), or possibly reduce incentives to compete in R&D or in downstream product markets (Encaoua and Hollander, 2002).

Following the US, Europe has now decided that software can be protected under patent law, in addition to copyright law, under which it would be protected

[9] See Raskind (1998) and Kitch (1998). For a broad overview, see Towse and Holzhauer (2002). For a theoretical economic justification for copyrights, see Landes and Posner (1989); Hettinger (1989) provides a broader discussion of the rationales for copyrights.

previously. The protection patent law offers is shorter than copyright law, but is more powerful.[10] Copyright law protects the particular expression of an idea, while patent law protects the idea itself irrespective of the way in which it is expressed. As ideas can usually be expressed in more than one way, copyrights offer a weaker kind of protection than patents do. Copyrights do not need to be registered in most countries, albeit that registration may facilitate enforcement in some case, and is in force immediately after publication of the material, while an application for a patent needs to be filed and approved, involving a variety of expenses.[11] Several criteria need to be met before a patent can be granted: an inventive step needs to be involved, one that is non-obvious to someone skilled in the prior art. There needs to be an industrial application, and, in addition, at least until recently, a physical component has to be part of the application.

The scope of patent law is most hotly debated at the moment, both in the US and in Europe, in relation to the question of whether business models and software should also be patentable. Does Amazon.com's patent for 'one-click shopping' not violate the requirement that a patent should involve a physical component and must involve an inventive step? It is true that software is often not clearly distinguishable from hardware, and the demand that a patent application needs to constitute an inventive step might be difficult to sustain. Reneging on these requirements too easily might, however, give rise to rent-seeking behavior on the part of the producing firms. In this case, only software is involved, while the software ('cookies') had already been developed prior to the patent application by Amazon. The particular business model is a useful invention, to be sure, but does the patent on this model not unduly raise communications costs? Certainly, it does for other firms who would like to use this method and now have to license it. In addition, the model also allows firms to increase the extent to which they may differentiate their products and discriminate their prices. The net result of the latter is likely to be that consumers suffer (cf. Dolfsma, 2004). The decision to extend the scope of patents to include living tissue is contested as well. Besides the moral aspects of the debate, there is the issue that the distinction between discovering and inventing, never entirely clear, is blurred to the extent that it no longer exists. The latter (invention) used to be a precondition for a patent to be granted. Patentability on living tissue might, but need not, have sped up the discovery of the exact shape of the human genome, for instance, but it will severely restrict the use to which that knowledge can be put for the coming years.

The duration of patents has increased too, most recently (1998) from 18 to 20 years in the US. The lengthening of the patent for pharmaceutical products is probably less problematic in this light, given the requirements these face before they are allowed on the market, although it does fit the general picture. Fisher (2001) provides a more extended discussion of the development in patent law and its effects on innovative activity.

Copyrights equally have extended in scope and duration; legal scholar Lessig (1999, 2001) is among the more prominent people to lament this development.[12] Most recently, the duration of copyrights in the US was lengthened from life of the author plus 50 years to life of the author plus 70 years, effective retrospectively. Several years ago both the US and Europe has started protecting databases as part of copyright laws. In the past a collection of 'brute facts' would not constitute a creative act and would thus not warrant protection, now a database is now protected however (Maurer et al., 2001). The American Digital Milennium Copyright Act (DMCA, which came into force 1998) as well as the European Directive on Copyright (2001) prohibit agents from making available technical measures that might be used to circumvent measures taken to protect copyrighted work (Koelman, 2000). As these means can often also be used for other, legitimate purposes, this element of the new copyright law is much debated. It is also unclear what 'making available' means: does a scientist in the field of, e.g., cryptology presenting his work to fellow scientists make available a means to circumvent the technical protection (encryption) on

[10] In 1998 in the US, the duration copyrights last has increased from life of the author plus 50 years to life of the author plus 70 years, effective immediate. In that same year, again following Europe's example, the duration of patents has increased to 20 years, from 17 years, in the US.

[11] OECD (1997) discusses some of the differences in the way in which patents are administered in the US versus Europe, as well as their implications.

