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THE ECONOMICS OF INTELLECTUAL PROPERTY: A REVIEW TO IDENTIFY THEMES FOR FUTURE RESEARCH

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The Economics of Intellectual Property: A Review to Identify Themes for Future Research

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1 Introduction

1.1 Introduction to the Review

This paper reviews the literature on the economics of intellectual property rights. Intellectual property rights (IPR) refer to the legal protection accorded to certain inventions or creations of the mind, and certain features of IPR are of particular interest to economists. This section introduces the main issues that arise when studying economic aspects of IPR.

1.2 The trade-off between incentives and monopoly

An important part of analysing intellectual property involves characterising the rivalrous nature of goods (see Paul Romer, 2002). A nonrival good is one that can be used simultaneously by many people; its use by one application does not make it harder for other people to use the same nonrival good. An example of a nonrival good would be a mathematical theorem. Goods that are rival cannot be used simultaneously by more than one person (David Romer, 1996)[1]. An example of a rival good would be a set of clothes being worn at a particular time: only one individual can successfully wear a particular piece of clothing at that instant.

Since the cost of reproducing a nonrival good, once the good has been discovered, is zero, the marginal cost of such a good is zero. Elementary economics tells us that resources are allocated efficiently when prices are equated to marginal costs. If a positive price is charged, then the price of a nonrival good is above zero, so there is loss of efficiency. If a zero price is all that is possible, the development is not motivated by a desire for profit. However, nonrival goods can sometimes be made excludable: a good is said to be excludable if it is possible to prevent it use by others. Acquiring an IPR for a particular creation of knowledge is an example of making a nonrival good excludable.

Economists are particularly interested in this feature of IPR. Economists and others have long argued that strong property rights applied to rival goods result in efficient outcomes. Strong property rights, such as IPR, for nonrival goods involve a trade-off. Since a nonrival good by definition can be used by many people at once, it is clear that the creators of a nonrival good must either not care about profit, being motivated by other incentives, or the good will not be produced or marketed. Weak property rights for nonrival goods will result in a level of provision below the socially efficient level (Paul Romer, 2002). Agents that undertake research in the expectation of earning profits will not be willing to take on the risks and costs of such activity, since any rewards from doing so will evaporate due to imitation almost as soon as the creation is marketed.

To give people an incentive to produce socially desirable new innovations, IPR allow the creators of a nonrival good to appropriate the returns of their innovation for themselves alone. But since IPR make a nonrival good excludable, it constitutes an inefficiency,

[1] Some of what follows is based on David Romer (1996).

since the price of the good will be above the marginal cost of producing the good. In other words, granting an IPR to an entity is tantamount to conferring a monopoly. Economists are then left to adjudicate as to the desirability of using IPR as a spur to innovation, and as an instigator of monopolistic inefficiency. This trade-off between encouraging innovation and suffering the consequences of monopoly was noted by many writers and was formally analysed in a modern way by Nordhaus (1969).

What are the monopoly costs of strong property rights for IPR?[2] A monopolistic firm sells its produce at a monopolistic price, and earns monopolistic profits. For a monopoly resulting from the holding of an IPR, this results in suboptimal incentives to commit resources to investment, since monopoly profits are less than the overall benefit to society. In other words, a rational monopolist will only invest in an amount of research that will earn it the monopoly profit, and such behaviour will not achieve the maximal benefit to society that would obtain if production were undertaken in a competitive market. Consumers lose because monopolists restrict output to boost price, and therefore lose out by not enough of the monopoly good being sold (see Shavell and Ypersele, 2001). Understanding whether these monopoly costs of IPR are less than the benefit to society emanating from the spur IPR give to innovation constitutes the motivation of the economic study of IPR, and provides the major theme of this review. Even where economic analysis cannot provide final answers, many of the works reviewed here offer partial contributions to this over-arching theme.

1.3 Preview

In the next section, we consider the origin of intellectual property and its relation to overall economic activity. This section discusses the relationship between intellectual property creation, firm size, and market structure. The topical and complex issue of the relationship between antitrust policy and intellectual property policy is also reviewed. Section 3 reviews work concerned with establishing valuations of intellectual property. This section reviews a literature that estimates the economic returns from obtaining legal protection over intellectual property. The literature in this area has used the cost of obtaining intellectual protection as a guide to how valuable such protection is in practice. Economists have also examined how important economic variables such as productivity, market value, and wages and unemployment are affected by the existence of IPR. Section 4 reviews the small but growing literature on the costs of enforcing IPR. Section 5 discusses the relationship between science and industry. This topical issue considers the benefits of, for example, close links between universities and industry, and the role of intellectual property in universities. Section 6 examines domestic policies to promote innovation and the adoption of intellectual property, and includes a review of some of the issues connected with the recently introduced tax credits for R&D performed by companies large and small. Section 7 discusses international aspects of intellectual property, including the very controversial Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), which has profound implications for economic development in poor countries. The final section identifies some important questions for future research.

[2] The following is based on the discussion in Shavell and Ypersele (2001).

2 Determinants of innovation and acquisition of IP rights -The Schumpeterian issues of market structure and innovation

2.1 Introduction

A central issue in economics, that has long commanded the attention of both academics and policy makers, concerns the role played by alternative forms of market structure in determining the intensity of price competition and the nature of allocative outcomes (see Symeonidis, 1996). Monopolistic and oligopolistic forms of market structure are believed to induce static allocative inefficiencies, arising primarily from the lack of price competition that such market structures entail. Nevertheless these market structures may give rise to dynamic efficiencies emanating from the ability of large firms in concentrated industries to conduct socially beneficial R&D, hence lowering costs (process innovation) and offering a wider range of goods (product innovation). This point of view, that large firms in industries with a small number of competitors are the driving force behind technological progress, was first enunciated by Schumpeter (1942). Schumpeter's claims provoked a long line of economists (see Cohen, 1995) into considering the effects of market structure and firm size on innovation.

In this section of the review, the nature of the relationship between innovation and market structure is assessed with two questions in mind. First, what is the relationship between innovation (and intellectual property) and market structure? Second, how should competition policy be framed with respect to industries in which intellectual property is important? The second question arises as a natural consequence of the first.

Competition policy seeks to encourage competition by limiting how firms in oligopolistic industries exercise their market power. Intellectual property rights, such as patents, confer monopoly power on the owner of the patent with a view to encouraging innovation by shielding the owner from competition (see Carlton and Gertner, 2002). Therefore, there is an inherent and fundamental tension between IPR and competition policy. Gilbert and Tom (2001) discuss how the Microsoft antitrust proceedings have opened a debate as to whether regulatory agencies are more concerned with their traditional aims of investigating firms that restrict output or engage in other anti-competitive practices, or whether they have begun to consider whether such behaviour may be acceptable in the context of innovative industries.

Below, we introduce the most important and relevant of Schumpeter's hypotheses on innovation and market structure. Although many of Schumpeter's claims subsequently received little empirical support, it is useful to review his contributions to this area since his work was influential in spawning a very large amount of work examining the relationship between market structure and innovation. We then review the small but growing literature on the relationship between competition policy and intellectual property rights.

2.2 Innovation, Intellectual Property and Market Structure: Theory and Evidence

Schumpeter (1912) wrote that small firms provide the most significant stimulus to innovation, but reversed this position in Schumpeter (1942) where he argued instead that large firms operating in concentrated industries constitute the engine of technological progress. Schumpeter (1942) argued that, without very much evidence, monopolistic firms were more able to conduct meaningful R&D because they can use funds earned from monopoly profits to fund R&D. Schumpeter's work suggests an important role for IPR, which may be understood by revealing the central role Schumpeter accorded to the entrepreneur. The entrepreneur was seen as a pivotal figure that controls and directs the other factors of production (land, labour and capital) towards their most productive use. Any successful new product introduced calls forth imitation and ultimately profit is eroded. There is therefore a fundamental incompatibility between perfect price competition and modern entrepreneurial activity since such immediate imitation reduces incentives to innovate. Schumpeter argues that oligopolistic market structures, with their perceived intensity of product and factor cost competition will achieve more for social welfare than the severe price competition exhibited by perfectly competitive market structures.

Many reasons have been advanced since Schumpeter's (1942) work as to why large firms may be the engine of technological and innovative progress, and these have been subsequently been formulated as hypotheses, most of which were already present in Schumpeter's work (Symeonidis, 1996). For the purposes of the present review, the two most important Schumpeterian hypotheses are the following. The first hypothesis postulates a positive relationship between innovation and market share or power. The reinvestment of profits together with the advantages of scale in investment in risky R&D, so that all research eggs are not in one basket, yields commercially viable innovation. The second hypothesis states that large firm size and innovation are correlated. This hypothesis was based on Schumpeter's belief that a large diversified firm would be better able to reap the benefits of innovation regardless of where in the industry's product range innovation happened to occur. Furthermore, indivisibility in cost-reducing innovations makes innovations more profitable for large firms.

As noted above, Schumpeter's provocative claims sparked a huge literature concerned with establishing whether these hypotheses had any basis in fact. However, rather severe methodological problems have been shown to afflict almost all of the empirical studies that have sought to test or expand the basic Schumpeterian hypotheses. These methodological issues make it difficult to assess the existing literature in this area, but reviewing a small number of influential studies will serve as examples of the complexities involved in conducting empirical research in this field.

With very few exceptions, most of the literature concerned with testing the second Schumpeterian hypothesis about the relationship between firm size and innovation regressed some measure of innovative output or input on a measure of size, usually using cross-sectional data of firms from one or many industries (see Symeonidis, 1996). Studies in this tradition, starting with the work of Horowitz (1962), Hamberg (1964) and

Scherer (1965) have been criticized as failing to recognise or deal with numerous methodological problems. For example, there was a serious sample selection problem arising from the non-random nature of samples, since the sample of firms studied typically only included those firms that reported R&D.

A further issue was the extent to which studies managed to successfully control for firm characteristics other than size. This creates problems for empirical work since the intensity of R&D varies across firms (Cohen, Levin, and Mowery, 1987). A related problem relates to the need to control for industry effects. Since firm size and innovation are likely to be affected by attributes of the overall industry such as the level of technological opportunity and regulatory considerations, studies that use inter- and intra-industry data need to control for the industry level effects in order to obtain unbiased estimates of the effect of the specific influence of firm size on innovation. Moreover, as Cohen (1995) notes, controlling for industry effects in firm level data can be extremely difficult given that many large firms are often composed of smaller units that operate in and across several industry categories.

Perhaps the most serious fault of much empirical work in this area is the implicit assumption that causality runs from firm size (and market structure) to innovation. In fact, it is now widely recognised that variables such as firm size, market structure and innovation are endogenous variables within systems in which the most important factors determining overall economic outcomes are technology, institutions, demand, strategic considerations and randomness (Symeonidis, 1996). Work by Sutton (1991, 1998) has emphasised the endogeneity of firm size, market structure and innovation. For example, some have argued that the rapid growth in IP in the US might be associated with the increasing dominance of incumbent firms and a reduction in regulation to achieve competition. This has been called the *regulatory capture hypothesis*, where large firms lobby regulators to obtain favourable outcomes; however Kortum and Lerner (1997) find no strong evidence for this in the US since 1980.

This takes us on to the literature concerned with testing the first of Schumpeter's two hypotheses, which postulated the existence of a positive correlation between innovation and market share. Again, interpreting the empirical literature in this area gives rise to several difficulties. Most work has regressed a measure of innovative activity on a measure of industry concentration. This assumes that concentration unidirectionally causes innovative activity, whereas in practice it is almost certainly the case that there is two-way causality. The problems noted above of the difficulties of controlling for firm and industry effects also contaminate much of the research on innovation and market structure. A further issue was noted by Symeonidis (1996) and Sutton (1991). Schumpeter hypothesized that innovation is higher in the presence of market power, but most empirical studies have examined the relationship between industry concentration and innovation. As Sutton (1991, 1998) there are theoretical reasons and empirical studies that suggest that higher levels of competition can increase concentration, due to the profit margins of some firms being reduced so that these firms cannot cover fixed cost.

A related point is that high levels of competition might be thought to both raise investment in innovation and the quality of the innovation. However, there is the possibility that intense competition will reduce funds available for investment and, the gains to innovation. This potential non-monotonic relationship between competition and performance has a long history in economics (Scherer, 1992). Aghion et al. (2002) develop a model in which two contrasting forces in the relationship between innovation and competition vie to create an inverted U shape: with rising competition innovation provides the opportunity to enhance profit in sectors with low variation in costs and profits; against this is the Schumpeterian effect whereby higher competition reduces the differential rents of innovation in sectors with some degree of technology and profit variation.

Evidence about the relationship of market structure to innovation that could inform present day policy is rather limited for the UK. In two historical studies, Symeonidis (2002) analyses changes in competition regulation in the 1950s and their impact on subsequent performance. Blundell, Griffith and van Reenen (1999) find a positive relationship between innovative performance and the nature of product market competition, while Nickell (1996) undertakes econometric analysis on 1972-86 data and finds broadly similar results. Aghion et al. (2002) use more recent data for 1971-94 for a small sample of 236 large UK firms, but their measure of innovation is limited to patents granted in the US. This is a relevant innovation indicator for these large firms, but is not equally important for the many smaller UK firms which contribute extensively to output and productivity growth without seeking patent protection in the US (Greenhalgh, et al. 2001). Further, their small sample makes their empirical findings rather unreliable when testing for differences between 20 production sectors, some of which contain very few firms.

The evidence of the older literature on the relationship between market power, firm size and innovation has begun to be seen as unreliable. Nevertheless, the conclusions of this literature, such as they are, do not provide much support for the two basic Schumpeterian hypotheses. Two reviews of this literature (Scherer, 1992 and Geroski, 1994) agree that Schumpeter was wrong to believe that large monopolistic corporations are the driving forces of technological innovation. Scherer (1992) notes that there is no evidence to suggest that countries should seek to "re-allocate innovative activity away from venture firms to the well-established giants lauded in Schumpeter's (1942) book". The evidence of this literature suggests that, for firms above a particular size, R&D and innovative output rise proportionally with firm size and that there is little evidence of a strong relationship between innovative output and market structure (Symeonidis, 1996). Indeed, large firms may be at a disadvantage in conducting R&D (Cohen, 1995). Instead, industry characteristics such as technological opportunity and appropriability conditions may be more important in determining innovation.

