

THE INNOVATION DEFENCE

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Innovation effects of alleged anticompetitive behaviour are being considered in a significant number of cases. The process should involve competition regulators assessing a tradeoff between allocative and dynamic efficiency. Those innovation effects can be used both in defence of firms' actions and in challenging anti-competitive activities. Such effects need to be carefully examined on a case by case basis as they depend on: the type of antitrust behaviour; the history of the industry; the nature of innovation; and, the economics of innovation in that market. With disruptive technologies a "natural" dominance may evolve and this implies that restrictive trade practises deserve greater scrutiny. In merger reviews, a history of accumulated incremental innovation with long term projects and substantial scale economies in R&D should lessen competition concerns but regulators should be wary of alleged efficiencies that lower R&D budgets. This involves looking beyond measures of concentration to the roles different sized firms play in bringing innovations to market.

Plusieurs affaires portant sur des allégations de pratiques anticoncurrentielles font état de conséquences négatives sur l'innovation. Dans le cadre de telles causes, les autorités de réglementation de la concurrence doivent trouver un équilibre entre une allocation optimale des ressources et un progrès dynamique. Ces conséquences sur l'innovation peuvent être utilisées par les entreprises pour défendre leurs actions et pour combattre des accusations de pratiques anticoncurrentielles. Ces conséquences doivent toutefois être examinées de très près, au cas par cas, car elles dépendent du type de mesures antitrust, de l'historique du secteur, de la nature de l'innovation et des principes économiques régissant l'innovation dans le secteur. La présence d'innovations technologiques perturbatrices peut placer certaines entreprises en situation de domination « naturelle » nécessitant un examen approfondi des pratiques commerciales restrictives. En matière d'étude des fusions, un historique d'accumulation d'innovations cumulatives associé à des projets à long terme et à des économies d'échelle en recherche et développement devrait diminuer la pression de la concurrence. Toutefois, les autorités de réglementation devraient se méfier des diminutions de budget de R et D attribuables à de prétendus gains d'efficacité. Il faut donc aller au-delà des mesures de concentration et considérer les rôles joués par des entreprises de différentes tailles dans l'introduction des innovations sur le marché.

I. Introduction

The importance of innovation to economic growth has grown prominent in the consciousness of the political leadership of most of the developed nations in the past few decades leading to policies encouraging an innovation eco-system. This innovation fostering political agenda has not gone unnoticed by those facing anti-trust action. Some antitrust remedies have been countered by what can be described as the “innovation defence” — that the enforcement of antitrust laws would be detrimental to the process of innovation and thereby impede economic growth. Antitrust authorities are also more sensitive to innovation effects in justifying challenges to mergers. Gilbert and Weinschel report that in challenges to mergers by the U.S. Department of Justice (DOJ) and the Federal Trade Commission (FTC) in the United States citations of innovation effects had risen from about 3% of cases in the early 1990s to 38% of cases in the early few years of this century.² It is these innovation effects that we will examine in this Study — when, and under what conditions, such an Innovation Defence (or Challenge) might have merit.

There are at least two economic features of innovation which suggest that the defence has merit. First, radical innovation creates fast changing environments creating new markets and destroying the boundaries of old markets — rendering antitrust action moot. There are many examples of this, such as the example of the MS Media player decision of 2003 and the rapid ascendancy of iTunes in 2004/2005. More recently, examples may be found in the Google case and the ongoing case in hotel booking websites. The fundamental question that this feature of innovation creates for antitrust economics is: should the economic basis for competition policy shift from enlarging allocative efficiency to ensuring dynamic efficiency?

The second feature of innovation, and perhaps the economically more important one, is incremental research and development (“R&D”)’s slow and steady march improving the quality, features, cost effectiveness of existing products and services. An example of this is the automobile industry’s prodigious investments in improving the fuel efficiency of the cars produced. For more than a decade the industry has improved fuel efficiency of its automotive products at an average rate of just over 2% per annum.³ This form of innovation was material in the 1982 case of *United States v AT&T Co.*,⁴ the 2000 ruling by Judge Thomas Penfield Jackson against Microsoft⁵ and, the changes in antitrust legislation allowing for research joint ventures. This feature of innovation requires a re-examination on the basis of new studies of

a decades old debate on market power and firm size and its effect on R&D.