[12] His is not a unique position among legal scholars (see Netanel, 1996) a.o. and among economists see the collection edited by Towse and Holzhauer (2002); in addition, see Stiglitz (1999).

copyrighted work? Encryption technology is also used to prevent consumers from making copies of work to be used in different regions of the world than their own. The world is divided into regions that each has different hardware specification, which disable software from one region to be recognized in another region.[13] The cost to society seems evident as consumers are restricted in the consumption of something they have legally obtained (Dunt et al., 2002). Encryption may also be used to prevent consumers from playing a CD on a personal computer, making a copy for personal use, to share with family and close friends, or as a back-up. This increases storage costs especially.

The tendency to strengthen the protection offered by copyright law is also clear in the way in which it is enforced. A law can never spell out how exactly it should be applied, and perhaps it should not as a matter of principle. Therefore, judges when applying the law have room for their own interpretation, certainly in a Roman Law system but even in a Common Law system where leeway for a judge looking at a specific case is more limited by the need to consider to a larger degree the rulings given in earlier, similar cases. Considerations about the effect of enforcing copyrights for competition in a market are rarely aired – the fields of IPR and anti-trust law are quite separated even when one sees them conflict in reality (Encaoua and Hollander, 2002, Dolfsma, 2002b). An example is the ruling on Napster, where what is called in legal terms 'normal exploitation' of a work is extended to the full exploitation, covering the publication of a work in ways that were not foreseen at the time of the creation. Walt Disney could not have foreseen that his creation Mickey Mouse (formerly known as Steamboat Willey) would be published digitally and distributed over the Internet. This creation would formerly not be protected under copyright law from publication by others on the Internet, as this means of exploitation would not be included under 'normal' exploitation at the time of the creation. Now this existing work is also protected, retrospectively, under copyright law from distribution over the Internet. In actual fact, there is another catch to this court case against Napster. The court decided that existing players should first be allowed to develop a means by which to make music available in digital form legally, without limiting the time they could take.[14] The use of copyright law as an entry barrier has become stronger.

The developments listed above restrict the use of a legally acquired work by a consumer. Either directly or indirectly the limitation built into copyright law of 'fair use' is restricted by a combination of legal and technical means.[15] At present, legal and technical developments are thus under way to make a 'strong' system of digital rights management (DRM) possible under copyright law. In addition to a strict enforcement of a strengthened copyright law, techniques such as encryption are required. The circumvention of the latter needs then to be prohibited by law as well. These developments have clearly been informed by a desire to strengthen the economic position of the owner of the intellectual rights (Koelman, 2004). For their effects on the dynamics in the economy to be expected one would have to assess their impact on communication costs, either directly or indirectly.

Relating the discussion about the development of IPRs to the different kinds of communications costs introduced in Section 3 is quite straightforward. Certainly, communication costs increase in relative terms as a result of the full-scale application of IPRs to the knowledge economy (Stiglitz, 1999), a result further shored up by the developments in the system of IPR itself. Decoding costs rise as a result of the technical measures to prevent copyrighted works from being copied, used in certain electronic equipment, or outside certain geographical boundaries. One needs to acquire more information carriers than one would otherwise, or pay the higher price for the carrier that can be used

[13] There are six regions (Dunt et al., 2002). These are: (1) USA, Canada and US territories; (2) Japan, Europe, South Africa and Middle East; (3) South-East Asia; (4) Australia, New Zealand, PNG, Pacific Islands, Central and South America; (5) Africa, Russia, Former Russian States, North Korea, East Asia; (6) China and Tibet.

[14] Court of Appeals for the Ninth Circuit, A&M records, INC. versus Napster, INC; see also Dolfsma (2002).

[15] For a discussion of the US 'fair use' principle (fair dealing in the UK), and its relation to similar limitations in continental European law –in the Roman Law tradition – see Alberdingk Thijm (1998). In brief, in continental Europe an exhaustive list of uses that copyright does not prohibit is drawn up, while the US uses a procedure to establish if the use of copyright protected material is fair. How computer code (software) can restrict uses that are in fact legal is discussed by Lessig (1999). Guibault (2002) discusses how contract law is used to obviate the limitations to exclusive exploitation by the copyright owner present in copyright so as to allow for an extended legal protection.