Recently, a small number of studies have emerged which seek to avoid the aforementioned problems of the earlier literature. Several papers have focused on one specific industry. For example, Gambardella's (1995) study of the biotechnology industry revealed that small firms often come up with radical new innovations and discoveries, but are unable to take the commercialisation of the product much further. He notes that the "result has been a new division of labour, with smaller firms specializing in early research and larger firms conducting clinical development and distribution". This conclusion suggests a much more subtle process of technological innovation than the one postulated by Schumpeter. As another example, Gruber's (1992, 1995) studies reveal the importance of "first mover advantage" in determining market share and innovative output in the semi-conductor memory chip industry. Firm specific learning is important in this industry because an early innovator is more capable of learning how to improve product quality in the face of rapid overall industry quality improvement than a late entrant to the industry who will have less time to learn how to improve quality. The link that Gruber draws between market share and innovation has been neatly summarised by Symeonidis (1996). The technological leader will introduce new generations of product and will have a high then a declining share of the world market. The second firm will have a mostly constant market share in each generational cycle, since its strategy is to follow the leader. The third firm, who is a late entrant, has a low but increasing market share for each generation of the product. Again, these two examples of detailed work on particular industries reveal just some of the subtlety of the mechanisms relating innovation, firm size and market share. Much more detailed industry specific research in this area is clearly needed.

Sutton (1998) contains a wealth of detail on industry structure and technology for particular industries, as well as an empirical formulation that can, in principle, be applied across industries. Sutton's concern in this book was to develop an empirical strategy, based firmly in a game theoretic setting, which could be applied in a consistent way across an interestingly broad range of industries. The predictions of the model are used to divide the set of possible outcomes into two sets, one set corresponds to what could be observed in the real world and one set corresponds to outcomes that could not be observed. Hence, this approach is sometimes referred to as the bounds approach. Sutton argues that the impact of a technological innovation will be higher when the industry is not fragmented into niche submarkets, since an innovating firm can win a large market share if products and tastes are homogenous. This leads to Sutton's claim that industries that have high R&D to sales ratios and few fragmented submarkets will be more concentrated. Sutton's case studies appear to bear out these predictions, although some of his results have been queried (Scherer, 2000). Sutton's work is particularly useful in highlighting, in contrast to much of the "Schumpeterian" work, some of the endogenous, complex and subtle mechanisms shaping the relationship between innovation and market structure. Sutton's (1998) study of the size distribution also reveals more subtleties than are typically dealt with in the older literature, where he emphasizes again the potential influence of submarket fragmentation and also the role played by strategic considerations such as first mover advantage. See also Beath, Katsoulacos and Ulph (1995) on the role of strategic elements in technological innovation.

2.3 Competition Policy and Intellectual Property Rights

2.3.1 Introduction

As noted above, there is a fundamental tension between competition policy and intellectual property policy. Competition policy is concerned with improving consumer welfare by constraining the behaviour of firms with market power. Intellectual property rights confer a certain degree of monopoly power on the owner of the intellectual property. Nevertheless, it is also the case that both policies share a common goal of enhancing consumer welfare (see James, 2002).

Regulation of intellectual property has also expanded dramatically in many countries and in many industries (see the discussion in Kahin, 2002) and competition authorities are increasingly being asked to consider cases with significant implications for intellectual property policy. As Gangi, (1999) has noted, determining the duration and scope of patents is not something that has been traditionally been within the remit of competition authorities. This naturally gives rise to the question as to whether or not such bodies are the most able at settling disputes in this area. It has also been argued that competition in innovative industries is fundamentally different from competition in industries that have traditionally served as the focus of competition policy. The issue has taken on an increased importance and visibility in the wake of the numerous high profile court cases, especially because of certain merger proposals in the pharmaceutical industry and the Microsoft antitrust proceedings. For example, Gilbert and Tom (2001) note how the number of mergers challenged, because of possible adverse effects on innovation, by the US Department of Justice and the Federal Trade Commission rose from only 4 in the 199-1994 period to 47 in the1995 to 1999 period. Innovation issues also featured prominently in several recent non-merger cases brought by these two US agencies.

Indeed, the interface between competition policy and intellectual property policy has already attracted the attention of governments. Japan issued guidelines in 1989 to help manage the interface, while the US and the European Commission issued guidelines and regulations in 1995 and 1996 respectively. The OECD Committee on Competition Law and Policy undertook a roundtable on Intellectual Property Rights in 1997. Certain provisions of the 1996 Trade Related Agreement on Intellectual Property Rights (1996) also relate to the relationship between competition policy and intellectual property policy.

This section of the review provides an introduction to some of the economic issues involved in this highly complex area. The literature is still (rapidly) developing, and economists have posed more questions than answers concerning how to successfully combine competition and intellectual property policy. Hence, what follows will serve primarily to draw attention to most important issues highlighted thus far by scholars and policymakers.

2.3.2 The Issues

Perhaps the most important first-order question to address is: Is there in fact any substantive conflict in practice between competition policy and intellectual property policy? Both policies share a common goal of promoting consumer welfare (OECD, 1998a). Intellectual property rights are normally treated by the law as simply another form of property, and this principle is embodied in the guidelines and regulations issued by many authorities, including the 1995 Department of Justice and Federal Trade Commission guidelines. Smith (1998) however notes that intellectual property requires distinct protection under the law due to ease with which intellectual property can be copied and its rewards appropriated by third parties. Smith (1998) further notes that, if one takes all forms of property rights (including intellectual property rights) as given, the role of competition policy is to apply corrective measures in instances of market dominance with a view to improving the efficiency of the allocative outcome achieved by the relevant market. Moreover, the granting of an intellectual property right does not necessarily or immediately translate into dominant market power (Gangi, 1999), although if there are no reasonably close substitutes for the new technology then a large market share will likely result.

However, in practice it is often the case that it is very hard for the competition authorities to evaluate those cases where the authority should intervene and those cases when it should not. The OECD (1998a) highlights the problem that entirely legitimate use of intellectual property rights can entail undesirable restrictions on competition, and that evaluating this trade-off between static inefficiency and long run dynamic gains from innovation is certainly outside the remit of patent offices. Evaluating this trade-off is "inherently difficult for competition agencies to make" (OECD, 1998a), and reaching a sensible decision will be complicated further if competition authorities take a short run view of competition. Smith (1998) notes how an older view of intellectual property rights tended to view such rights as inimical to competition and often thought of as being equivalent to the conferring of market power. Therefore, courts and competition agencies tended to be unsympathetic towards intellectual property rights in cases where competition was felt to be threatened. However, several commentators have observed what appears to be a much more lenient attitude in the US and the EU towards possibly anticompetitive conduct that involves the use of intellectual property (Encaoua and Hollander, 2002).

Gilbert and Toms (2001) ask, "Is innovation the king at antitrust agencies?" They assessed those merger and non-merger cases, in which innovation concerns were deemed to be important, considered by courts and regulatory agencies since the introduction of the intellectual property guidelines in 1995. They conclude, on the basis of the cases they study, that innovation concerns have not replaced the more traditional preoccupations of competition authorities. Nonetheless, innovation considerations have been very important in a number of cases, and have led to a number of different remedies: "In this respect, the status of innovation competition as a dimension of antitrust enforcement has been elevated dramatically in the latter half of the 1990s, and we believe appropriately so”. Gilbert and Toms also find that the rulings in these cases have generally been consistent with the 1995 guidelines.

However, there is also concern that patents are used in some sectors, such as biotechnology, to stifle competition and retard innovation. These concerns emanate from the practice of obtaining several patents very similar to each other in scope, which has the effect of making it very difficult for potential entrants to acquire industry know-how. Gangi (1999) refers to such activities as the “excessive compounding” of intellectual property rights, and Shapiro (2002) refers to a “patent thicket”. The OECD (1998a) advises against direct remedial action on the part of competition authorities in every such case, and instead recommends that competition authorities engage patent offices in dialogue to help draw out the anticompetitive implications, for specific industries of overbroad patents. On a related point, Encaoua and Hollander (2002) note the fears raised by some commentators concerning the fact that intellectual property law is being used as an anticompetitive barrier to entry. Potentially anticompetitive behaviour associated with intellectual property rights may arise when intellectual property is licensed, cross-licensed or pooled. We review below some of the literature connected with each of these issues.

Licensing is a particular important topic, because as the South African Competition Commission (2001) note, much of the interface between intellectual property and competition policy takes place within the scope of licensing agreements. Licensing involves the owner of a piece of intellectual property granting a third party the right to use the intellectual property for their own ends in exchange for a fee. Licensing is generally seen as being procompetitive, and the third 1995 guideline of the Department of Justice and the Federal Trade Commission recognises this fact. As the South African Competition Commission further notes, licensing has the beneficial feature that it allows intellectual property to disseminate throughout an economy. Furthermore, many intellectual property owners do not possess the means to develop or commercialise their technologies, and licensing represents a convenient means of introducing useful new innovations to society. As Smith (1999) notes “Licensing represents the trading and exchange of intellectual property, which intellectual property rights are in part designed to facilitate and promote. In this regard, the exchange or licensing of intellectual property should generally be considered to contribute positively to the competitive market process and therefore be viewed as being pro-competitive”.

However, certain forms of licensing may be anti competitive, depending on the conditions attached to the license to which the licensees are subject. Encaoua and Hollander (2002) note that a particular tension between competition policy and intellectual property policy arises when consideration is given to the exclusionary context of the terms of a licensing agreement. The exclusionary terms will relate to restrictive clauses involving exclusivity terms, output restraints, market sharing agreements, territorial mandates, and grant back requirements. Theoretical and empirical economic analysis has, thus far, relatively little to say about the appropriate mix between competition policy and intellectual property policy, and Encaoua and Hollander further note how EU and US courts have not provided "clear direction as to when a refusal to deal is anti-competitive where it involves IP."

In the US, the Xerox case showed that a patent holder has the right to refuse to grant a licence to a third party without regard to the intent or effect on competition (Encaoua and Hollander, 2002). As Kirsch (2002) notes, in this case, "intellectual property rights trump antitrust law". Similarly, the ruling in Intergraph vs. Intel case ordained that antitrust laws do not negate the patentees right to exclude actual or potential competitors from licensing. However, the Microsoft case concluded that "copyright law does not give Microsoft blanket authority to license (or refuse to license" (see Kirsch, 2002). Similarly, the court in the Kodak case found that the patent right to exclude is permitted, but this was right was rebutted in this case since it was found that Kodak's intent was to stifle competition.

Kirsch's (2002) analysis of US cases leads him to conclude that the decision in the Xerox case mentioned above is the law in Federal courts. Encaoua and Hollander (2002) conclude that US court decisions assesses cases concerning the refusal to licence using three criteria: "(i) the intent of the party refusing to issue a licence (ii) the 'essentiality' of the input embodying the know-how; and (iii) the impact on the incentives to innovate. At this stage, though, clarity is still missing. This appears to be true in the EU as well". All commentators and authorities agree, however, that the distinctive features of intellectual property rights call for a customised and industry-by-industry approach to the competition policy interface.

One particularly interesting case involved the proposed merger of Ciba-Geigy and Sandoz. It made amongst other things, the consent order for a merger conditional on the mandatory licensing of an important proprietary technology (Encaoua and Hollander, 2001). The consent order required that not only should rivalry be maintained in the product market, but also in the technology and innovation markets, and compulsory licensing was seen by the court as a means to encourage competition and was therefore imposed as a remedy in this case. This remedy was reached because of an expectation that the merged entity would be one of only a few firms capable of producing a wide range of commercial gene therapy products; a merged firm would therefore face little competitive pressure and diminished incentives to create innovative gene therapy products.

The OECD Roundtable (1998a) looked favourably on the new concept of "innovation markets" and suggested that this concept has the potential to "significantly expand the degree to which competition policy interacts with IPR…the main advantage of the innovation market concept lies in its focus on an easier to understand actual rather than hypothetical constraint on competition". However, Carlton and Gertner (2002) argue, in the context of mergers, that there is little justification for the courts and competition agencies to expand their traditional focus on product market competition to encompass consideration of competitive conditions in the innovation market. They argue that the taking into account of innovation markets depends on three conditions holding (i) reducing R&D expenditures is undesirable (ii) fewer firms performing R&D means less

R&D is done in the aggregate (iii) it is possible to determine that there are not enough remaining firms to do R&D. They argue that there is very little support, either theoretical or empirical, to support these claims. Innovation market analysis has yet to be used extensively in merger cases, and it remains to be seen whether the advice of the OECD or the arguments of Carlton and Gertner will prove the most influential in this regard.

Another significant aspect of this interface involves the issue the pooling of patents. A patent pool is defined by Shapiro (2002) as follows: "A patent pool involves a single entity (either a new entity or one of the original patent holders) that licenses the patents of two or more companies to third parties as a package". It is a means by which "industries seek to commercialize new technology that is covered by many overlapping intellectual property rights" (James, 2002). Although patent pools will be procompetitive if they involve technologies that are complements, they clearly have the potential to be anticompetitive. The OECD (1998a) considers a number of potential problems. First, if the technologies are substitutes, then horizontal competition will be reduced. In fact, the US Department of Justice has supported this approach in three recent reviews of three technology patent pools (Shapiro, 2002). Second, even when the relevant technology components are not substitutable, patent pools may amount to collective boycotts, with adverse effects of existing and potential competition. Third, consumers will suffer if patent pools slow the pace of innovation. The OECD suggests a rule of reason approach to dealing with patent pools.

Numerous other aspects of the competition policy/intellectual property interface are also of increasing importance. There is not adequate space here to cover all of these topics, but excellent reviews are provided by Shapiro (2002) and the OECD (1998a). These include primarily issues of cross-licensing, international aspects of the interface, and standard setting. Maskus and Lahouel (1999) provide a comprehensive review of the issues for developing countries in synergising competition policy and intellectual property policy Cross licensing involves mutual agreements on the part of two or more interested parties to use the intellectual property of other consenting members. Though normally a spur to innovation, cross licenses may be abused if they give rise to cartels to block access to non-member firms. Standard setting by industry has long been recognized as being of significant importance to consumers, since the benefits of compatibility between the products (and sometimes services) of different manufacturers are considerable. However, the coordination between manufacturers to effectuate a working policy may give rise to anticompetitive influences.

3 The Valuation of Intellectual Property Rights

3.1 Introduction

This section reviews modern attempts made by economists at determining the value of Intellectual Property Rights (IPR), but first the reasons for being interested in this topic are discussed. Interest in determining the value of IPR is motivated by several distinct but related concerns.

At the most fundamental level, academic economists, and the policy makers they advise, are concerned with establishing scientific or quantitative evidence for or against the view that technological advance is crucial to economic performance and development. The most important policy question in economics has been described (Romer, 2000) as "how to increase the trend rate of growth of output per capita". A consensus that asserts that technological advance is critical to economic growth therefore deserves to be investigated and scrutinized very carefully. We do not review here the extensive literature on the relationship between macroeconomic growth and innovation; see Cameron (1999) for a review of these issues. Instead our focus is on the microeconomic underpinnings of such aggregate relationships. Determining the quantitative contribution of technology in a satisfactory and scientifically robust manner is a non-trivial endeavour. As Griliches (1995) notes, detailed economic analysis is necessary to address questions such as whether or not current levels of public and private sector investments in innovative activity are adequate, whether the value of such investments has changed over time, or whether the familiar contemporary system of IPR represents an appropriate balance between enhancing consumer welfare and providing sufficient incentives to encourage innovation.