Those studying the economics of innovation and antitrust economics have often posed this as a deep rooted problem pitting Schumpeter (1942) (who is accredited with the term “creative destruction”)⁶ against Arrow (1962).⁷ While their analyses came to two different conclusions as to which market structure fostered innovation to a greater extent — Arrow on the side of more competitive markets, Schumpeter on the side of less aggressive competition — one has to keep in mind the different situations they were modelling. Arrow posed the question of an inventor (who could be external to the industry) who has developed a cost reducing technology, licensing it to firms in an industry, and whether that inventor would prefer that industry to be more or less competitive.⁸ In other words, the invention came from outside the industry as an exogenous shock. Schumpeter’s starting point was that the innovation comes from within the industry, requiring R&D investment and (assuming that the likelihood of innovation was positively correlated with R&D investment size) examining under what market conditions would one see greater R&D investment.⁹ So here again, the answer and the type of analysis conducted depends on the source and the type of innovation.

In what follows we will examine each of these types of innovation in greater detail with a particular focus on the economic aspects that relate to competition policy. We survey the literature in the economics of innovation to glean from it the knowledge that could provide some guidance to competition authorities and those advising firms on competition issues.

II. Disruptive Innovation — The Creation of New Markets and the Destruction of Old

In this type of innovation described by Schumpeter as “creative destruction” new products are introduced which replace old products. Clearly, consumers must perceive some advantages in the new product which creates the incentive to switch buying patterns. New consumers may enter the market as they find value in these new products. Furthermore, existing consumers find new uses for the product through additional features that the new products may offer. Thus additional consumer surplus can be generated.

How do we recognize such technologies? There are detailed case studies which describe how superseding technologies are often introduced to the marketplace by newer players rather than the existing dominant firms in the old market.¹⁰ Thus an economic feature of this

type of innovation is “churning” in the industry. Foster finds that early indicators are that: prototypes technically outperform the early versions of the existing technology; the new technologies have higher R&D productivity rates; and the practical limits to their technical performance exceeds that of the older technology. For later stage technologies, disruptive technologies are getting some consumers to switch and appeal to most of the new consumers. Figure 1 below illustrates some of the basic economics of the introduction of new technologies.

Figure 1
The welfare impact of the creation of new markets

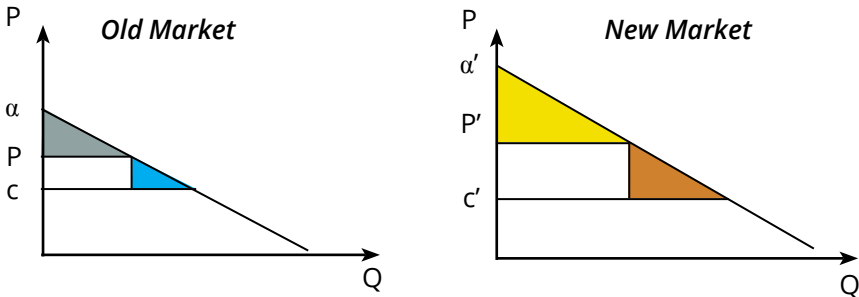


Figure 1 above shows the demand, (constant) marginal cost, prices, Consumer Surplus and Deadweight Losses for an “Old Market” and the “New Market” created by a superseding product. The innovation could involve a reduction in costs (from c to c') and, as illustrated, it creates more value to the consumer so the demand intercept shifts from α to α' . This increase in value to the consumer may increase price (as illustrated, from P to P') or such an increase in price could take place through a change in market structure. Cases can easily be constructed whereby the Consumer Surplus (and Total Surplus) has increased going from the Old Market to the New Market despite increases in price and increases in Deadweight loss. How do the above features affect Competition Policy? In most countries this policy has focused on restricting moves by firms that would restrict the Consumer Surplus in existing markets (the blue triangle in the above, Old Market diagram) or restricting the Total Welfare (the grey triangle together with the rectangle below it). This type of innovation suggests that the goal of Competition authorities should be to prevent actions of firms that inhibit the creation of the new market with its corresponding larger Consumer Surplus (the yellow triangle) and Total Welfare (the yellow triangle and the rectangle below it).