in the different regions. Using available knowledge for new acts of creation will become more expensive when the scope and duration of IPRs expand – this basically relates to direct transmission costs (licenses), but also to costs that need to be born to find out if one tries to discover one would be violating another party's legal rights (Lessig, 2001). As the development of knowledge is necessarily cumulative, such costs may be high and having to incur such costs will not be a stimulus for innovation. Storage costs rise as a consequence. The fact that transmission costs rise seems clear, certainly when discussing developments in the area of copyrights. For copyright law two central notions come into play: publishing and copying. Transmitting knowledge, either using an existing channel or using a new way of publishing material, becomes more expensive due to the developments discussed as the right holders' position has become stronger over the years. A rights holder can refuse to publish a work through a new means of communication. More kinds of works are protected, while the number of limitations to a legal position has been restricted, thus increasing transmission costs. This holds for transmission of knowledge protected under patent law as well, as circumstances under which a party would need to take a license proliferate. Unless the authorities impose a compulsory license when the public interest would seem to demand it, the right holder can prevent the use of a particular piece of knowledge by others, implying a steep increase in transmission costs.

5. IPR, competition and social welfare

As knowledge is often communicated as information, the characteristics of information goods are important to note. The well-known characteristics of such goods and the markets they are exchanged on (Dolfsma, 1998) entail that a full scale application of IPRs in a knowledge economy is itself a *de facto* strengthening of IPRs, and certainly to the extent that the knowledge economy is a digital one (Stiglitz, 1999), irrespective of the developments in IPR that may be witnessed. Stiglitz (1999, p. 10) holds that information goods generate more positive externalities than do physical goods. While the social returns to innovation are much bigger than the private ones in general anyway (Jones and Williams, 1998), the creation of new information good (knowledge) would in this line of reasoning serve the public interest even more. Restricting the development and diffusion of such information and knowledge would generate high opportunity costs than for physical products.

Considering this discussion of the development of IPRs in light of the proposed dynamic welfare perspective developed in earlier session, one could claim with Stiglitz (1999, p. 9) that "it is possible that an excessively 'strong' intellectual property regime may actually inhibit the pace of innovation", and slow the pace of economic development. Such a conclusion hinges, of course, on the effects of developments in IPRs in terms of communication costs on innovative activity.

Economists would be interested in the effects of such developments on competition in a market too (Boldrin and Levine, 2002, Romer, 2002). Some of these effects are not always clear, and can perhaps be illustrated best by referring to the case of the music industry and the role copyrights play. The existing business model of firms in the music industry is strongly predicated on the existence of copyrights (Huygens et al., 2001; Dolfsma, 2000). At least until a complete harmonization on all legal issues of law is realized across the globe, a legal system's geographical boundaries are important to keep in mind. The geographical basis of copyright law is a *de facto* restriction of the relevant market, allowing firms to monitor each other's behavior closely – indeed a game theoretic analysis shows that collusion is likely to occur (Klaes, 1997). In the oligopolistic market such as this one is the outcome is an absence of competition on price (cf. Selten, 1973).

It is Baumol (2002) who has argued forcefully that competition in a free market is to be regarded as the main cause for economic growth. His explanation is the creation, but *most importantly* the diffusion of knowledge that is best facilitated by the free market (see also Mokyr, 2002). According to calculations by Baumol (2002), 80% of the economic benefits generated by innovations do *not* accrue to the parties directly or indirectly involved with the innovation. Extending the scope and duration of IPR should decrease that percentage. The conviction that creation of new knowledge is thus stimulated is premised on a number of beliefs that need not be true – instead, their validity needs to be established empirically. These (possibly incorrect or incomplete) views include:

- innovators are motivated by monetary/material rewards (only)[16];
- creative individuals possess the rights in their creations and will thus receive the reward;
- IPRs are the best means to reward creative individuals materially[17];
- it is always, or at least in most cases, in the best interest of rights holders to diffuse the knowledge (or the products which embody them) as much as possible once they have obtained IPR protection.[18]

The latter issue about the inclination to diffuse newly developed knowledge, stimulated by the system of IPRs, relates to the matter of what circumstances stimulate economic growth. Does allowing innovators a larger share of the economic pie stimulate innovation and economic growth such that in absolute (even if not in relative) terms everybody's pie is larger, or is it a zero-sum game? The matter relates directly to a governments' goal of the public good and if that is best served by enforcing IPRs. The argument as suggested in Section 3 particularly is that the dynamic effects are at least as important in such considerations as the static, distributive ones, and that the effects of developments in IPRs in these terms may well have to be judged as detrimental.