Furthermore, firms and their accountants are subject to important commercial and competitive pressures to correctly determine the value of their assets. Consequently, they have sought to develop means of valuing intangible assets, including IPR, as an important part of the process of determining the value of their company, as well as to guide planning decisions, and also occasionally for transfer pricing purposes or to settle legal cases (Hall, 2000). It is also of considerable interest to investigate the nature of changes in the economic structure induced by the existence of IPR. For example, do firms that hold a lot of IPR have higher share prices, higher profits, or because they are more productive? Do changes in the value of the IPR cause significant effects of firm or industry performance? What effect do IPR have on wages and unemployment? These are some of the questions that are addressed when the value of IPR is discussed.

Related to this internal need of companies of to accurately value their intangible assets is the need of investors to perform the same task with a view to determining a "fair" value to pay for the company's shares. Indeed, investors, financial economists and occasionally even central bankers and regulators are sometimes interested (Hall, 2000) in constructing measures of "fundamental value", which may be described as the price an efficient capital market would place on a publicly traded share. Investors, for example, will attempt to find and purchase shares they believe are under priced according to their estimates of the shares' fundamental value. Central bankers, for example, may alter monetary policy if large deviations from estimated fundamental value are observed in capital markets.

Given all these considerations, accurately determining the value of IPR to firms, their shareholders and their employees is an important task. In the next section we review the modern literature on IPR valuation and the private economic returns to IPR.

3.2 Approaches to Valuing IPR

3.2.1 The Costs Approach

One method that was used in the early literature in this field for determining the extent of IPR is to use patent counts as a measure of innovative output. This method simply counts the number of patents granted or applied for by a particular economic unit, such as a private firm or government department. More patents, controlling perhaps for other influences such as firm size or geographical location, represented a higher volume of innovative output and were thus taken as an indicator both of the value of the idea patented, and as representing the value of the proprietary rights created by patent protection laws (Lanjouw, Pakes and Putnam, 1998).

Patent counts were widely used in empirical research concerned with the valuing of IPR until the work of Schankerman and Pakes (1986), who convincingly argued that the simple patent counts are unlikely to be good measures of the value of innovative output or IPR, since the value distribution of patents themselves is so skewed. In other words, most patents are worth very little to either their inventors or to society; instead, a very small minority of patents are of high value and are lucrative financially to their inventors and yield sizable benefits to the economy in terms of improved consumer welfare. Therefore, adding up the number of patents issued to a particular entity is an uninformative measure of innovative output and of economic value.

Schankerman and Pakes (1986) demonstrated the existence of a skewed value distribution for the United Kingdom, France and Germany. They improved on the patent count literature by confronting the problem of a skewed value distribution by basing their empirical analysis on the observation that in these three countries (and in most other countries), patentees must pay an (annual) fee to renew their patents. Schankerman and Pakes argue that it is reasonable to assume that firms, governments and other patent holders make renewal decisions on the basis of the value of the patent. These authors then exploit this fact by using data on renewals and renewal fee schedules for the three aforementioned countries to reveal information on the distribution of the value of patent rights. Forming this empirical distribution then facilitates estimation of the economic value of patents, albeit as a lower bound estimate, given that renewal only occurs if the anticipated value of the patent exceeds the renewal fees.

Their study covers all patents applied for in the UK, France and Germany for the period from 1950 to 1979. There is no breakdown for industrial sectors in any of the countries[3]. Based on data obtained directly from national patent office, France and the UK share similar patterns of slowly rising cost and falling rates of patent renewal with patent age. In Germany, renewal costs rise rapidly after the patent has been in force for six years and initially high renewal rates fall more sharply after this point.

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[3] Schankerman (1998) presents estimates of the private value of patent protection amongst different technology fields.

As noted above, the Schankerman and Pakes' observed distribution of renewals by countries appears consistent with their starting hypothesis that renewal fees influence the decision to renew: in each country the distribution of patents by duration (and thus by imputed value) is extremely skewed. In the UK and France roughly 60% of patents survive five years but only a quarter survive past age thirteen, which shows that the available legal maximum patent life is not relevant for the majority of patents because the value of the intellectual property falls to zero, either due to technological redundancy or to commercial non-viability. The small proportion of patents that are renewed to the limit are of course those with highest value.

Given the fact that the life of individual patents can vary so much and that so many have short lives, the average value of all patents is not a particularly informative statistic. Because of this, Schankerman and Pakes also looked at the value of patents which service to at least five years of age. Measures reveal similar values in France and the UK, but much higher values in Germany. This difference is probably reflective of the higher initial rejection rates in Germany (only about 30% of patent applications were accepted), which of course implies that any patents that are accepted in Germany are likely to be of a somewhat higher value than those in the other two countries. Hence it is to be expected that the five-year value will be highest in Germany.

The importance of using value statistics rather than count statistics is well illustrated by one of the findings of Schankerman and Pakes. A secular decline was observed in the number of patents issued in the late 1960s, prompting worries that the West had entered a period of "technological exhaustion" (Lanjouw et al. 1998). However, the Schankerman and Pakes method of weighting patents by value reverses the decline implied by the patent count method and crucially reveals that the estimated value of patents increased over the period of their study.

The work of Schankerman and Pakes (1986) shifted the cost-based approach to valuing intellectual property away from simple patent counts towards more sophisticated analyses of patent value distributions. Putnam (1996) uses international data on both renewals and applications to estimate a distribution of both domestic and foreign value, and he also studies and measures the international flow of returns, thereby extending the usefulness of patent data. The international data is particularly useful because it allowed Putnam to form an estimate of the total value of an innovation, rather than just the value of the patent protection in one particular country.

One interesting result in Putnam's work is that, for 1974 data, there appears to be quite significant cross-country differences in the mean value of internationally filed patents, with Japan being a particularly significant outlier in this respect. For example, the mean value of a patent differs greatly between Germany and Japan, two countries that at this time had economies of similar size. Putnam's results therefore imply that innovators regard the Japanese patent as offering less protection, holding constant the "quality" of the invention, to their work than an internationally filed German patent.

Harhoff, Scherer, and Vopel (1997) studied another refinement of the patent renewal approach. Their study was inspired by the observation that work on application and renewal data was silent on those patents that were renewed for the maximum possible duration. Since patents that are renewed for the maximum possible statutory term are presumably the most valuable, Harhoff et al point out that the renewal studies will only uncover information on a small amount of the total value of a national patent portfolio.

Harhoff et al confirm the skewed value distribution found in many other studies, but present this result for the tail of the most valuable patent applications made in 1977 and expiring at full term in 1995. A novelty of the empirical approach in this paper is that the value estimates were obtained directly from patent holders through the use of a survey conducted in 1996, a year after the final year's fees. German data was used because, as noted above, the German system of patent renewal is particularly rigorous in rejecting applications of low inventive output (Harhoff et al., 1997), and because of its highly progressive renewal fee schedule. (A progressive renewal fee schedule means that the fees that must be paid to the relevant patent office increase with each year that the patent is in force.)

The survey asked the patent holders how much they would have been willing to sell the patent for soon after it was granted, assuming they had perfect knowledge at this time of patent's contribution to future profitability. This distinguishes the Harhoff et al. study from other renewal data papers, since responses to this survey question mean that patent values can be measured relative to the counterfactual of being deprived of the use of the patent. This method results in much higher extreme values; the estimated value levels are hundreds of times higher than those in other studies that use renewal and application data. The results also exhibit a high degree of skewness: the most valuable 5% of all German patent renewals accounted for over 50% of total sample patent value, and in the US the most valuable 8.5% of patents account for around 80% of total patent value.

In related work, Harhoff, Narin, Scherer, and Vopel (1997), a survey was conducted to determine which asked inventors to estimate the economic value of their inventions. These yielded 962 estimates of value for inventions made in Germany and the US, and for which German renewal fees were paid to full term expiration in 1995. The survey results indicated that, unsurprisingly, that patents not renewed to full term were worth much less than those renewed to full term. Moreover, within the class of patents renewed to full term, citations of the patent rise with economic value, although this relationship is somewhat noisy.

A further refinement to the patent renewal approach is studied in Lanjouw (1998), who uses patent renewal data in West Germany between 1953 and 1958. The improvement this paper offers over other renewal-data based papers is that it explicitly takes into account the potential legal cost of protecting the patent from infringement. The threat of legal action clearly affects value of holding a patent. A noteworthy feature of her results is that patentees in different technological areas differ in their ability to defend legal claims related to their patent rights. The mean values of patents also differ substantially across technology groups. Her estimated value distribution is, unsurprisingly, very skewed; those patents that ultimately turn out to be valuable generate high returns.

Lanjouw's estimates of the value distribution reveal lower mean patent values than comparable studies, such as that by Pakes (1986), on West German data. The fairly large difference in values turns out to be hard to explain, but Lanjouw argues that the differences turn on the effects of sample selection. She suspects that estimates of value in Pakes' work may be biased upwards since the use of a long time period imparts a downward bias to mortality rates in early rates. This causes an upward bias to value estimates, since the value estimates in most of this literature are based on mortality rates. Therefore, a major contribution of Lanjouw (1998) is to emphasize issues of sample selection, and to include the cost of potential litigation in an optimising economic model of the patent renewal decision.

3.3 Econometric Evaluation of IPR Value

3.3.1 Productivity Approaches

One approach to assessing the value of IPR and the innovation they embody is to assess the contribution such rights make to productivity. Productivity is perhaps the single most important statistic used by analysts interested in seeing how firms and countries are performing. Recently, a small number of papers have attempted to assess this contribution at the firm level. Two papers that have taken this approach using British data are Greenhalgh and Longland (2002) and Bloom and Van Reenen (2002).

Bloom and Van Reenen (2002) study a database of over 200 UK firms for the period 1968-1996, and examine the impact of patents registered in the US on both firm productivity and firm market value. In this section, we focus on the productivity aspect of their work. The empirical formulation in the paper is to create and study observable proxies for technical change, such as simple patent counts and patents weighted by citations. Patents are included as a proxy for knowledge in an econometric specification of firms' production functions; the dependent variable in these regressions is based on firm's real sales, which the author's take as a measure of productivity.

Note that in common with many other econometric studies, these authors do not use actual renewals data, unlike the costs approach to patent value, to construct actual patent stocks. Rather they investigate alternative specifications of calculated patent stocks to reveal the timing and impact of leads and lags in their impact on productivity, using a variety of assumed depreciation rates. Clearly citation weights pose further problems in that the importance of any patent is revealed slowly throughout its duration and some citations may be as yet to come, necessitating either estimation of unobserved future citations or the adoption of a fixed time cut-off. Bloom and Van Reenen report three different specifications for the patent variable: patent stocks estimated using a fixed depreciation rate, and two variants of citation-weighted patent stocks, using imputation of future citations for one measure and a five year cut-off for the other.

The empirical results point to a significant and positive effect of the patent measures on total factor productivity (as measured by the real sales variable). Patent stocks, when estimated as the sole measure of knowledge in a firm, are highly significant and have an estimated elasticity of 0.03, implying that total factor productivity will rise 3% if total patent stocks are doubled. When both citations and raw patent stocks are included estimated jointly, the simple patent stock variable is no longer significant. This implies, as one would expect, that citations provide significant and important information concerning the effects of innovation and IPR on productivity. However there is little difference in the estimates depending on which approximation to citation weights is used.

Despite the sophistication of these estimates, Greenhalgh and Longland (2002) have criticized the empirical strategy employed in this paper. They point out that Bloom and Van Reenen estimate a gross output production function (using real sales as their dependent variable), but do not include as regressors any variables related to the use of intermediate inputs. Research by Greenhalgh and Gregory (2000) has demonstrated that supply chains vary greatly across sectors and over time, which implies that ratio of gross sales to value added also varies. This suggests that Bloom and van Reenen's choice of sales as a proxy for net output is a rather poor one. Their study is also confined to the impact of patents registered and cited in the US by a small sample of large firms.

Greenhalgh and Longland (2002) use a larger panel database for 1986-94 and they relate firms' net output (measured by value added) to the contribution made by intangible knowledge assets, as well as to the contribution made by capital and labour services. These authors also seek to widen the range of measures of IPR, arguing that while the acquisition of new patents may be reflective of more efficient production processes or improved product variety and quality, the launching of new products is also often associated with registration of trade marks. Consequently, they investigate gains from intellectual property by measuring the number of new patents registered in three geographical domains, the UK, EU and US, and by trademarks registered in the UK.

Greenhalgh and Longland (2002) test for evidence of productivity gains in firms registering trademarks and patents, but also examine the size and duration of benefits to IP protection for the firms in their sample. This question is of interest since it would be useful to know if the economic gains to IP protection correspond to the length of protection enshrined in statute. A closely related question addressed by Greenhalgh and Longland relates to the non-depletability of knowledge assets. In theory knowledge is not "used-up" by being applied (Arrow, 1962), so Greenhalgh and Longland asses whether the absolute amount of R&D, or the total amount of IP assets, is important for firm performance. They compare this idea of knowledge as a non-rival good with a contrasting hypothesis of knowledge as a depletable good, whereby the intensity of R&D and IP relative to firm size becomes important as each process or product only affects part of the range of the firm's output in a multi-product firm.

The empirical analysis reveals that firms that register trademarks and patents, and who do R&D (for those firms who report R&D separately in their accounts) are more productive. Interestingly, the immediate productivity benefits revealed by panel data analysis appear to be fairly short-lived. Dividing their sample between firms which are located in high and low technology sectors shows that the dynamic returns for acquiring new IPR are non-significant for high technology firms, but significant for firms in low tech sectors. (These panel data estimates control for persistent differences between firms.) Even so, cross-section analysis reveals that persistent differences in productivity are associated with the presence of R&D and IP activity in both high and low tech firms and firms which do not participate in any of these innovative activities are persistent laggards. They also find that innovative firms do not possess the ability to use knowledge equally effectively in all areas of their activity, as the intensity of R&D and IP matter. Hence Greenhalgh and Longland suggest that firms need to continually renew their intangible assets stocks to improve both their production technology and product offering.

This result is similar to conclusions of survey work on US firms in the high-tech semiconductor industry: Hall and Zeidonis (2001) conducted their own survey of 100 firms in the semiconductor industry. This industry is characterized by technological sophistication and extremely short product life cycles. Earlier surveys of many sectors report that managers regard patents as one of the least effective ways of extracting value from intellectual property. The authors note that firms in the semi-conductor industry tend to rely more on measures such as lead time, secrecy and design capability than on patents. This evidence is particularly surprising given the widespread and increasing use of patents in this industry.

Hall and Zeidonis conclude that many patents are registered so as to quickly allow individual firms to negotiate access to important external technologies. Thus, firms use large patent portfolios as "bargaining chips" to get around the problem of investment being delayed due to certain patents being held by external economic units. Such behaviour leads to "patent portfolio races" on the part of firms trying to amass, for strategic reasons, large numbers of patents. Hall and Zeidonis observe that such behaviour would not be observed if patent rights were awarded on a strictly "novel" basis, so that it would become very difficult to get a patent when a substantial body of "prior art" exists.