This suggests an interesting question — how much larger does the new market need to be to compensate for a (possible) more adverse market structure? Let us examine a worst case scenario where the old market was perfectly competitive and it is replaced by a new market which is monopolized. To make the situation even worse, let us say that there are no efficiency gains ($C = C'$). With the above linear demands for the new market to generate greater Consumer Surplus α' would have to be greater than $2\alpha - C$. In other words, the new market would have to be about double the size of the old market or more. Using a Total Welfare standard α' would have to be greater than $(2/\sqrt{3})\alpha - (2/\sqrt{3} - 1)c$ which implies that the new market need be more than about 15% larger than the old market. Both conditions are conceivable with the Consumer Surplus standard being more stringent.

This puts competition authorities in a rather difficult position. With the old competition analysis framework, data on costs, prices and quantities are available and Consumer Surpluses and Deadweight losses are computable. Accepted models for the existing products for which the counter-factuals' prices and quantities can be computed also exist. So the machinery is in place to assess the effects on the existing market of possible anticompetitive acts by firms. With this type of innovation we are asking the competition authorities to consider the impact on a hypothetical situation — the product which is unknown or at least loosely specified, the firms involved may be nascent and the benefit to consumers and ultimate market size being difficult to assess. Quantitative analyses of counterfactual cases have their precedents in competition cases. Estimates of the R&D production function would be more reliable for incremental innovation examined below. As we shall see in the section on dynamics and positive feedbacks, below, the models appropriate for disruptive technologies are relatively nascent. The want of quantitative models of disruptive innovation is not to say that Competition authorities have little to do in such a situation. On the contrary, for the new market to come about, market access for the new firms becomes paramount. Regulations concerning market restrictions then deserve greater study. The new technologies being primarily championed by different players need access to the market. If they were blocked or inhibited by not appearing in searches by potential buyers or, retailers restricted to the sale of certain suppliers' products then the sales growth of even a dominant technology can be slowed resulting in a lack of dynamic efficiency.

An example of such a case is that of *Microsoft Corp. v Commission of the European Communities*¹¹ where the Commission was concerned about abuse of dominant position in particular with respect to Microsoft (MS)' Windows Media Player product and the interoperability

of similar products with the Windows operating system. In 2003, the Commission reached a preliminary decision, and in March of 2004 ordered MS to, in addition to other penalties, divulge server information necessary for competing networking software to interact fully with Windows desktops and servers within 120 days and to produce a version of Windows without Windows Media Player within 90 days.¹² In April, 2004 MS released a commentary on the ruling which included the statement, “The commission is seeking to make new law that will have an adverse impact on intellectual property rights and the ability of dominant firms to innovate.”¹³ In October of 2003 Apple introduced version 4.1 of iTunes which included support for MS Windows 2000 and Windows XP. By 2012 iTunes matched the market share in streaming media players of Windows Media Player (iTunes Store has now an approximately 80% market share of music downloads). So it appears that the opening of the market facilitated the penetration of the market by a new technology.

In summary, disruptive technologies are ones where new products supersede old ones and there are clear performance benefits to consumers so that many switch to the new technology and new consumers enter the market opting for the new technology. These new disruptive technologies are often introduced by new suppliers. In this situation, competition authorities need to focus on restrictive trade practices to ensure that these new technologies have access to the market.

III. Incremental Innovation — the Steady Improvement of Existing Products

In this type of R&D existing firms have a clear advantage — a proven track record for commercialization, experience with production and marketing, and access to financial resources as well as (arguably) an incentive to conduct such R&D. A basis to the innovation defence lies in the question of whether there are economies of scale in research and development. This question is not as straightforward as it initially appears. A related issue, and one which concerns antitrust authorities, is the still unresolved debate on market structure and innovation — does market power foster greater investment in R&D? These two issues of firm size and innovation and market power and innovation are often intertwined and often confused.