6. Conclusion

A knowledge-based economy needs a welfare theory that is able to grasp and evaluate its dynamics. In this article, I have taken suggestions from Schumpeter for a dynamic welfare economics and developed some ideas for a dynamic welfare economics. These ideas acknowledge the role of knowledge for an economy. As knowledge develops cumulatively in direct interactions between people, and is not simply available off the shelve where it winds up like manna from heaven to be put to use freely, the costs of communication has a strong impact on the creation and diffusion of knowledge, and the social welfare of a country. I distinguish storage, decoding and transmission costs related to communication of knowledge, to indicate that changes in these costs will affect (future) social welfare. Recent developments in Intellectual Property Rights in the terms of their effect on communication costs, turn out to be debatable. Changes in IPRs increase the costs of communication and could therefore be a potential impediment for the dynamics of the economy, and thus for future social welfare. The conclusion drawn by Romer (1993, p. 66) that an economics of ideas requires "a policy of openness with few distortions" would thus find support (cf. Nelson, 2004).

[16] See Hui and Png (2002), or Frey (1997) and Le Grand (2003) for a more general argument.

[17] However, see Shavell and van Ypersele (2001); see Dolfsma (2000) for some information on the skewed nature of the distribution of royalties among musicians.

[18] Compare Jaffe and Lerner (2004).

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References

Adams, W.J., Encaoua, D., 1994. Distorting the direction of technological change. European Economic Review 38, 663–673.

Alberdingk Thijm, C., 1998. Fair use. Informatierecht/AMI 9, 145–154.

Arundel, A., 2001. The relative effectiveness of patents and secrecy for appropriation. Research Policy 30, 611–624.

Audretsch, D.B., 1998. Agglomeration and the location of innovative activity. Oxford Review of Economic Policy 14, 18–29.

Bandura, A., 1986. Social foundations of thought and action – a social cognitive theory. Prentice-Hall, Englewood Cliffs, NJ.

Baumol, W.J., 2002. The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism. Princeton UP, Princeton, NJ.

Blaug, M., 2001. Is competition such a good thing? Static versus dynamic efficiency. Review of Industrial Organization 19, 37–48.

Blaug, M., 1980. The Methodology of Economics. Cambridge UP, Cambridge.

Boldrin, M., Levine, D., 2002. The case against intellectual property. American Economic Review 92, 209–212.

Casson, M., 1997. Information and Organization – A New Perspective on the Theory of the Firm. Clarendon Press, Oxford.

Cowan, R., David, P., Foray, D., 2000. The explicit economics of knowledge codification and tacitness. Industrial and Corporate Change 9, 211–253.