This work is especially helpful in highlighting the need to explicitly take strategic factors into consideration when studying patent behaviour. It is also useful in highlighting how the firms in the same and different industries all react to, and benefit from, patent laws in vastly different ways. This suggests the need for careful and detailed statistical analysis when studying these issues in the future.

3.3.2 Profit, Market Value and IPR

In a modern market economy, the private economic value of a good may be inferred from the price the good trades at in a well functioning market. However, intellectual property rights are rarely traded. This makes it difficult to determine private returns to intellectual property in the absence of very detailed firm level data (Hall, 2000). One popular approach to determining the value of such rights is to infer the value of IPR from the share prices of publicly quoted companies. In this section, we review recent studies that have examined the relationship between IPR and market value.

The share price of a quoted company represents the markets' best valuation of the expected future dividend or share repurchase payments likely to be made by the company. The maintained assumption (Hall, Jaffe, and Trajtenberg, 2000) in the literature on IPR and market value is that investors have "rational expectations" concerning the relationship between the firm's knowledge assets and its stock of knowledge. In other words, financial markets are assumed to price shares "correctly". Investors' estimates of the future dividend payments will be a function of the stock of tangible and intangible assets owned by the company. IPR are one component of a firm's intangible assets, and evidence that measures of knowledge assets such as patent statistics are correlated with market values constitutes evidence, argue Hall et al (2000), that such statistics are good proxies for the (private) economic value of a firm's knowledge stock. An advantage of this approach is that it is inherently forward looking (Bosworth and Rogers, 2001), which distinguishes it from the costs and productivity approaches described above. But as Hall (2000) notes, intellectual property assets are usually embedded within a particular product, and evaluating the separate contribution made by these and other types of assets is difficult.

One very important recent contribution to this literature is the work of Hall, Jaffe, and Trajtenberg (2000). This paper is a detailed and careful empirical analysis, based on a newly constructed American dataset, of the correlation between a firm's market value and the firm's patent citations and stocks of patents. These authors construct a variable representing citation-weighted stocks of patens as a proxy for the firm's stock of knowledge. The sample consists of over six thousand publicly traded manufacturing firms with data from 1965 to 1995, although data is only available for patent citations from 1976. Their specification of the firm's market value function is a standard one (Toivanen, Stoneman, and Bosworth, 2002): the value of the firm is defined as the value of equity plus debt, and this is related to the value of tangible and intangible assets.

The Hall et al. (2000) empirical analysis replicates a familiar result from this literature: the R&D stock is more closely correlated with market value than either patents or citations, but that citation weighted patent stocks are more highly correlated with the firm's value than unweighted patent stocks. A more interesting result is that, after controlling for firms' R&D, the citation variable is associated with increased market value. Firms with heavily cited patents exhibit what Hall et al. (2000) describe as "almost implausibly" large market value differences. This result implies that firms with heavily cited patents will enjoy a market valuation 50% higher than a firm with the same R&D and patent stocks, but with only the median citation intensity. Another novel result is that preliminary results of their data suggest that firms with a higher share of self-citations enjoy a higher market value, other things equal. A self-citation is simply a citation made by a company to a patent already owned by that same company. Although self-citations may be strategic, Hall et al note that such citations may mean the firm is successfully protecting positive downstream impacts and successfully appropriating benefits for itself. The positive association between market value and self-citations confirms this intuition.

Toivanen, Stoneman, and Bosworth (2002) conduct a similar analysis using a newly created database of British firms. Annual samples varied between 574 and 840; the estimation period was 1989-1995. Toivanen et al are careful to take into account the possibility of selection bias. Since the market value equation can only be estimated for firms on which there is data on both R&D and patents available at the same time, sample selection bias may infect the data sample if the provision of R&D and patent data is in fact a choice made by the firm. In practice, the authors argue that missing patent statistics probably reflect data source coverage, and instead model only R&D as an endogenous variable. The patent data actually used are unweighted patent application data.

There is no evidence that the sample selection is a significant problem, although it is of course sensible to test rather than assume this result. Interestingly, although the paper reproduces the familiar result that the market values R&D, the authors find that once R&D is taken into account, patents actually have a negative effect on market value. The authors interpret the negative impact of patents in the same way as Bosworth and Stoneman (1994): patenting will be higher when it is difficult to appropriate returns to innovative activity. In such a scenario, innovation will have less of an impact on market value. The authors do acknowledge that their results may be contaminated by short-termist behaviour in the capital markets.

The work of Bloom and van Reenen (2002), discussed above in the context of productivity, also examines the role that patents play in determining market value. Bloom and van Reenen found that patents (recall that US patents and their citations are used in this paper) positively affect market value. Patents also affect market value much more quickly than they affect productivity measures, a result that is likely due to the time it takes to embody new innovations in work processes and to adjust physical capital to the new innovation.

Bosworth and Rogers (2001) study the relationship between market value and knowledge stocks using a new database of intellectual property and R&D for large Australian firms. A novel feature of this paper is that trademark and design application data are used as proxies for investment in innovation. Sixty Australian firms are studied for the years 1994 to 1996. They employ a standard econometric specification in that market value is related to stocks of tangible and intangible assets.

One limitation of their study is that they have one year of data on patents, trademarks and design applications. If there is substantial variation in these variables from year to year, then analysing just one year of data will have serious adverse implications for the results reported in this study. A related problem, not mentioned by the authors, concerns the short sample period used to collect data on market value. Whereas economists believe that financial markets are efficient over the medium to long term, many economists would acknowledge that inefficient deviations from fundamental value may be observed over short time horizons. Another problem is that the patent data are counts of patent applications, and hence are not citation weighted. There is little evidence of a positive effect of trademarks and design applications on market value, although the patent variable is positively related to market value. The results do suggest, however, that trademarks have a positive association with market value for non-manufacturing firms.

Rogers (2001) studies the relationship between profitability and R&D, patents and trademarks. The data is for a panel of 721 Australian firms between 1995 and 1998. The basic equation to be estimated is similar to the other studies cited above: market value is related to measures of tangible and intangible assets. The nature of competitive conditions in each industry are also controlled for, as Rogers argues that the intensity of competition in an industry is likely to affect the rate of return to innovative activity.

R&D is strongly and positively associated with market value, but patenting activity, which Rogers measures as the ratio of patent application to total revenue, is never significantly associated with market value. Rogers acknowledges that this result may be a consequence of the fact that patent applications are probably a poor measure for innovative activity. He also suggests that the (Australian) stock market may fail to recognise the value of patents, although such reasoning is contradicted by the empirical work of Hall et al (2000) and much theoretical work on the efficiency of capital markets. Trademark activity, measured as the ratio of applications for trademarks to total revenue, is actually negatively related to market value. Rogers suggests that the reason for the surprising result on trademarks may reflect over investment by firms in the judgement of the market, since trade marks will be closely associated with marketing and advertising expenditures. However, these results do not hold on trademarks do not hold for the non-manufacturing sub-sample.

3.3.3 Wages, Employment and IPR

Another matter of considerable importance to economists and policy makers concerns the effect of IPR on wages and employment. This strand of the literature addresses how the gains from innovation are distributed within firms, industries, regions and countries. Technological advance is often seen as one of the culprits for the rise in wage inequality in many OECD countries over the last 15 years. In this view, innovation is expected to cause job losses because of labour saving process innovation in production. As Greenhalgh, Longworth and Bosworth (2001) note, this is an unnecessarily restrictive view of the effects of new technology and innovation. As Greenhalgh and Longland (2001) point out, the old view of the effects of new technology ignored the positive labour demand effects that may be expected to result from innovation supporting product demand. Creating new technologies requires R&D research staff, and launching new products needs new production and marketing staff. Moreover, firms making increased profits from their innovations are expected, and are likely, to share some of the windfall with their workers. This is likely to be the case, since Hildreth and Oswald (1997) demonstrated that long run movements in pay are correlated with prior changes in profitability. In other words, wages are higher in those companies that have a greater ability to pay high wages.

Greenhalgh and Longland (2001) conduct an empirical analysis of the relationship between intellectual property assets and wages. They use data on up to 1000 UK production firms in business between the mid-80s and mind-90s, although the exact number of firms used in each regression differs according to data availability and other related considerations. The four IP measures used were, as in the value added study cited above, UK, EPO and US patents, and UK trade marks. The empirical analysis of wages concerns changes in the average worker per employee. This may reflect both wage gains to workers after new IP assets are acquired, or any shifts in the average quality of the workforce, which would occur if innovation changed the composition of the workforce. The firm wage is estimated as a function of variables such as the industry wage, the ratio of R&D to sales and IPR variables. Because of difficulties related to the timing of the effects of new IP assets, the model was estimated using a variety of lead and lag specifications. The results indicate that extra patents do not induce any changes in relative nominal wages, but that new trademarks and increasing investment have a significant and positive effect on wages.

Work by Greenhalgh, Longland and Bosworth (2001) on a panel of UK firms between 1987 and 1994 confirms that firms that acquire new intellectual property via patents and trademarks have higher levels of employment, other things equal, than other firms. To assess the impact of new IP assets on employment, the model examines the derived demand for labour as a variable factor of production. Thus, labour demand is seen to be affected by its own cost, the cost of capital, and the price of energy and materials. A labour demand equation is estimated which includes measures of the firm's intellectual property assets and commercial intangible asset stocks. Three alternative measures of patents were used corresponding to the three patent publishing measures mentioned above in the Greenhalgh and Longland (2001) work. The largest panel used in this work included over 500 firms. The empirical analysis reveals that increased R&D and patenting lead to significant employment gains. There is also a persistent positive effect of patent and trademark ownership on employment.

Two related pieces of work by John Van Reenen (1996, 1997) also find a positive effect of technical change on jobs. Van Reenen (1997) also finds significant and positive persistence of the effect of innovations on employment. This work combined data from a very wide variety of sources, the main source being a panel of manufacturing firms listed on the London Stock Exchange for at least 5 continuous years between 1976 and 1982. Innovation count data was drawn from the Science Policy Research Unit's innovation database. As noted earlier, two weaknesses of this database are that the sample stops at 1982 and that intellectual property is measured as patents taken out in the US.

The econometric analysis is designed to be robust to a wide range of specifications and controls, and the results indicate that, as noted above, technological innovation is associated with higher firm employment. In related work by Van Reenen (1996), innovating firms are found to have higher wages, but there is some evidence that rival innovations exert a downward effect on own wages. The data used in this paper is very similar to Van Reenen (1997), and hence is subject to the same criticisms made above. Again, a lot of care was taken to ensure the empirical specification was as robust as possible. The main result is that average wages in a firm rise as a result of innovative activity, and that the rise in wages peaks at three to four years after commercialisation.

4 The Costs of Enforcing Intellectual Property Rights

4.1 Introduction

The incentives to invent even under an IPR system depend on net returns after costs of obtaining and enforcing the IPR. If the law cannot be used to enforce rights or is prohibitively expensive then the IPR system is clearly not an effective incentive system. We now turn to the costs of enforcing legal claims on intellectual property rights (IPRs). This is a particularly important and topical issue given the increasing importance of knowledge assets to many enterprises (Lerner and Lanjouw, 1997). It begins by reviewing some of the rather sparse available data on the extent of IPR infringement. It then discusses the small but developing theoretical and empirical literature concerned with establishing the characteristics of the costs of IPR infringement.

4.2 Measuring the costs of IPR infringement

A serious problem with studying the infringement of IPR is the almost total lack of reliable data. This is a particularly important problem with trademarked and copyrighted goods. This unsurprising fact arises essentially from the clandestine conditions under which counterfeits of copyrighted and trademarked goods are produced and distributed. Manufacturers of counterfeit goods almost never record their activities or register with the authorities for tax purposes (OECD, 1998b). Indeed, organised crime units are believed to be responsible for much counterfeit activity. Such goods are often sold on "grey markets" alongside genuine products, over-runs, recycled goods, copies and stolen products. Moreover, even the genuine manufacturers of such products often do not have specific enforcement departments within their organisations, meaning that efforts to curtail infringement are often dispersed across finance, marketing and legal divisions with no easily measurable or identifiable budget attributable directly to enforcement. Because of these features of counterfeit products, there are no comprehensive or reliable statistics available. The same problems afflict patented products, but researchers have recently begun studying legal cases involving patent infringement, and this facilitates estimates of the cost of enforcement, and some of this literature is reviewed below.

Returning to the measurement of the size of counterfeited goods problem, a variety of sources have been used to provide a perspective on the problem. Customs seizures of illegal goods amounted to a value of $54 million in the US in 1997. The top five countries of origin behind this statistic were China, Korea, Taipei, Hong Kong, and the Philippines. The top countries of origin for counterfeit goods seized by EU customs officials were Poland, Thailand, Turkey, and the US. In the US, the composition of these seizures was primarily apparel, consumer media goods such as videos, music recordings and computer games, and power goods (OECD, 1998b). In 1993, US Customs Service estimated the total American job loss due to counterfeited goods to be 750,000 (International Anti Counterfeiting Coalition (IACC), 2002). The IACC (2002) also report that the New York City Consumer Affairs Commissioner estimated a tax loss to the city due to counterfeit goods of $350 million in 1993. In the EU, roughly 50% of the seized goods were apparel products. In 1993, US Customs Service estimated the total American job loss due to counterfeited goods to be 750,000.

As Bosworth and Yang (2002) note, it is hard to take these statistics seriously because of the fortuitous nature of customs seizures: a category of good may go unrecorded for a year due to bad luck on the part customs officials to seize that type of good in a particular year. Moreover, Bosworth and Yang (2002) report that the International Chamber of Commerce estimate the value of trade in counterfeit goods to be about 5% of world trade in 1995, which puts the very low value of the US Customs seizure in perspective. Companies in industries particularly affected by counterfeiting activities have formed a number of trade associations, and some of these bodies have produced estimates of the extent of infringement in their industries. For example, the most active bodies internationally come from the US copyright industry. They estimate that the share of counterfeit goods as a percentage of turnover is 33% in the music recording industry, 43% in software, and 50% in the market for motion picture videos (OECD, 1998b). Although these estimates come from trade associations and are hence likely on the high side, they are useful in providing an industry perspective on the matter.

4.3 The costs to consumers, producers, and governments

The previous section discussed some of the relevant available statistics on counterfeiting. This section considers other types of costs that have not yet been quantified or are likely never to be quantified, and is based primarily on the discussion in OECD (1998b). The holders of the IPR suffer because of losses in sales and a loss in goodwill if consumers wrongly associate a counterfeit product of inferior quality to the manufacturers of the genuine brand. Enforcing IPRs also consumes scarce resources of companies, and counterfeit products are known in some cases to dominate markets, thereby creating a socially undesirable barrier to entry. Companies may be forced to withdraw from particular markets and/or territories if the counterfeiting problem is perceived as being especially acute. Similarly, countries where the counterfeit product is sold are likely to suffer reduced tax revenue, job losses, diminished investment in innovation, and the public administration costs associated with detection, enforcement and litigation. Grossman and Shapiro (1988a) also note that a country to which a counterfeit good is exported will suffer a deterioration in its terms of trade, caused by foreign counterfeits driving up prices in the export sector of the originating country.