There have been a multitude of attempts to resolve these issues both theoretically and empirically.¹⁴ The empirical studies are plagued by a common problem in empirical IO studies — endogeneity. On this issue the causality can run in either direction — R&D can result in a firm obtaining both increased size and market power, and that increased size and market power can provide a firm with greater financial

resources with which to conduct R&D. Another problem with the empirical studies in this area are the measures used for innovation — either measures of R&D outputs, such as patents or measures of R&D inputs, such as R&D expenditures. A third issue is how to measure market power. There are many other econometric issues that plague these studies but in at least one well cited empirical study there is the finding that R&D intensity is maximized in a market structure that lies between the two poles of monopoly and perfect competition.¹⁵

The empirical literature on market structure and innovation is not conclusive but the details of those studies are informative. Again, the difficulties in conducting such empirical work should not be underestimated. Both market structure and innovation variables are endogenously determined with interactions with many other variables. There are industry-specific features which are correlated with both concentration and innovation, for example, technological opportunity or appropriability. The early work in this area — which had mixed results — is surveyed by Kamien and Schwartz.¹⁶ One confounding issue discovered by Lunn (1986) was the different effects of the different types of R&D.¹⁷ His work made a distinction between process and product technologies and he found that there was a positive relationship between process R&D outcomes and a negative but less significant relationship when it came to product innovation.¹⁸

On the matter of firm size and innovation, some theoretical and empirical justification seems to exist. Theoretically, it appears quite plausible that R&D inputs, both financial and personnel, represent large upfront costs that the institution incurs often well before revenues from the R&D output accrue. The research personnel, being highly qualified and highly specialized, are not readily available on the spot market. The competing alternatives offering tenure make this form of labour a fixed cost. Furthermore, the nature of the activity with longer term projects makes it an activity which is difficult to speed up or slow down. There are theoretical arguments for firm size increasing the technological opportunities available to firms.¹⁹

An example of this is the testing required for pharmaceutical products. The personnel required are highly-educated medical personnel trained in the treatment of a certain ailment. The health regulators would mandate a certain protocol for the experiment that would require the monitoring of a minimum number of treated individuals of certain characteristics for a minimum amount of time. The average expenditure on research to bring a pharmaceutical product to the market is now in the order of hundreds of millions of dollars.²⁰ While it is conceivable that capital markets might be able to provide the financial

resources required by smaller firms, the highly specialized nature of the information makes this an investment difficult to assess for the average investor. Consequently, in this industry, an active market in licensing technology between large pharmaceutical firms and smaller biotechnology companies has evolved. While small biotechs still go to the capital markets, the signal given to investors of a licensing deal with a large, well-established pharmaceutical company is an important determinant of the value of the share offering. Debt markets are far less likely to be a mechanism to avoid financial constraints, as Hall showed that leverage has a strong negative relationship with R&D intensity.²¹ Retained earnings being a preferred mode of financing R&D gives a distinct advantage to large firms and perhaps conglomerates which may cross-subsidize across divisions.

One argument for large firms has been that with the evolution of an industry further improvement becomes more expensive to the point where only the largest firms within that industry may be able to finance the next generation. One industry where this claim has been made is in aerospace with the oft-cited example being the development of the Boeing 747. It has been contended that in the early 1960s the development of the next generation large-bodied, long-range passenger carrier involved such a large investment that Boeing, the largest airframe producer at the time, risked the company sustainability on one product, the 747. Happily for Boeing, this investment paid off handsomely but there is no doubt that the investment was substantial and required a long-term perspective.

That the size of the firm or its market power may affect the nature, quality and quantity of the research conducted is a notion for which there is some anecdotal evidence from the *United States v AT&T* case and its resulting consent decree. It is claimed that Bell Labs has never recovered from the resulting breakup and it is now largely an internal consulting division of the corporation. Similar claims — that the quality of R&D has diminished with the moderated dominance and size of their parent organizations — have been made of IBM's Watson laboratories and Xerox PARC.

Empirically, the literature on firm size and R&D intensity is mixed (albeit much of it suffering from the econometric problems described above). What follows is an extremely brief survey of this literature. Soete found that R&D as a percentage of sales increased with firm size in some sectors and decreased in other industries.²² Subsequently, Pavitt, Robinson and Townsend, using employment as the measure of firm size, found that R&D output increased with an increase in firm size.²³ Examining relatively large firms, Bound et al found that

smaller firms among the dataset of large firms and large firms were more research intensive (as measured by patenting) than the medium sized firms.²⁴ Cohen and Klepper, drilling down to the business units of firms, found a positive relationship between R&D intensity and business unit size due to the larger entity being able to spread the costs of R&D.²⁵ To summarize this vast literature, there are clearly industry effects, there are the effects of the nature of the R&D activity, there are consequences of R&D appropriability (e.g., patenting) as well as the effects of the details of the organization — all impacting on innovation. To determine the direction and significance of an innovation effect and possible remedies, the details of the case are material.