Cowen, T., 2000. Introduction. In: Cowen, T. (Ed.), Economic Welfare. Edward Elgar, Cheltenham, pp. xiii–xviii.
Denison, E.F., 1967. Why Growth Rates Differ. The Brookings Institute, Washington, DC.
Denzau, A.T., North, D.C., 1994. Shared mental models: ideologies and institutions. Kyklos 47, 3–31.
Dolfsma, W., 1998. Internet: an economist's utopia. Review of International Political Economy 5, 712–720.
Dolfsma, W., 2000. How will the music industry weather the globalization storm? First Monday, 5 May, www.firstmonday.org.
Dolfsma, W., 2001. Metaphors of knowledge in economics. Review of Social Economy 59, 71–91.
Dolfsma, W., 2002. The mountain of experience: how people learn in a complex, evolving environment. International Journal of Social Economics 29, 675–684.
Dolfsma, W., 2002b. Napster & KaZaA: copyright & competion. IER – Intellectueel Eigendom en Reclamerecht 18, 178–180.
Dolfsma, W., 2004. The logic of collective consuming: consumers as subcontractors on electronic markets. International Journal of Social Economics 31, 832–839.
Dosi, G., 1982. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Research Policy 11, 147–162.
Douglas, M., 1986. How Institutions Think. Routledge & Kegan Paul, London.
Dudley, L., 1999. Communication and economic growth. European Economic Review 43, 595–619.
Dunt, E., Gans, J.S., King, S.P., 2002. The economic consequences of DVD regional restrictions. Economic Papers 21, 32–45.
Encaoua, D., Hollander, A., 2002. Competition policy and innovation. Oxford Review of Economic Policy 18, 63–79.
Fisher, W., 2001. Intellectual property and innovation: theoretical, empirical, and historical perspectives, in industrial property, innovation, and the knowledge-based economy. Beleidsstudies Technologie Economie 37.
Frey, B.S., 1997. Not Just for the Money – An Economic Theory of Personal Motivation. Edward Elgar, Cheltenham.
Granstrand, O., 1999. The Economics and Management of Intellectual Property. Edward Elgar, Cheltenham.
Guibault, L., 2002. Copyright Limitations and Contract, Ph.D. thesis. Institute for Information Law, Amsterdam.
Gurbaxani, V., Melville, N., Kraemer, K., 2000. The production of information services: a firm-level analysis of information systems budgets. Information Systems Research 11, 159–176.
Hansen, M., 1999. The search-transfer problem: the role of weak ties in sharing knowledge across organizational subunits. Administrative Science Quarterly 44, 82–111.
Hettinger, E.C., 1989. Justifying intellectual property. Philosophy and Public Affairs 18, 31–52.
Hui, K.-L., Png, I.P.L., 2002. On the supply of creative work: evidence from the movies. American Economic Review 92, 217–220.
Huygens, M., Baden-Fuller, C., Van Den Bosch, F.A.J., Volberda, H.W., 2001. Co-evolution of firm capabilities and industry competition: investigating the music industry, 1877–1997. Organisation Studies 22, 971–1011.
Jaffe, A., Lerner, J., 2004. Innovation and Its Discontents. Princeton UP, Princeton, NJ.
Jones, C., Williams, J., 1998. Measuring the social returns to R&D. Quarterly Journal of Economics 113, 1119–1135.
Kitch, E.W., 1998. Patents. In: Newman, P. (Ed.), The New Palgrave Dictionary of Economics and Law, 3. Macmillan, London, pp. 13–17.
Klaes, M., 1997. Sociotechnical constituencies, game theory and the diffusion of the compact disc. Research Policy 25, 1221–1234.
Koelman, K., 2000. A hard nut to crack: the protection of technological measures. European Intellectual Property Review 22, 272–288.
Koelman, K., 2004. Copyright law & economics in the eu copyright directive: is the Droit d'Auteur Passé. International Review of Intellectual Property and Competition Law 35, 603–638.
Landes, W.M., Posner, R.A., 1989. An economic analysis of copyright law. Journal of Legal Studies 18, 325–363.
Le Grand, J., 2003. Motivation, Agency and Public Policy. Oxford UP, New York.
Lessig, L., 1999. Code and other Laws of Cyberspace. Basic Books, New York.
Lessig, L., 2001. The Future of Ideas – The Fate of the Commons in a Connected World. Basic Books, New York.
Lev, B., 2001. Intangibles – Management. In: Measurement and Reporting. Brookings Institute Press, Washington, DC.
Levin, R., Klevorick, A., Nelson, R., Winter, S., 1987. Appropriating the returns from industrial research and development. Brookings Papers on Economic Activity 3, 783–831.
Levinthal, D.A., 1998. The slow pace of rapid technological change. Gradualism and punctuation in technological change. Industrial and Corporate Change 7, 217–247.
Mäki, U., 1993. Social theories of science and the fate of institutionalism in economics. In: Mäki, U., Gustafsson, B., Knudsen, C. (Eds.), Rationality, Institutions and Economic Methodology. Routledge, New York, pp. 76–109.
Maurer, S.M., Hugenholz, B., Onsrud, H.J., 2001. Europe's database experiment. Science 294, 789–790.
Milgrom, P., Roberts, J., 1988. Communication and inventory as substitutes in organizing production. Scandinavian Journal of Economics 90, 275–289.
Mishan, E.J., 1960. A survey of welfare economics. Economic Journal 70, 197–265.
Mokyr, J., 2002. The Gifts of Athena – Historical Origins of the Knowledge Economy. Princeton UP, Princeton, NJ.
Nelson, R.R., 2004. The market economy, and the scientific commons. Research Policy 33, 455–471.
Nelson, R.R., 1990. Capitalism as an engine of growth. Research Policy 19, 193–214.
Nelson, R.R., 1981. Assessing private enterprise: an exegesis of tangled doctrine. The Bell Journal of Economics 12, 93–111.
Nelson, R.R., 1959. The simple economics of basic scientific research. Journal of Political Economy 67, 297–306.
Netanel, N.W., 1996. Copyright and a democratic civil society. Yale Law Review 106, 283–387.
Nooteboom, B., 2000. Learning and Innovation in Organizations and Economies. Oxford UP, Oxford.