Countries where the counterfeit good is manufactured are likely to endure a potential loss of tax revenues, jobs, foreign exchange and foreign direct investment (FDI). Mansfield's (1994) survey evidence demonstrates the importance of the strength of IPR systems in host countries for shaping FDI decisions on the part of firms. Consumers of counterfeit products are likely to pay high price for products of inferior quality. Grossman and Shapiro (1988b) do however draw a distinction between "deceptive" and "non-deceptive" counterfeiting. Non-deceptive counterfeits are bought in the full knowledge on the part of the purchaser that they are buying a counterfeit product, whereas a deceptive counterfeit is the converse of this concept. Nevertheless, although counterfeiting allows non-deceived consumers to enjoy the use of a branded good at a low price, they do impose a negative externality on purchasers of the genuine product because the status attached to the genuine product is reduced by the existence of counterfeits.

Another area of concern to many policymakers is the matter of parallel imports. Parallel imports are defined by the OECD (2002) as "genuine goods sold in the country of export with the permission of the rights holder, but imported by a reseller without the authority of the rights holder in the country of importation. Parallel imports are banned from countries that do not practice international exhaustion." International exhaustion is discussed in the penultimate section of the review. There is some concern about why parallel imports occur and their effects of consumers and intellectual property rights holders. The OECD (2002) study concludes that the less vigorous is competition among relevant rights holders, and the more that bans on parallel importation inhibits such competition, then permitting the use of parallel imports will increase consumer welfare through beneficial effects of competition. The OECD calls for greater empirical work, but their survey of the very small empirical literature shows that consumers would generally benefit from a repeal of parallel import bans, but that producers would be perhaps adversely affected.

4.4 Enforcement costs

Lanjouw and Schankerman (2001) study the determinants and outcomes of patent infringement and declatory judgment suits, using a sample of all patent suits reported by US Federal courts over the period 1978-1999. They find that the threat of court action is very important: most settlement occurs soon after the soon is filed, and sometimes before pre-trial hearings take place. Lanjouw and Schankerman conclude that this aspect of the enforcement process is desirable, since it implies that the use of judicial resources are minimized. However, individuals and smaller companies are much more likely to be engaged in a suit, conditional on the characteristics of their patents. Interestingly and importantly, what is significant for settlements is that firms have a portfolio of intellectual property to trade, or that firms have some other means of encouraging cooperative behaviour. Again, this puts small firms and individuals, with their small intellectual property portfolios, at a disadvantage. Nevertheless, the authors do suggest that patent litigation insurance would be a plausible proposition.

In related work, Lanjouw and Lerner (1996) study the use of preliminary injunctive relief in patent litigation. Preliminary injunctive grants prevent alleged infringers from using the infringed patent during the period of the trial. They investigate whether small firms, who are weaker financially than larger firms, would be unable to compensate the patentee for damage occurring during a trial if found guilty, or might not be able to sustain even an injunction. In other words, they test whether the possibility of increasing legal costs and the possibility of going out of business may lead defendants to settle on unfavourable terms; this issue is relevant to financially constrained smaller firms since such firms would probably be worse off when faced with a preliminary injunction. They find a positive relationship between plaintiff size and the likelihood they will request an injunction. Interestingly, the difference between plaintiff and defendant size is also important, which Lanjouw and Lerner argue may be due to strong firms preying upon smaller and weaker firms in an effort to drive up the costs of their smaller competitors. They also cite unpublished work by Lerner, which shows that patent cases involving smaller firms display a disproportionate concern with trade secrets, which Lerner concludes is due to high costs, both direct and indirect, of patenting for these firms.

In other work, Lerner (1995) studies the patenting behaviour of 49 new American biotechnology firms. He finds that firms with the highest litigation costs are twice as likely to patent in patent subclasses with no rival awards, although he does not consider the possibility that unobserved characteristics of such firms may be driving this result. He also finds that firms with high litigation costs face a lower likelihood of patenting in areas where there are firms who have a lower cost of litigation. Again, it is possible that new firms do not make this decision purely on the basis of legal costs, but instead are driven to patent in areas where there are few older, established competitors.

The issues of the ability to defend IPR and the costs of doing so represent a very under-researched area of the economics of IP and offer a large canvas for future research involving collaboration between law and economics.

5 Science and Society

5.1 Introduction

Science may be defined as the systematic pursuit of knowledge, and technology may be defined as the practical application of the new knowledge created by science. Policy makers and academic economists have begun to show an increased interest (Mason, Beltramo, and Paul, 2001) in the distribution, utilisation and generation of knowledge, since cross-country differences in economic performance are believed to be due in large part to differences in technological capabilities (Branstetter and Sakakibara, 2002). This section of the review assesses the literature on public policy towards science, innovation, and technological progress. Scientists working in universities and research institutes, commercial firms and the government all undertake scientific research in advanced capitalist economies. This review examines the separate contribution of, and interaction between, each of these three sources of scientific research and examines the different implications that alternative policy regimes may have on technological advance.

5.1.2 Facts about innovative activity

Various measures of innovative can be, and are, used to assesses overall national technological capabilities. These include (see Hall, 2002) various R&D measures, various patent related measures, scientific publication citations, measures of education, expenditure on information and communications technology, and measures of venture capital funding. As Hall (2002) notes, the most important measures of a country's innovative activity are R&D spending and patents granted to resident inventors. These measures vary quite widely across countries. Non-defence R&D spending in 1999, as reported in Hall (2002) was 1.8% in Canada, 2.01% in France, 2.38% in Germany, 1.03% in Italy, 2.91% in Japan, 3.73% in Sweden, 1.67% in the UK and 2.25% in the US. Bloom and Griffiths (2001) report that total gross expenditure on R&D as a share of GDP in the UK has been falling almost every year for the past twenty years, which is in contrast to other major economies. Hall (2002) also provides details of the change in the number of US patents granted to various countries between 1985 and 1998. These are 12l.6% for Canada, 53.1% for France, 35.4% for Germany, 72.1% for Italy, 142% for Japan, 42.9% for Sweden, 38.9% for the UK, and 103% for the US.

5.1.3 The origins of technological innovation

Technological innovation arises from the efforts of research scientists working in and for universities, firms, and the government. This section of the review examines the incentives researchers have in each of these institutions to advance scientific knowledge. It also looks at the interrelationship between the three sources of scientific research, as well as public policy towards science and its links with industry and technological innovation.

5.1.3.1 Incentives for scientists engaged in pure research

A significant proportion of scientific research conducted in industrialised economies is done without any expectation on the part of the scientists concerned that they will earn the private market return accruing to any innovations that they may develop. In the G5 economies, Bloom and Griffiths (2001) report that higher education accounts for about one fifth of all R&D done. This figure ranges from 16.8% in France to 23.6 in Japan. The figure for the UK is 18.5%. Scientists working in universities and related research institutions may be said to fall into this description, although increasingly research in universities is being informed by the priorities and prerogatives of external industrial concerns. This last point will be discussed in more detail below. Given the typically small monetary rewards available for pure research, what incentivizes these researchers?

Such researchers may be motivated by a love of knowledge (Romer, 1996), or the satisfaction gained from puzzle solving (Hull, 1988) but economists have come to recognise that the most plausible explanation for such behaviour is that scientists are interested in establishing *priority* and the status and monetary rewards that flow from attaining priority. The notion of priority is due to the work of Merton (1957, 1988) who argued that scientists are concerned to be the first to communicate a significant new development in their field. The reward or gain to establishing priority has been described by Stephan (1996) as "the recognition awarded by the scientific community for being first". The importance of priority gives this type of scientific research some of the character of a race where the winner takes all (Frank and Cook, 1995). Financial remuneration for this type of scientist is also of course a motivating force. Although the earning profile is rather flat in science, Stephan notes how “A variety of extra-institutional awards await the successful scientist in the form of prize money and speaking and consulting fees.”

5.1.3.2 Private and public incentives for R&D

The creation and deployment of many innovations is motivated purely by the expectation of private gain. The amount of R&D performed by business in the G5 economies, as reported by Bloom and Griffiths (2001), as a share of total R&D ranges from 60% in France to 72.3% in the US. The figure for the UK is 66.5%. All types of knowledge are nonrival (Romer, 1990) in the sense that the use of a particular piece of knowledge does not exclude anyone else using an identical piece of knowledge elsewhere. Therefore, for R&D to result from a desire to earn profit, any knowledge created by R&D must be to some extent excludable (Romer, 1996), which implies that the exploiter or licensee of a new innovation will have some degree of market power. Intellectual property rights are an example of an institution that confers aspects of excludability on knowledge.

Governments have traditionally provided support for R&D in industries whose final products possess public goods characteristics, such as the national defence, health and environment industries. While governments continue to provide substantial resources to research in these areas, governments have increasingly become involved in policy to stimulate and regulate the other players. This involvement of the government in action to encourage the other two players, and the separate but related trend on increased contact between universities and firms is the subject of the next section.

5.2 Public policy, and the three players

There is a good deal of overlapping in the objectives of the three players. Universities produce some commercially viable products, while industry conducts some basic research as opposed to purely applied, market-oriented work. Governments have an interest in both the commercial viability of domestic industry and the quality of indigenous universities.

5.2.1 University-industry links

University-industry links have increased in importance and popularity in many industrialised countries. This increased importance is due in some cases to deliberate policy on the part of governments, while in other cases it arises from the mutual needs and wants of universities and enterprises being satisfied by joint collaboration. Joint collaboration may take many forms, as discussed by Poyago-Theotoky et al (2002). Enterprises may approach academic units within universities to conduct R&D on the firm’s behalf, or at the other extreme a university researcher may approach a firm with a view to commercialising a particular innovation or idea. Poyago-Theotoky et al (2002) discuss two intermediate examples. One situation is where the university generates new research but commercial potential is largely unexplored. Another increasingly common intermediate type of partnership (Hall, Link, and Scott, 2002) is one where universities and firms join forces to work on a new product or technology together. In this case, neither party can produce or commercialise the idea by relying solely on its own resources (Poyago-Theotoky et al, 2002).

What implications do such collaborations have for national economic performance, university performance, firm performance and the market for knowledge? In what follows we draw on the work of Poyago-Theotoky et al (2002), and then discuss the results of other more detailed and specific research into these questions.

One potential beneficial implication of university-industry links is that exposure of the party with most knowledge (usually the university scientist) to the party with less knowledge is beneficial since the knowledge has been shared and is thus more widely known. This may be described as a beneficial research spillover. Another positive effect of industry collaborations may help exploit fundamental knowledge, since, as Poyago-Theotoky et al (2002) point out, knowledge is usually only appropriable if the creator of knowledge can communicate his ideas to one who is in a position to use and implement the idea.

Negative effects of university-industry linkages may include (see Poyago-Theotoky et al, 2002, for a longer list) possible adverse effects on the quantity and quality of fundamental research, the time allocated to teaching by academics, and on the culture of "open science". Of course, all of these negative effects could be offset by their converses, and hence detailed research is necessary to evaluate whether or not overall impacts are positive or negative.

Two related studies by Mason and co-authors (Mason and Wagner, 1999 and Mason, Beltramo, and Paul, 2001) are interesting in this regard. Universities and related research institutes are considered part of a "knowledge infrastructure" in Mason et al (2001), and differences in this national knowledge infrastructure are used to compare samples of electronic establishments in the UK and France. The electronic sectors in both of these countries have quite extensive formal links with university-based researchers. About half of the sampled French enterprises had some link with universities, compared to 80% of British enterprises. This difference is due in part to the longstanding relationships of French firms with public research laboratories. The relationships in France between universities and enterprises were found to be more stable than in the UK. The authors argue that the faster rate of new relationship building in the UK is due to the need of British universities to mitigate financial problems caused partly by cutbacks in central government funding. Thus, the authors find that British universities tended to be more proactive in finding funding for its electronic research and were more disposed to conduct market driven research.

A related article by Mason and Wagner (1999) examines the link between knowledge transfer and innovation performance in electronics producers and research establishments. Their study is motivated by the argument that universities and related research institutions may have an important role to play in helping enterprises to identify and use knowledge in areas outside the direct competency of the firm. They compare patterns of knowledge transfer and innovative activity using a (matched) sample of electronics firms and research establishments in Britain and Germany. They find that, unlike in traditional fields of engineering, measures of industrial performance in the electronics sector, such as net trade balances and patenting, are in Britain's favour. They attribute this good performance to increased levels of foreign investment, which has served to raise patenting and has integrated British researchers into dynamic international research networks. The also find however that cuts in government funding in both countries reduce the time and resources dedicated to basic research. Few of the companies in the sample had formal links with universities and research institutions, suggesting that such institutions do not fulfil any of the needs of the commercial enterprises. Mason and Wagner therefore conclude that targeted research and knowledge transfer programmes may better serve British electronics enterprises.

Audretsch and Stephan (1996) present interesting statistics on the US biotechnology industry. For a sample of 45 biotechnology firms with links to 445 university scientists with data on 1990-1992, they find that scientists help the company in a number of ways. These may include facilitating knowledge transfer from university laboratories, signalling the quality of the firm's research to capital and resource markets and help to chart the direction of the company. Their sample indicates that scientists fill formal roles in companies as follows: 9% are founders, 82% sit on scientific advisory boards, 5% act as advisory board chairmen and 9% are major stockholders. The same individuals may of course hold more than one of these positions. They also find that 70% of the research links between university based and scientists and enterprises in the US biotechnology industry are nonlocal. Their findings serve to highlight the fact the relationships between scientists and enterprises embody a "multiplicity of dimensions". They find that geographic nearness is important when the nature of the knowledge transmission is informal, but geographic proximity is much less important for formal knowledge transfers, since such transfers of knowledge will be carefully planned in advance. However, it is still the case the geographic proximity matters, and it matters more for founders than scientific advisors.

While these studies are useful when considering knowledge transfer to and form enterprises, their data prevents them from making strong claims as to whether such university-industry collaborations harm basic research. Interestingly, a study by Zucker and Darby (1996) found that prominent researchers in biotechnology appeared to have outstanding research records even after involvement patenting and other forms of commercialisation, although there may be a sample selection problem here. Siegel, Waldman and Link (1999) find that researchers with commercial interests tended to re-invest some of the funds gained from commercial sources in new equipment and student support.

On the other hand, not all examples of researcher involvement in commercial concerns appear to have positive educational outcomes. Stephan (2001) suggests that industry links will reduce the time available for the more traditional responsibilities of academics, including teaching, administration and supervision. Work by Louis et al. (2001) found that university and research institute scientists with commercial links tended to reject requests for research results from other academics more than academics with no such industry links; a very similar result was also found by Blumenthal et al. (1996). On a somewhat different theme, David (2001) recommends that ownership rights of scientific databases should include provisions for the compulsory licensing of the contents of the database at marginal cost to interested research bodies.