The area of competition law where the above issues have their greatest impact is in merger regulations and in cases where the proposed remedy involves the breakup of a large corporation. The aforementioned breakup of AT&T, and the proposed breakup of Microsoft by Judge Jackson in *United States v Microsoft Corp.*²⁶ are examples of such cases. In the *Microsoft DC Appeal* case, the United States was concerned with the abuse of dominant position consisting of predatory behaviour and creating barriers to entry and one of the remedies proposed by Judge Jackson was a breakup of Microsoft.

With respect to merger regulations, the problem is succinctly described by Katz and Shelanski:

Merger policy's problem: if antitrust enforcement is to promote and not disrupt the benefits of innovation, and if antitrust is properly to account for innovation's effects on market performance over time, to what extent should it adhere to its conventional presumptions regarding concentration in markets characterized by technological change?²⁷

As we have shown in the above Figure 1, one can readily generate cases where the “Old Market” may be perfectly competitive while the “New Market” is serviced by a monopoly and yet the welfare — both Consumer Surplus and Total Surplus — is higher under the “New Market”. This implies that a simple change in concentration measures may not suffice to challenge a merger. For example, Hall found, after controlling for propensity to merge, that the merger event resulted in increased R&D intensity.²⁸

As an example, let us say there is an industry consisting of eight firms — four firms each with 20% market share and four firms each with 5% market share. Such an industry would have a Hershman-Herfindahl Index (HHI) of 1,700. If two of the larger firms were to merge and there is no business “stealing” effect the industry becomes one of three firms with market shares of: 40%, 20%, 20% and four firms with 5% resulting in a HHI of 2,500. Are we really better off in the former market

configuration? A recent study by Agrawal et al is informative for answering this question.²⁹ This inquiry shows that different sized firms play different roles in bringing innovations to market similar to our Pharmaceutical industry example above. They find that metropolitan areas that have a greater diversity of firm sizes have a greater number of patents registered. The later market configuration in our example has a greater diversity of firm sizes but this is something that the HHI measure is inclined to depict negatively.

In summary, large firms in oligopolistic industries tend to invest large sums in R&D. Consequently, they are capable of taking on large scale projects. They tend to invest more in the R&D process. Competition authorities need to examine the extent to which these factors affect Consumers Surplus and Total Surplus and weigh those against possible new product developments (and their enhancements of Consumer Surplus and Total Surplus) from smaller rivals that may be adversely affected by the presence of a larger competitor. Competition regulators should also take into consideration related licensing markets as evidence that large firms may facilitate smaller firms' access to markets.

IV. Introducing Dynamics into the Analysis — Positive Feedbacks

An early study of the effect of market concentration on innovation was conducted via a detailed case study of the U.S. commercial aircraft industry, thus controlling for industry effects, appropriability and types of innovation by Phillips.³⁰ He found that a series of innovations exogenous to the industry resulted in a rise in market concentration which, in turn, led to an increase in R&D investment. This success leading to success was a pattern replicated (for more than a decade) by Nortel. Nortel, being a beneficiary of the AT&T consent decree while simultaneously being successful in developing an electronic digital telecommunications switch, became (by a far margin) the largest private investor in R&D in Canada for many years. Success leading to success is an indication of the presence of positive feedbacks in the economics of innovation.

“Positive feedbacks” is an idea championed by Brian Arthur³¹ among others. Positive feedbacks occur when there is a closed causal loop where an increase in an input is positively reinforced. In an example of negative feedbacks, with a downward sloping demand function and upward sloping supply functions, greater consumption leads to higher cost supply which negatively feeds back on the demand through higher prices. Many examples of disruptive technologies, however, exhibit positive feedbacks. Network effects are one example of positive feedbacks. Websites which create markets require both large numbers of

buyers and large numbers of sellers. Increases in the number of buyers increase the value of listing an item for sale on that site, which increases the number of sellers and items for sale which, in turn, increases the value to buyers visiting the site. Another example is one where the value to consumers of an operating system on a laptop computer depends positively on the base of consumers who have already purchased such an operating system. In this case, instead of the negative feedback of a downward sloping demand function, previous purchases positively feed back into greater demand. Arthur cites many examples of positive feedbacks with the introduction of new technologies.³²