Organisation for Economic Cooperation and Development, 1996. Employment and growth in the knowledge-based economy, OECD, Paris.

Organisation for Economic Cooperation and Development, 1997. Patents and Innovation in the International Context, OESO, Paris.

Pigou, A.C., 1924. The Economics of Welfare, second ed. MacMillan, London.

Polanyi, M., 1983 [1966]. The Tacit Dimension, Peter Smith, Gloucester, Massachusetts.

Raskind, L.J., 1998. Copyright. In: Newman, P. (Ed.), The New Palgrave Dictionary of Economics and Law. Macmillan, London, pp. 478–483.

Romer, P., 2002. When should we use Intellectual Property Rights. American Economic Review 92, 213–216.

Romer, P., 1994. New goods, old theory, and the welfare costs of trade restrictions. Journal of Development Economics 43, 5–38.

Romer, P., 1993. Two Strategies for Economic Development: Using Ideas and Producing Ideas. In: Proceedings of the World Bank Annual Conference on Development Economics 1992, IBRD/World Bank.

Romer, P., 1986. Increasing returns and long-run growth. Journal of Political Economy 94, 1002–1037.

Rosenberg, N., 1990. Why do firms do basic research (with their own money). Research Policy 19, 165–174.

Rosenberg, N., 1994. Exploring the Black Box: Technology, Economics and History. Cambridge UP, Cambridge.

Saxenian, A., 1994. Regional Advantage. Harvard UP, Cambridge, MA.

Schumpeter, J., 1943 [1952]. Capitalism, Socialism and Democracy. Allen & Unwin, London.

Scitovsky, T., 1977. The Joyless Economy. Oxford University Press, Oxford.

Selten, R., 1973. A simple model of imperfect competition where four are few and six are many. International Journal of Game Theory 2, 141–201.

Shaikh, A., 1990. Humbug production function. In: Eatwell, J., Milgate, M., Newman, P. (Eds.), The New Palgrave: A Dictionary of Economic Theory and Doctrine. MacMillan, pp. 191–194.

Shapiro, C., Varian, H., 1999. Information rules. In: Harvard Business. Review Press, Boston, MA.

Shavell, S., van Ypersele, T., 2001. Rewards versus Intellectual Property Rights. Journal of Law and Economics 44, 525–547.

Stiglitz, J., 1999. Public Policy for a Knowledge Economy. Department for Trade and Industry and Center for Economic Policy Research, London.

Takalo, T., Kanniainen, V., 2000. Do patents slow down technological progress? Real options in research, patenting, and market introduction. International Journal of Industrial Organization 18, 1105–1127.

Takeyama, L.N., 1994. The welfare implications of unauthorized reproduction of intellectual property in the presence of demand network externalities. Journal of Industrial Economics 42, 155–166.

Towse, R., Holzhauer, R. (Eds.), 2002. The Economics of Intellectual Property, 4 volumes. Edward Elgar, Cheltenham.

van de Poel, I., Fransen, M., Dolfsma, W., 2002. Technological regimes: taking stock, looking ahead. International Journal of Technology Policy and Management 2, 482–495.

van der Panne, G., Dolfsma, W., 2003. The odd role of proximity in knowledge relations – high-tech in The Netherlands. Journal of Economic and Social Geography 94, 453–462.

Veblen, T., 1961. Why is economics not an evolutionary science? In: Veblen, T. (Ed.), The Place of Science in Modern Civilisation and Other Essays. Russell & Russell, New York, pp. 56–81.

Vickers, J., 1995. Concepts of competition. Oxford Economic Papers 47, 1–23.