On a related theme, Jensen and Thursby (2001) have analysed the issue of university licensing in the US in the wake of the Bayh-Dole Act to address the question of whether industrial use of federally funded research would be reduced without university patent licensing. The issue at stake was whether incentives for research such as university patent licensing constituted an unnecessary extra step to commercialise invention, or whether such an incentive such as university patent licensing helped take useful inventions out of the research lab and onto the marketplace. Jensen and Thursby's results show that most licenses are very embryonic, and commercialisation would be impossible would further collaboration and assistance from the inventor, implying that university patent licensing is often necessary for commercial exposure and commercial success. Indeed, 71% of cases reported that cooperation between inventor and licensee was required for successful development.

5.2.2 Government and business R&D

Government's involvement in stimulating and regulating the other two players on the national innovation stage takes many forms. Perhaps the most significant and most debated aspect of policy towards technological innovation has been the recent introduction of tax credits for certain forms of business R&D. This important issue and other related topics deserve extensive discussion and are therefore examined in detail in the next section of this review.

Direct public/private technology partnerships to subsidize R&D are one example of government involvement in technological innovation. Audretsch, Link, and Scott (2001) studied one such programme, the Small Business Innovation Research (SBIR) Programme in the US. This programme began in 1977 at the National Science Foundation (NSF) to encourage those activities of small businesses that were judged to be of commercial merit. A 1982 Act required government departments with external research programmes greater than $100 billion to set aside funds worth 0.2% of their research budget to SBIR initiatives; the level of funding was increased to 1.25% in 1987 and to 2.5 % in 1996. Survey evidence was used to demonstrate that the social rate of return of many of the SBIR programmes was much higher than the private return, suggesting that the SBIR was very useful evidence in correcting market failures arising from underinvestment in "socially valuable research in emerging technologies". They also computed a social rate of return and compared it with the opportunity cost of the funds committed to the SBIR by government departments and found that the projects were of high economic value when measured on this basis. The authors conclude that "Not only is there systematic evidence that the program has been instrumental in stimulating research and efforts to commercialise that would not otherwise have taken place and that does lead to commercialisation, but also the social benefits associated with this research are substantial".

Another American public private initiative that has received attention is the 1993 "Partnership for a New Generation of Vehicles (PNGV)". This programme was introduced with the goal of furthering research on energy efficient vehicles (Sperling, 2001). The question he then addresses is whether the provision of public funds for R&D to the three private sector participants (Ford, General Motors, and Chrysler) significantly affected their behaviour for the better. Sperling's review of the motor industry finds that smaller, non-PNGV motor firms were much more efficient and quick at introducing commercially viable energy efficient technologies. PNGV did bring benefits in terms of focusing the federal governments transport R&D budget, and helped stimulate technological advances in fuel cell technology. This benefits are extremely difficult to measure, and Sperling suggests that the greatest benefit of the programme may have been what he refers to as the "boomerang effect". The boomerang effect emanates from the increased motivation given to European and Japanese carmakers by the PNGV, which spurred them on to greater efforts in their own research, which had the effect of further accelerating the American efforts. Another interesting conclusion concerning the effectiveness of public R&D funding for such projects is that such funding should occur when the targeted technology is far away from commercialisation since manufacturers have powerful incentives to provide their own funding when a potentially lucrative project is close to being marketed. Sperling's analysis suggests that a more fruitful use of the R&D funds would have been to award such funds on a competitive basis outside of the PNGV partnership as grants to small companies, universities and other research centres.

Governments also sometimes become involved in various aspects of research consortia. Research consortia may arise spontaneously between private firms, or the government may choose to directly subsidise such a consortia. Potential benefits to firms and society of research consortia include the elimination of wasteful duplication of effort, leading to reductions in costs and allowing the pooling of risks. Agreements to share research results can improve the diffusion of inventions into a range of alternative applications. Research economies of scale may be important in some fields and research joint ventures can obviate the need for full-scale mergers (which may apply to the current trend in the pharmaceutical industry towards huge and ever larger mergers).

Branstetter and Sakakibara (2002) examine data on every joint research venture in Japan between companies that involved a degree of government involvement from 1980 to 1992. The results indicate that consortia enjoy greater benefits when they do basic rather than applied research. They also find that design of a consortium is more important than the level of resources dedicated to it, suggesting the importance of strategic factors. Three key characteristics of a consortium for research are complementary research assets, high potential for spillovers within the consortium and if the member enterprises are not direct rivals in their final product market. These results, as the authors note, may be expected to apply to research consortia in any country, and hence they may be used in evaluating the public and private returns to such consortia. It may be the case however, that government support for such programmes may diminish somewhat in Japan, where there is a growing realisation (Goto, 2000) that the activist public private technology partnerships that had characterised post-war Japan may be of little relevance in fast changing high technology industries.

6 Domestic Policies to promote IP and its adoption

6.1 Introduction

Given the growth enhancing prospects of innovation, governments have a direct and understandable desire to encourage innovation and they generally display an interest in the concomitant creation of genuine and useful intellectual property rights. This section of the review assesses the literature concerned with policies to encourage the creation of innovation with or without existing IPR systems. An interesting feature of the literature in this area is that many of the policies measures advocated below have never been implemented in practice, some have been implemented in the past but their use has lapsed or been discontinued, whereas other policy instruments enjoy active deployment in many countries. This aspect of the research in this area results in many novel and provocative policy conclusions. Below, we discuss a number of different proposals, and special attention is given to the R&D tax credit, which is a particularly topical policy issue in many countries, including and especially Britain.

6.2 Alternative Systems to Promote Innovation

A fundamental question that must be addressed in the first instance is the following: Is the existing system of IPR actually the most effective means of achieving the ends to which this system aspires? A quote due to Penrose (1951) is frequently cited as a means to summarise economists' thinking on this question "If national patent laws did not exist, it would be difficult to make a conclusive case for introducing them; but the fact that they do exist shifts the burden of proof and it is equally difficult to make a really conclusive case for abolishing them." This then raises the issue as to what might take the place of the modern, familiar system of IPR, or how the contemporary structure of IPR ought to be modified, if at all.

6.2.1 The Reward System

One useful way of addressing this issue is to consider a rather old proposal designed to achieve the same ends as the modern system of IPR, and one that has recently received renewed attention from economists. Shavell and Ypersele (2001) study and contrast the effectiveness of the patent system (which is taken as exemplifying IPR) as against a reward system in promoting innovation. In the reward system, governments directly pay an amount of money, which corresponds to the benefit to society of the innovation, to the inventor. This payment provides the appropriate incentives to the inventor, and all innovations pass directly into the public domain, meaning the undesirable monopoly distortions that characterise the patent system are absent. Assuming conditions of perfect competition in the product market, and because the innovation is freely available to all to imitate, the product in which the innovation is embodied will trade at marginal cost. Shavell and Ypersele (2001) note that reward systems were widely and seriously discussed in many countries as an alternative to the patent system, especially in European countries in the 19th century. Many influential bodies and individuals advocated their use and adoption, but ultimately reward systems were to be only rarely used and rarely discussed, although scientists in the former Soviet Union were given incentives to innovate under reward systems.

What are the relative advantages and disadvantages of the reward system over the patent system? An obvious and significant difficulty with the reward system is that the government needs to acquire information concerning the value of the patent, and typically the inventor will have much better information concerning the likely value of the innovation. Therefore, because patents ultimately elicit the private information of the inventor about the value of the new innovation, they have an advantage over the reward system. However, a reward system may have an advantage over the patent system because reward systems provide the optimal incentive to innovate. This is because, as noted in the Introduction, the incentives to innovate under a patent system are not optimal because the monopoly profits arising from patents are less than the social surplus of the innovation. Moreover, the reward system avoids the deadweight efficiency loss of monopoly production under patents.

The model studied by Shavell and Ypersele (2001) assumes that the innovator knows the eventual demand curve for his product before he commences research or commits any investment resources. The government only knows the probability distribution of demand curves; in other words, the government doesn't know which demand curve will apply to the commercially available product, but it can associate probabilities to the likelihood of observing any demand curve in practice. Three systems are studied: the patent system, a reward system, and a system where an innovator can choose between obtaining a reward and obtaining intellectual property rights, designated as an optional system. They argue that under particular circumstances a patent system is better for society than a reward system, but under different circumstances the opposite conclusions holds. They also note that the government could use the quantity of a good sold to determine the size of the reward to give to the innovator. They also conclude that the optional system and the reward system may be superior to each other under different conditions, but that the optional system is always superior to a patent system. Whenever the patent system is superior to reward, then the optional system is better than the reward system.

Factors that are likely to impinge on the optimality of one scheme over another, as well as on the practical operation of any scheme, but which were not formally modelled include the following. The exact nature of the information in the government's possession will be important, as will the fact that the optimal reward will be affected by the race to be the first to innovate. Administration of a reward system would impose burdens of the government, while taxes collected to fund rewards may themselves causes distortions in the wider economy.

Shavell and Ypersele argue that the benefits of an optional reward scheme are likely to be substantial. The benefits would include cheap products, including pharmaceuticals. New inventions would not be held up by the owners of IPR blocking useful extensions to the original innovation; and one practical benefit of the proposed scheme is that firms are most unlikely to oppose it. If governments were conservative in determining the size of the reward, the innovator could always elect to obtain IPR. A situation in which rewards schemes are likely to be very helpful include the cases in which the value of the innovation is known to a relatively high degree of certainty. One prominent example of such a case concerns vaccines for diseases prevalent in many parts of the developing world. Harvard economist Michael Kremer has been at the forefront of efforts to surmount the serious health care problems of the developing world caused by the existing system of IPR, and some of his work is reviewed below, starting with a general paper that proposes an incentive system to increase innovation.

6.2.2 Kremer on Vaccines and Auctions

Kremer (1997) analyses patent buyouts. Patent buyouts involve a patent being purchased and placed into the public domain by the government. Two historical examples are discussed in detail by Kremer, the most famous of which is probably the purchase by the French government in 1839 of the patent for the Daguerreotype process, which was the first process to allow photographic images to be created. Patent buyouts overcome the problems of underprovision of research due to private rates of return being much less than social returns and eliminate the monopoly distortions associated with patents. Kremer notes that the most difficult issue in implementing such a system involves determining an appropriate price. He advocates and analyses the use of an auction system to determine the private values of innovations. The government would then buy the patent and place it in the public domain at the price to include both the private value and a mark-up that would correspond to the difference between the private and social values. Inventors would have the right to keep or sell their patents. He also argues that patent buyouts are likely to be particularly useful in the pharmaceutical industry, which he characterises as suffering from severe patent induced distortions. Removing the right to patent would, in Kremer's view, greatly improve competitiveness in this industry.

Is this proposal practical? One helpful feature of the proposed system is that private firms would continue to be the driving force behind the allocation of inventive resources, although the government would have more discretion than under the current patent system. He also proposes resolutions for a number of technical difficulties that could arise. These include a means to deal with the problem of close, substitute patents acting as a disincentive to innovate. A well-known problem with auctions is that bidders have an incentive to collude in order to force prices down to artificially low levels, and Kremer discusses a number of ways in which governments could counter the effects of collusion.

Kremer has also conducted a large amount of research on how to create functioning markets for cures for those diseases that are most prevalent in the developing world. Malaria, tuberculosis and HIV kill an estimated five million people per year, and most of the victims are from developing countries. However, research on vaccines for these diseases is depressingly paltry, a consequence of the fact that pharmaceuticals companies do not believe they will ever recover the huge costs of developing drugs for the poor. Another severe problem, noted by Kremer (2001a) is that governments in developing countries "are tempted to use their power as regulators, major purchasers and arbiters of intellectual property rights to force prices to levels that do not cover research costs." Glennerster and Kremer (2001) argue that an advance commitment from the government to purchase vaccines and make to make these vaccines available to poor countries would provide powerful incentives for researchers to engage in research on vaccines for these countries. A commitment to compensate private researchers for successful vaccines means that taxpayers only bear the cost of the most successful and useful patents. Researchers therefore face incentives to try to find only those vaccines that have a reasonable chance of commercialisation. An appealing aspect of this proposal is that is market oriented, and private firms make the crucial decisions as to what vaccines to pursue, meaning that no government funds will be spent on projects with little chance of success. The purchase commitment program could start by offering a low price, and then increase this price until the necessary research was forthcoming, which is a mechanism similar to an auction (Kremer, 2001b). Developing countries could also act as co-contributors to the commitment payment. Attaran, Kremer, Sachs and Sievers (2000) have also proposed the use of a tax credit for vaccine sales to "harness the innovative potential of the free market."

6.2.3 Other proposals

Ayres and Klemperer (1997) study a proposal to alter the existing legal system applying to patents by examining the role of uncertainty and delay in patent litigation. Their motivation proceeds from the observation that patents are not a cost effective way of encouraging innovation, because patent holders do not extract their profits from society in the least cost effective way. This fact is a consequence of static monopolistic inefficiencies. They provide some simple economic models to illustrate how uncertainty and delay in patent litigation may have the ultimately beneficial effect of limiting the patentees market power without reducing economic incentives to innovate. This beneficial effect will arise if uncertainty and delay cause a limited amount of interim infringement on the patent, which will have the effect of limiting the extent of the patentees' market power. This limited degree of infringement does not reduce patentees' market power because there is some probability that the patentees will be compensated for any infringement. The authors do note that these conclusions may be vitiated if certain caveats apply. These caveats to the model include the fact that they do not consider the costs of litigation, and the possibility that existing deadweight losses due to patent monopolies may be rather small in practice.

Kingston (2002) argues that the existing patent system be altered so that the grant of a patent is made not only for a certain length of time, but that the grant also take into account recent developments in accounting so that the grant of a patent will reflect relevant financial considerations. As Kingston notes, it is only a matter of chance that the awarding of a patent for 20 years, or affording copyright protection to a corporation for up to 120 years, will be precisely what is needed to provide incentives to innovate. If all inputs and outputs could be measured perfectly, then protection would last until the inventor had received a profit corresponding to an appropriately risk adjusted multiple of the amount invested. The EU has seriously studied such a proposal, but Kingston discusses a number of practical problems that must be confronted before any implementation could take place. Subjective assessments of risk differ widely across investors, and monitoring the allocation costs and profits is difficult in multi-product firms. An appropriate R&D cost base would also need to be established, and deciding whether the “multiple” should be a function of a firm’s entire R&D budget or only of the R&D of the particular project for which patent protection is sought. Kingston suggests that establishing an appropriate risk adjusted multiple would also be very difficult in practice.

6.3 Tax Credits for R&D

As noted in the introduction, the use of tax credits for R&D is a popular and topical policy measure in many countries. Many other types of policies could be used to increase the amount of R&D done (Griffith 2000), including direct funding of R&D, investment in education (see Romer, 2000), and strengthening product market competition. However, because the debate on tax credits for R&D is both important and of considerable contemporary relevance, this section focuses on this particular measure. This section looks at some of the rationale that might apply to such a policy, and also considers Britain’s recent adoption of an R&D tax credit.