The lessons from the economics of positive feedbacks that are relevant for competition policy are: (a) history matters, the systems exhibit path dependence; (b) market dominance is a natural (and can be a welfare superior) outcome of such economic systems; (c) technology lock-in (into possibly inferior technologies); and (d) the models are not good predictors of which technologies/firms will attain dominance. For example, in the aforementioned Microsoft DC Appeals case positive feedbacks help explain why and how MS attained market dominance in operating systems. In fact, Bill Gates has stated that he was cognizant of positive feedbacks and recognized how this would affect the evolution of the product, and he designed firm strategies accordingly.³³ Whether this market dominance comes about through a conscious firm strategy or by simply firms muddling through, positive feedbacks suggest that this is a natural feature of such a market. For competition enforcers such a natural dominant position *per se* should be less of a cause for alarm but does suggest that vigilance for abuse of dominant position should be more significant in such markets.

In Judge Jackson's Statement of Facts at the district court level, he stated the following:

Microsoft's refusal to offer a version of Windows 98 in which its Web browser is either absent or removable, however, had no such purpose. Rather, it had the purpose and effect of quashing innovation that exhibited the potential to facilitate the emergence of competition in the market for Intel-compatible PC operating systems.³⁴

[...]

Microsoft threatened to terminate the Windows license of any OEM that removed Microsoft's chosen icons and program entries from the Windows desktop or the "Start" menu. It threatened similar punishment for OEMs who added programs that promoted third-party software to the Windows "boot" sequence. These inhibitions soured Microsoft's relations with OEMs and stymied innovation that might have made Windows PC systems more satisfying to users.³⁵

Furthermore, Judge Jackson noted that “by pressuring Intel to drop the development of platform-level NSP software, and otherwise to cut back on its software development efforts, Microsoft deprived consumers of software innovation that they very well may have found valuable”.³⁶ Bill Gates protested Judge Jackson’s interpretation of software innovation this point in a television interview: “[t]he ruling says to creators of intellectual property that the government can take away what you’ve created if it proves too popular.”³⁷ He also contended that many of the other remedies proposed would be “very damaging to consumers”.³⁸

The proposed breakup remedy was overturned on appeal. Positive feedbacks may well explain the dominant position of the Windows operating system. What was lacking in Judge Jackson’s Statement of Facts and also from MS’s response, was an explanation for, or any proof of, how the linkage between the application software and the operating system benefited or did not benefit consumers.

In summary, the models of positive feedbacks illustrate methods by which dynamics can be incorporated into antitrust analyses of innovation effects. Such models demonstrate market features which can fundamentally change antitrust decisions and proposed remedies.

V. Discussion and Conclusions

Innovation is an important part of economic growth and the private sector’s investment in R&D is essential for innovation to contribute to economic growth. Disruptive technologies disrupt industries and markets and in the process, while there are winners and losers, on net they create surplus. The vast literature on the economics of innovation, only a small subset of which is discussed here, shows that this process of creating wealth through innovation is not straightforward. The innovation process is a complicated brew of firms of different sizes and types and in possibly different industries conducting different types of innovation. Firms may have incentives to encourage and conduct some types of innovation while having the motivation to harm other types of innovation. Competition is clearly a driver of innovation but depending on the type of innovation, product market competition in the existing market may enhance or hamper it.

In McGowan’s assessment, courts will need to consider the following for innovation cases:

[I]nnovation cases will require courts to take into account the interests of particular firms or institutions whose innovative work is alleged to have been harmed through anticompetitive acts. Without particular

innovators to provide concrete evidence of the alleged harm, innovation cases are likely to be unmanageable. Courts must therefore take such interests into account without returning to a version of antitrust policy that seeks to protect particular firms.³⁹

He recommends that:

In all but exceptional cases courts should require evidence of harm to innovation generally, rather than only to particular firms. In considering the question of causation in monopoly maintenance cases, courts should take into account the structure of the market, the type of claim advanced, and the feasibility of tailored remedies. The degree to which technology facilitates transitions among products and product generations is also relevant to such claims. Last, remedies in antitrust innovation cases should be tailored to reflect market structure and the strength of the evidence on causation.⁴⁰

McGowan is suggesting here that evidence be garnered from innovating firms but that the remedies should not necessarily be geared to protecting those same particular firms. The question is, how should this be achieved?