Why should the government give to tax credits to private enterprises for R&D these companies would perform even without the extra incentive of a tax break? The main reason for government to subsidise R&D in this way is based on the view that the private returns to such activity are well below the social returns. Since companies are obviously capable of appropriating only the private return to their research activities, they will invest less than is socially optimal. Social returns are higher than private returns because R&D is seen as delivering benefits to the overall economy in terms of increased knowledge and skill levels, amongst other things. Estimates of the social rate of return to R&D are consistently higher than the private rate of returns, and estimates of the social return range from 17% to around 100% (Griffith, 2000). The use of tax credits is seen as one way in which the private returns to R&D can be made the same as social returns, thereby hopefully resulting in an optimal level of R&D.

Recent work by Bloom, Griffith and van Reenen (1999) assessed the sensitivity of R&D investment to changes in the user cost across nine industrial countries, including the UK, in which tax incentives have been used to encourage R&D. Their results suggest, even after controlling for country specific shocks and world economic conditions, that tax changes significantly affect the level of R&D. The estimated impact is small but the long run impact may be much larger. Griffith’s (2000) summary of these results is that a 10%

decrease in the "price" of R&D would result in a 1% increase in the amount of R&D in the short run, compared to a 10% increase in the amount of R&D investment in the long run. Hall and van Reenen (1999) review the literature on this topic. They find that the fiscal effects of R&D tax credits have been little studied outside of the US context, due in part to the more recent implementation of such schemes outside the US, and the fact that researchers and policy makers have often looked to studies based on the US experience to provide answers as to the effectiveness of such programs. Nonetheless, the evidence from these limited number of countries is similar to the US evidence: the response of R&D to tax credits is small initially, but appears to increase over time. Their review of the literature suggests to them that the most sensible estimates of R&D elasticity are –1, implying that a 1% decrease in the cost of R&D will lead to a 1% change in R&D spending.

Does this mean that R&D tax credits are a good thing? The literature suggests that the answer may still be negative. The costs of administering such a scheme on the part of both governments and enterprises may be significant (Griffith, 2000), and there is some evidence that such tax breaks serve mainly to enrich the scientists who work on tax designated products (Goolsbee, 1998). Bloom, Griffith, and Van Reenen (1999) also present some empirical evidence that such breaks may give rise to harmful tax competition between countries.

Turning to the case of the UK, it is useful to very quickly review some trends in R&D activity. Griffith (2000) reports that since the 1980s, R&D intensity levels have increased faster in other major countries than in the UK, and "the UK now has a smaller proportion of GDP devoted to R&D and significantly less than any other G5 country". These statistics however do not take into account the rather large amounts of R&D spending undertaken by UK firms in foreign countries.

The Finance Act 2000 stipulated that from 1 April 2000, spending on small and medium sized enterprises (SMEs) could qualify for R&D tax credits. The scheme was extended in 2002 to include all other companies. SMEs are defined by EC state aid rules, and describe companies with employment at 250 people or below, and annual turnover not greater than £25 million, or having a balance sheet total of £17 million or less. Tax relief is available to SMEs in two ways. The usual deduction for their qualifying non-capital expenditure is increased from 100% to 150%, or, for companies not in profit, a cash payment of £24 for every £100 spent on qualifying R&D (Department of Trade and Industry, 2000). Large companies are permitted, since 1 April 2002, to deduct an additional 25% of their current expenditure on qualifying R&D, over and above their normal 100% deduction. The Inland Revenue provide the following example: a company spending £100,000 on qualifying R&D would be able to deduct this amount its taxable income under existing tax rules, as well as an additional £25,000 under the new R&D credit.

Because of the very recent introduction of these tax credits, there is, unsurprisingly, practically no research that evaluates the effects of these specific provisions. One thing that is almost certain to happen is an increase in the reported qualifying R&D

expenditures for firms, as they seek to reduce their tax bill by taking advantage of the new credit. This may cause an increase in the administrative burden facing the tax authorities, as Hall (2001) reveals that determining which expenditure is qualifying under the meaning of the act is a major headache for American Internal Revenue Service. Eisner, Albert and Sullivan (1986) show that the qualified R&D share of US companies grew greatly in the year immediately following the introduction of an R&D credit in that country.

The fact that we can reliably expect an increase in reported R&D is also related to another concern that has been raised by analysts of the new credit. There is some fear that the credit will not actually increase R&D at all, since it is essentially establishing a tax break for something large firms were doing anyway. Bloom, Griffith and Klemm (2001) note that this can represent a substantial dead-weight cost to the government. It is sometimes also argued that a volume-based measure does not provide much incentive for future R&D research.

Perhaps a better solution may have been to give the credit to *additional* R&D expenditures, although implementing such a scheme is not without its own difficulties. A problem with implementing such an incremental scheme is that requires detailed historical information. Defining the R&D base has taken two forms in other countries: define the base as a rolling average of past R&D, or define a particular year as being the fixed base year (see Bloom, Griffith, and Klemm, 2001). Canada, France and the US use a rolling average design. Hall and Van Reenen (1999) report that the evidence from the literature suggests that such schemes have greatly reduced the incentive effect of the R&D credit in these three countries. See Bloom, Griffith and Klemm (2001) for a discussion of the disincentive effects of moving average schemes.

Bloom, Griffith and Klemm (2001) conclude their study by comparing the effects of different hypothetical policies, using a sample of 138 UK firms and assumptions regarding the magnitude of the credit. Their work was conducted before details of the 2002 credit for large firms were disclosed, but they are still useful in showing that the design choice for a credit scheme is very important. Volume credits were shown to provide generous benefits but at a high cost to the Exchequer. Rolling average measures were cheap but ineffective. A fixed base credit was seen as the most desirable policy, given the trade-off between cost and incentives, and given the size of the sample and the particular assumption made by the researchers in their model. They conclude that incremental credits are better value, but must be defined in a way that does not cause firms to face perverse incentives.

7 TRIPS

7.1 Introduction

The extent and nature of protection afforded to IPR varies widely across the countries of the world. These differences have recently assumed a very important policy significance.

This significance emanates from the fact that the proportion of goods and services that are internationally traded, and which embody a substantial proportion of intellectual property, has risen dramatically in recent years. The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) was reached, during the Uruguay Round (1986-1994) of negotiations on the reform of the world trading system, with a view to reducing or eliminating tensions due to cross country differences in the treatment of IPR (WTO, 2002). In this section, we discuss international aspects of IPR, with particular reference to the effects of the TRIPS agreement, which was deservedly been described (Maskus, 2000) as "the most significant international undertaking on IPR in history".

7.1.1 What is TRIPS?

The TRIPS Agreement is a comprehensive multilateral agreement on intellectual property. It came into being as a result of the negotiations of the Uruguay Round (1986-1994), which represented the final round of General Agreement on Trade and Tariffs (GATT). The GATT negotiations began 1948 were designed to provide rules for international trade in goods, and to reform the international trading system that had arisen in the aftermath of the war. The Uruguay Round signalled an end to the provisional organization and agreement of GATT by creating the World Trade Organization (WTO) on 1 January 1995. The WTO's stated objective (WTO, 2002) is to help trade flow "smoothly, freely, fairly, predictably". Some of the ways it attempts to achieve these aims include (WTO, 2002) administering international trade agreements, acting as a forum for trade negotiations, settling trade disputes, and reviewing national trade policies. As of 1 January 2002, WTO had 144 member countries, representing 90% of world trade, and 30 more countries are engaged in negotiations to join.

Member countries of the WTO are obliged to ratify and implement TRIPS. The exact date for implementation of TRIPS depends on the level of economic development of the member country, but all member countries have had to comply with requirements on national treatment and most favoured nation treatment since 1 January 1996. The national treatment requirement states that foreign and indigenous individuals and companies are to be treated in the same way. Developed countries were obliged to ratify the treaty by 1 January 1996. Developing countries and countries experiencing a transition from a centrally planned economy had until 1 January 2000. Developing countries newly extending patent protection for the first time to areas such as pharmaceuticals were given until 1 January 2005 to implement the treaty for these newly protected products and sectors. These sectors, in most developing countries, are pharmaceuticals, agriculture, chemicals, food, and micro organisms (Maskus, 2000). Those countries on the United Nation's list of least developed countries have until 1 January 2006 to enact TRIPS, but these countries may apply for an extension to this date. The Doha Declaration gives these countries until 1 January 2016 to implement TRIPS in respect of pharmaceutical products. Members may bring disputes related to TRIPS to the WTO's Disputes Settlement Body.

TRIPS has three main component strands. These three strands relate to standards of protection, enforcement and dispute settlement. The standards section sets out the minimum level of protection to be afforded to intellectual property in each country. Areas of intellectual property affected are patents, industrial design, trademarks, geographical indicators, trade secrets, copyright, and *sui generis* treatments for integrated computer systems, plant breeders' rights, and database protection. The enforcement provisions refer to domestic enforcement procedures as well as to remedies. Finally, as noted above, disputes concerning matters related to TRIPS between WTO member countries are subject to the WTO's dispute settlement procedures (WTO, 2002).

Clearly TRIPS did not establish a universal IPR system. Instead, it lays down a set of minimum standards for the legal protection of intellectual property that WTO members are expected to comply with, subject to the special arrangements of the transition period discussed above.

7.2 What does TRIPS mean for the global economy?

As a starting point for thinking about the effect of TRIPS on the world distribution of income, one useful way to consider the issue is to examine the historical record. One general problem that has been raised by several commentators is the fact that the international architecture to which TRIPS has given rise may be said to be somewhat of a one size fits all arrangement. Although there were and are transitional periods, as well as the Doha round exemptions, TRIPS essentially imposes uniform standards on all member countries. Interestingly, many of the developed member countries that are the most enthusiastic supporters of TRIPS were very reluctant to accept externally imposed or uniform intellectual property standards over the course of their own economic development. As noted by the United Kingdom's Commission on IPR, national intellectual property regimes were generally used to advance some perceived national economic gain. For example, between 1790 and 1836 the US only permitted patents to be issued to its own citizens. Copyright was restricted to US citizens until 1891, on the argument that it needed such a facility in order to educate its own citizens (The Economist, 2002).

In another contrast to the enacted TRIPS stipulations, many successful modern economies developed through a process of extending selective exemptions to the need to patent to certain sectors, often on the grounds that monopolies would be undesirable in the provision of particular goods deemed essential to national economic prosperity. Swiss industrialists, for example, opposed the introduction of a national patent system in their country so that they could continue to imitate with impunity the innovations of their foreign competitors. This system was eventually changed under pressure from other countries, but in the Netherlands, no patents were issued between 1869 and 1912 (Commission on IPR, 2002). Many of the more successful East Asian economies tailored standards of intellectual protection to their own circumstances. The World Bank (2002) has remarked upon how "at different times and in different regions of the world, countries have realised high rates of growth under varying degrees of protection". As the Commission on IPR noted, the imposition of this one-size fits all treaty removes a significant degree of flexibility from development policy, and rules out the possibility that developing countries could follow the paths taken by the Swiss, Koreans, and Taiwanese to relative prosperity. In what follows, the implications of this restricted flexibility are reviewed and discussed.

TRIPS represents a fundamental change to the global intellectual property rights system. The main beneficiaries of TRIPS (assuming rights can be enforced) will be patent holders since TRIPS offers the potential increases quite considerably the value of patents with an international dimension. Given that the developed world holds the overwhelming majority of worldwide patents (IPR Commission, 2002), the full implementation will give rise to a large transfer of wealth from the developing world to the developed world. The United States, in particular, will benefit from enhanced international patent protection by an estimated 19 billion dollars per year (World Bank, 2002). However, the issue of the international protection of intellectual property goes deeper than these rather crude estimates of monetary gain or loss. As noted by Maskus (2000), because TRIPS confers much stronger rights on the developers of intellectual property, the short to medium term impact of TRIPS will be to effect a change in the distribution of gains from intellectual property away from intellectual property users and towards the developers of protected information and intellectual property. This benefits information creators in both the developed and developing world, but, as noted above, this will massively favour the developed world.

Even so, because TRIPS will alter international incentives for trade, foreign direct investment, domestic innovation, technology transfer and imitation, the overall effect is much more subtle than simple monetary calculations of losers and winners. In this section, we discuss how TRIPS affects the balance of advantage between poor and rich countries in terms of the static and dynamic gains that are expected to arise from the implementation of TRIPS. This will also involve a review of some of the contentious debates and growing literature concerning fields such as pharmaceuticals, living organisms, and traditional knowledge.

7.2.1 TRIPS and Macroeconomic Activity

We begin with a review of an instructive piece of research that ranks countries according to whether or not they are likely to benefit from the introduction of TRIPS. Lall and Albaladejo (2002) examine the potential significance of IPR by classifying countries according to the likely impact of enhanced protection of IPR. The classification is based on technological activity and other related characteristics for a sample of 87 developed, developing and transitional countries with significant industrial sectors between 1985 and 1998. To understand the results, it is necessary to do some very brief and simple a priori theorising as to what one might expect the effect of TRIPS to be on various measures of economic performance.

With respect to trade volume, there are two conflicting forces that can be expected to operate when international intellectual protection becomes stronger. TRIPS may be expected to increase market power for innovating firms, which will increase price and hence reduce trade volume. However, strong IPR are also likely to increase the size of the market for the product, leading to an elimination of local imitation and thus increasing export volumes. Strong IPR are also expected to have conflicting effects in terms of foreign direct investment (FDI). Weak IPR may induce firms to undertake FDI, so that the control of proprietary information is maintained through local production. On the other hand strong IPR may be seen as a pre-requisite for doing business in the local economy. Trade volumes and FDI will be discussed in somewhat more detail below; here the discussion is to give some context to Lall and Albaladejo's results.

Lall and Albaladejo divide the 87 countries into 4 groups using, inter alia, measures of R&D, US patents per capita, exports per capita, and the share of medium and high technology in manufactured exports. The classification results in a "high technology effort group" comprising Japan, US, many of the countries of Northern Europe, Switzerland, New Zealand, and newly industrialising countries such as Hong Kong, Singapore, Korea, and Taiwan. The moderate technology group is comprised of Greece, Spain and Portugal, Eastern Europe, South Africa, Mexico and parts of Latin America. The low technology effort group consists of North Africa, parts of the Middle East, parts of Latin America and much of Asia, including China and India. The negligible technology group is represented by parts of the Middle East, and Sub-Saharan Africa.

Lall and Albaladejo (2002) argue, as one would expect, that the high technology group will gain the most from stronger IPR for the reasons noted above. The moderate group are expected to gain, but will still face costs because of adjustment to existing IPR regimes. The low technology group is expected to face clear and significant costs, but possible long term benefits if the local economy is or becomes receptive to foreign multinational corporations. Unsurprisingly, the poorest countries fare the worst in Lall and Albaladejo's calculations. Countries in this group face short term and long term costs due to higher prices for protected products and technologies. This paper maybe criticised on the grounds that it quantifies in a somewhat crude way the technological capability of many different countries, but it is at least useful in highlighting that countries will respond very differently to TRIPS depending on their existing state of development.

It is of interest to examine the underlying mechanisms giving rise to these results, such as the relationship between IPR and FDI, trade volumes and technology transfer in somewhat more detail. Maskus (2000), the World Bank (2002), and the Commission on IPR have reviewed the empirical evidence on these issues. One problem with these studies, which has been emphasised in particular by the Commission on IPR, is that the econometric analysis in much of the empirical work in this area tends to suffer from rather serious defects. This is disappointing given the difficulty, mentioned above, in distinguishing between the likely effects of increasing intellectual property protection on the basis of purely theoretical economic reasoning. Maskus (2000) identified two problems with the empirical literature in this area. The first is that studies often use aggregate data and models, making it impossible to identify possibly crucial sectoral or cross-sector effects. The second problem is that there are no explicitly dynamic analyses, in spite of the manifest importance of dynamic effects in disseminating useful knowledge and in economic growth more generally.

However, the empirical evidence, such as it is, suggests that trade flows are positively related to strength of IPR protection. An influential study supporting this conclusion is Maskus and Penurbarti (1997), which studied exports from 22 OECD countries, of which 17 were high income and 5 were large developing countries. The sample of importers was 25 developing countries, of which 17 were large and 8 small. Note that Hong Kong, Singapore, and South Korea were described as large developing countries in this sample. The authors studied data for 28 categories of bilateral flows of manufactured goods with analysis of value of trade at world prices. The findings indicated that stronger patent laws in developing countries have a positive impact on imports, and these effects are present for both large and small importing countries. Interestingly, this study included many countries where there have been prominent disputes over IPR such as Mexico, Korea, Argentina, and Brazil. The findings also suggest that the market power effect is dominated by market expansion effects for rich countries that export to poor countries. Nevertheless, the size of the import expansion effects appear to be quite small. In related work, Coe, Helpman, and Hoffmaister (1997) found that productivity is increased because of high-tech imports made by developing economies. As the World Bank (2002) points out, however, the largest impacts were found in countries like Brazil and Argentina, which have high imitation capacities.

Turning to FDI, the Commission on IPR (2002) has noted the paucity of studies relating stronger patent protection to changes in foreign investment. Maskus's (2000) review of the literature in this area leads him to conclude that FDI is sensitive to the IPR regime, arguing that the "amounts of possible additional investment as a result of patent reforms could be large". He argues that dynamic benefits arising from knowledge spillovers could overcome terms of trade losses for those countries who suffer in the short to medium term in a transition to stricter IPR requirements. But since the empirical specifications do not model dynamics explicitly, there is little firm basis for this argument. There may be a slightly stronger case, based on work by Lee and Mansfield (1996), Smarzynska (2001) and Yang and Maskus (2001) that middle income countries could gain some benefit in terms of technology transfer from FDI. As the Commission on IPR noted, this is probably due to strong IPR facilitating access to sophisticated and protected technologies, through foreign investment or by licensing.

This brings us to the more fundamental question of technology transfer. Technology transfer takes many forms, and any technology transfer that takes place requires complementary absorptive capacity in the domestic economy to be effective. Such absorptive capacity will depend on things such as institutions, levels of education, and innovative and imitative capacity. This is a fact often overlooked in empirical and theoretical work, which simply sees IPR playing a role in technology transfer in the world economy similar to the role IPR plays in the domestic economy in being a trade-off between a device to encourage innovation with an attendant social cost arising from the granting of a temporary monopoly. The predictions of theoretical models do not offer unambiguous answers, but the empirical work is again rather weak.

Theoretical predictions fall at or between two extreme positions (Maskus, 2000). On the one hand, increased standards of IPR protection raises the costs of unauthorized and uncompensated imitation, and thus stronger rights will impede technology transfer that had previously worked through this channel. On the other hand, strong IPR will reduce the cost, in both a monetary and non-monetary sense, of authorized imitation. There is some evidence that the degree of openness of an economy affects the interaction between technology transfer and patent strength, with more open economies benefiting from effective IPR protection because of greater capacity to innovate (see Braga and Willmore, 1991). There is also some rather weak empirical evidence that licensing of foreign technology increases with stronger patenting laws (see Ferrantino, 1993 and Yang and Maskus, 2000).

7.2.2 Contentious Aspects of TRIPS

Having remarked above that TRIPS restricts the flexibility of development policy in many countries, it must also be noted that TRIPS does confer a reasonable amount of flexibility in how developing countries decide to introduce new systems of intellectual property protection. The Commission on IPR notes that this flexibility gives grounds for both progress and controversy with respect to the implementation of TRIPS in a number of important areas such as pharmaceuticals, education, traditional knowledge, and the patenting of living organisms. The Commission has done an excellent job in identifying and analysing the issues in these and other fields, and there is little point in this review repeating what has already been said. We confine ourselves to summarising briefly some of the main findings.

Perhaps the most controversial aspect of TRIPS concerns its effect on pharmaceuticals. While most developing countries have patent laws for pharmaceuticals, few countries enforce these laws. Enforcing TRIPS will cause an increase in the price of medicines for people of the poorest countries of the world (see Watal (1999) for a calculation of static price effects[4] in India), and a number of measures have been considered to improve access and to lower the cost of essential medicines. Perhaps the most prominent among these in debate has been the option to use compulsory licensing. Compulsory licensing involves the government of a nation conferring a license upon a drugs manufacturer the right to the manufacturing and selling of a patented drug product, without obtaining the consent of the patent holder. This could be done if the government deems the price of the drug to be excessively high.

A major issue with compulsory licensing is to ensure an adequate drugs provision in countries without the manufacturing capacity to take advantage of compulsory licensing. The report discusses some ways to achieve this aim, such as permitting countries with similar needs to group together, but perhaps the most important economic issue to be resolved is to ensure drugs suppliers face the correct incentives to supply their medicines. The Commission argues "The ultimate need is to create a pro-competitive solution for

[4] TRIPS only allows country exceptions to enforcement of IP rights if enforcement is "contrary to it sessnetial security interests".

the market in patented drugs in developing countries after TRIPS is fully in force which allows expeditious procurement of drugs in a sustainable manner at the lowest possible cost". One interesting aspect of this debate is that TRIPS is not incompatible with a system of differential charging, so that low-income countries would pay less for drugs. This system would obviously require mechanisms to prevent drugs sold in the developing world leaking back to the developed world, such as differential product labelling, and clauses restricting re-exporting, on which see below the discussion on parallel imports.

One of the most contentious issues of dispute between rich and poor countries concerns the relationship between intellectual property systems and traditional knowledge. Many corporations in the developed world are eager to use or exploit traditional knowledge, but traditional knowledge poses difficult problems for intellectual property. Such knowledge has the characteristics of a collective good (World Bank, 2002), and is therefore of uncertain ownership. Not only is traditional knowledge of uncertain ownership, but its date of creation is uncertain and its unwritten form poses unique difficulties for Western oriented intellectual property systems.

TRIPS does not contain any provisions concerning the definition and regulation of such collective goods. Even so, protection may be obtained for traditional knowledge using the existing IPR system and also through *sui generis* protection, although the Commission on IPR has argued that a single *sui generis* system may not be flexible enough to accommodate local needs. A key need is to establish means for valuing such knowledge appropriately and for providing payments and other incentives so that such resources are exploited efficiently and fairly. To this end, databases cataloguing traditional knowledge from developing countries are being created, and these catalogues should be included in the search documentation of international patent offices (Commission on IPR, 2002).

A key aspect of TRIPS relates to agriculture, since farming is an important economic activity in many developing countries (World Bank, 2002). Under TRIPS countries are obliged to award patents to agricultural chemicals, some microorganisms and biotechnological invention. Plant breeders' rights are also strengthened under TRIPS. The Commission has noted that public funding for agricultural research relevant to developing countries has decreased in recent years, and that Western private firms are unlikely to devote an optimal amount of research effort directly connected to the needs of developing countries. The Commission recommends that, within the terms of TRIPS, that developing countries restrict the number and range of patents issued in biotechnology, since such countries are unlikely to gain from the incentive to research effects of such patents.

7.3 Enforcement Aspect of TRIPS

One serious obstacle that will impede the full implementation of TRIPS in many developing countries is that many countries are simply unable to afford the costs associated with erecting and maintaining a modern national IPR system. As The Economist (2002) noted "Putting in a rigorous patent system will not make Angola a hotspot of biotechnology any time soon; a licence to drive is of little use without a car". National systems require the use of scarce resources, including financial resources and highly skilled workers, who are often in short supply in developing countries. The Commission on IPR has convincingly argued the case that the "… establishment and operation of an IP system is costly, and developing countries should not divert resources from already over-extended health and education budgets to subsidise the administration of a system for IPR".

Enforcing IPR also requires extensive, effective and functioning legal systems that can support public and private claims to intellectual property. Cases taken by developing countries against the citizens, corporations or governments of the developed world will involve costly legal fees for plaintiffs.

7.4 Intellectual Property Rights and Exhaustion

Another important international aspect of IPR relates to the issue of *exhaustion*. The intellectual property rights of commercial exploitation, once an IP protected good has been sold, are said to be exhausted once the product is first marketed. In other words, as the World Intellectual Property Organization (WIPO) notes (2002), "unless otherwise specified by law, subsequent acts of resale, rental, lending or other forms of commercial use by third parties can no longer be controlled or opposed by the originating [enterprise]." There is consensus that it is reasonable to apply such laws in the domestic context, but there is more controversy concerning the extent to which an IP protected good becomes exhausted on its sale in international markets. The issue is of particular relevance for the issue of "parallel importation".

Parallel importation refers to good produced and exported legally, but which arrive in foreign countries through channels other than those used by the official distributor. Consequently, such goods are often (Heath, 1999) referred to as "grey goods", since there is no contract between the manufacturer and the parallel importer. The issue of international exhaustion revolves around two competing claims. Does the IP owner have the right to oppose parallel importation based on the special intellectual property rights owned for a particular product by a manufacturer, or does the domestic exhaustion of the intellectual property mean that the right to oppose importation is also exhausted? Heath (1999) reports that courts in Japan and the UK have "…recently confirmed the lawfulness of parallel importation of patented products in the absence of any indication to the contrary". TRIPS states that "…for the purposes of dispute settlement under this Agreement…nothing in this Agreement shall be used to address the issue of exhaustion of intellectual property rights."

Szymanski (1999a and 1999b) has written two useful reviews on some economic aspects of international exhaustion. In Szymanski (1999a), he notes that there are conflicting arguments concerning the economic effects of international exhaustion. One the one hand, international exhaustion reduces the returns to innovative activity, and hence should be treated warily by policy makers. On the other hand, international exhaustion may increase competition and lower prices. Szymanski (1999a), noting the lack of empirical work in this area, concludes that the negative effects probably outweigh the positive. However, he does not explicitly address the potential benefits to developing countries of parallel importation arising from lower prices, technology transfer, and increased product variety.

The implications for developing countries were discussed in the companion paper (Szymanski, 1999b). This paper conducted a welfare analysis of international exhaustion in terms of the effect on domestic high-income consumers and overseas low-income consumers. His results show that that the welfare gain or loss is a function of the type of contract between the owners of intellectual property owners and their licensees. Prices will equalize across countries if there is competitive arbitrage of the product in the countries in which it is sold, which obviously improves the economic welfare of consumers who would otherwise pay high prices and diminish the welfare of those who would otherwise pay low prices. Therefore, the net effect is ambiguous. If there is a single reseller, Szymanski's analysis indicates that high valuation consumers gain, while low valuation consumers gain nothing. If the owners of the intellectual property offer high quality products in the high valuation products and low (er) quality products in the low valuation market, then the owners can exercise monopoly power in the high valuation market where consumers are not interested in the product. Since this would occur without the doctrine of international exhaustion being applied, the fact of international exhaustion causes product degradation to occur. This implies that high value consumers are no worse off, while consumers in the low valuation market are worse off because of the product degradation. This suggests that international exhaustion is inadvisable.

8 Questions for Future Research

Below we outline some important questions for future research. The list is necessarily incomplete, but the issues raised arise from the material discussed in the review. Many of the questions noted here would require the development of databases which are not yet in existence and for which there would be a large degree of non-rivalry in use by academic researchers. Before commissioning further studies to address many of these questions there may need to be a separate review of data sources, following which there might be some useful public investment in the creation of publicly available data sources on innovation and IPR, which could then be used for a range of different types of analysis.

We are also conscious that we have not been able to do justice to some areas of emerging literature in the economics of intellectual property. The most important of these are:
- The economics of copyright, its operation and the defence of IPR in the era of information and communications technology (ICT).
- The relationship between IPR and the rate of diffusion of innovation within and between domestic industries, which reflects an important element of the social returns to innovation.

A list of questions for future research:

Incentives offered by IP systems:

Given the limited evidence on IP as an incentive for innovation, what are the IP policies and institutions that provide the most significant incentives to innovate?

Does the weakening requirement of non-obviousness in many countries, especially in the US, have any substantive economic implications?

Efficiency of markets:

Which type of market structures are the most conducive to innovation and technological diffusion? Should public policy be concerned about concentrated markets in innovative industries?

Do we need bigger firms, smaller firms or a co-existing mixture of large and small firms to maximise the rate of innovation in each major industrial sector?

What distortions arise from the uneven application of different IP rights across high-tech sectors?

Is the IPR system effective in the protection of innovation in service industries?

Would the adoption of business method patents offer a better IPR system for Europe?

Rates of Return to IPR:

What is the best evidence of returns to IPR in each different sector of industry?

How might we obtain estimates of the full social returns of innovation arising from the adoption of new techniques and imitation of new products?

How far does IPR litigation increase costs or serve to effectively discipline potential imitators? Does IPR litigation make holding IPR less attractive, or is it just a part of doing business?

What are the economic costs of IPR infringement? What are the potential costs of increasing enforcement of IPR?

Science and Industry

Does IPR ownership by universities encourage or inhibit the commercial exploitation of science?

Is basic science gaining or losing ground to commercial science and does it matter?

Domestic policy issues:

How should the joint limits of intellectual property policy and competition policy be defined with respect to each other?

Is there a useful role for new variants of IP policy, including rewards and patent buy-outs?

How effective is the new R&D tax credit, not only in stimulating increased R&D, but in reversing the trend decline in IP acquisition by UK firms?

Should the government reward firms that generate IPR more than others doing R&D without registering such assets?

International aspects of IP systems:

Which countries do not protect IP to the full extent of the law, and why do these countries not do this?

Is TRIPS pro trade? Who will benefit and who will lose from its implementation?

Does the presence of an IP system influence inward foreign direct investment and/or technology transfer?

Could developing economies be given financial aid and technical advice to assist them with setting in train the protection of not only Western-style IP, but also of their traditional knowledge?

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