The fundamental issue that innovation presents competition authorities is a trade-off between allocative efficiency and dynamic efficiency. The familiar tools for calculating the static Consumer Surplus and/or Total Surplus need to be extended into a dynamic framework where new products and features and their resulting surpluses are considered. The ongoing work in the economics of innovation is already yielding some guidance for competition regulators. A distinction needs to be made with respect to which type of innovation is involved. When disruptive technologies are concerned restrictive trade practices deserve greater scrutiny. In a merger review, competition authorities should consider the history and nature of R&D in that industry. If there is a history of accumulated incremental innovation with long-term projects and substantial scale economies in R&D then that should lessen competition concerns, but regulators should be wary of alleged efficiencies that lower R&D budgets. Mergers between large established firms and small start-ups with the rationale being access to technology should be tested as to why research joint ventures and/or licensing do not suffice.

The work in positive feedbacks does provide descriptive dynamic models which are informative for antitrust. They show that technology adoption processes can be path-dependent, and that history matters. Such models also show a tendency towards market dominance which can be welfare enhancing using both Consumer surplus and Total surplus metrics. These models also indicate that effective remedies for increased concentration may be difficult to engineer.

While the work in the economics of innovation does not always provide definitive answers to many of the issues above, sufficient progress has been made to start addressing innovation effects in some competition cases where those effects can be decisive. No doubt there will be many more cases in the future which will have significant impacts on innovation.

Endnotes

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² Richard J Gilbert & Alan J Weinschel (2005), "Competition Policy for Intellectual Property: Balancing Competition and Reward," University of California at Berkeley Working Paper, online: <http://eml.berkeley.edu/~gilbert/wp/Antitrust_and_IP.pdf>.

³ U.S. Dep't of Transportation, "Domestic Passenger Car CAFE" in "Summary of Fuel Performance" 15 December 2014, online: <www.nhtsa.gov/staticfiles/rulemaking/pdf/cale/Performance-summary-report-12152014-v2.pdf>.

⁴ 552 F Supp 131 (DDC 1982) [*AT&T 1982 Case*].

⁵ *United States v Microsoft Corp*, 97 F Supp 2d 59 (DDC 2000) (direct appeal denied, pet cert denied, 530 US 1301 (2000)).

⁶ Joseph A Schumpeter, *Capitalism, Socialism and Democracy* (London, UK: Routledge, 1942, reprinted 1994) at ch 3.

⁷ Kenneth J Arrow (1962), "Economic Welfare and the Allocation of Resources to Invention" in Richard R Nelson, ed *The Rate and Direction of Inventive Activity: Economic and Social Factors* (New York: Princeton University Press, 1962) at 609.

⁸ *Ibid* at 619-22.

⁹ Joseph A Schumpeter, *Capitalism, Socialism and Democracy* (London, UK: Routledge, 1942 reprinted 1994) at ch 3.

¹⁰ See Richard N Foster, "The timing of technological transitions" in *Innovation: The Attacker's Advantage* (New York: Summit Books, 1986); Clayton M Christensen, *The Innovators Dilemma: When New Technologies Cause Great Firms to Fail* (Cambridge, Harvard Business School Press, 1997); and Joshua S Gans, "Beware of Business Fads: Disruptive Innovations and Competition Policy" in this Issue.

¹¹ *CFI Microsoft v Commission*, T-201/04, [2007] ECR II — 3619.

¹² *EC Microsoft v Commission*, COMP/C-3/37.792, [2004] online: <http://ec.europa.eu/competition/antitrust/cases/dec_docs/37792/37792_4177_1.pdf>.

¹³ Ina Fried, "Microsoft commentary slams EU ruling", *CNet News* (21 April 2004), online: <<http://www.cn-c114.net/582/a303449.html>>.

¹⁴ For a very good survey of the empirical literature, see George Symeonides, "Innovation, Firm Size and Market Structure: Schumpeterian Hypotheses and Some New Themes" in *OECD Economics Studies No. 27 1996/II* (Paris, OECD

Publication, 1996) at 35-70, although the literature has developed rapidly since.

¹⁵ See Philippe Aghion et al, "Competition And Innovation: An Inverted-U Relationship", 120:2 QJ Econ at 701-28.

¹⁶ Morten I Kamien & Nancy L Schwartz, *Market Structure and Innovation* (Cambridge, UK:Cambridge University Press, 1982).

¹⁷ John Lunn, "An Empirical Analysis of Process and Product Patenting: A Simultaneous Equation Framework" (1986) 34:March J Indus Econ 319-330.

¹⁸ *Ibid*.

¹⁹ Boyan Jovanovic & Rafael Rob, "Demand-Driven Innovation and Spatial Competition Over Time"(1987) 54:1 *Rev Econ Stud*, 63-72.

²⁰ Tufts Center for the Study of Drug Development, News, "Cost to Develop and Win Marketing Approval for a New Drug is \$2.6 Million" (18 November 2014), online: Tufts CSDD <http://csdd.tufts.edu/news/complete_story_pr_tufts_csdd_2014_cost_study>.

²¹ Bronwyn H Hall, "Mergers And R&D revisited" (1999) UC Berkeley Econometrics Laboratory Working Paper, online: <https://eml.berkeley.edu/~bhhall/papers/BHH99_mergers_rnd.pdf>.

²² Luc LG Soete, "Firm Size and Inventive Activity: The Evidence Reconsidered"(1979) 12 :4 *Eur Econ Rev* at 319-40.

²³ Keith Pavitt, Michael Robson & Joe Townsend, "The Size Distribution of Innovating Firms in the UK:1945-1983" (1987) 35:3 J Indl Econ at 297-316.

²⁴ John Bound et al, "Who Does R & D and Who Patents?" in Zvi Griliches, ed, *R&D, Patents, and Productivity* (Chicago: University of Chicago Press, 1984).

²⁵ Wesley Cohen & Steven Klepper, "A Reprise of Size and R & D" (1996) 106:437 *The Econ J*, 925-51.

²⁶ 253 F 3d 34 (DC Cir 2001) [*Microsoft DC Appeal*].

²⁷ Michael L Katz & Howard A Shelanski, "Mergers And Innovation" (2007) 74:1 *Antitrust LJ* 1 at 2.

²⁸ Hall, *supra* note 21 at 16 and Table 6.

²⁹ A recent study by Agrawal et al is informative for answering this question. See Ajay Agrawal et al, "Firm Size Diversity and Regional Innovation", (2012), University of Toronto, Rotman School of Management Working Paper, online: <http://mackinstitute.wharton.upenn.edu/wp-content/uploads/2013/01/Agrawal-Ajay-Galasso-Alberto-Cockburn-Iain-Oettl-Alexander_Firm-Size-Diversity-and-Regional-Innovation.pdf>.

³⁰ See Almarin Phillips, *Technology and Market Structure: A Study of the Aircraft Industry*, (Lexington, U.S.: Lexington Books,1971).

³¹ W Brian Arthur "Positive Feedbacks in the Economy," (1990) 262:Feb *Sci Am*, 92-99.

³² *Ibid* at 80, 82, and 84.

³³ Randall E Stross, *The Microsoft Way: The Real Story of How The Company Outsmarts Its Competition* (New York:Basic Books, 1996) at 184.

³⁴ U.S. DOJ, *United States v Microsoft Corp*, Court's Findings of Fact, Civil Action No. 98-1232 (TPJ), online: <<http://www.justice.gov/atr/us-v-microsoft-courts-findings-fact>>.

³⁵ *Ibid* at 203.

³⁶ *Ibid* at 410.

³⁷ See Scott Ard, "Judge: Microsoft must be broken in two",

CNET News (11 July 2002), online: <<http://www.cnet.com/news/judge-microsoft-must-be-broken-in-two/>>.

³⁸ Microsoft, "Microsoft Urges Court to Dismiss Government's Breakup Proposal Immediately" (10 May 2000), online: Microsoft <<http://news.microsoft.com/2000/05/10/microsoft-urges-court-to-dismiss-governments-breakup-proposal-immediately/>>.

³⁹ David McGowan, "Innovation, Uncertainty, and Stability in Antitrust Law" (2001) 16 Berkeley Tech LJ 729 at 730, online: <<http://scholarship.law.berkeley.edu/btlj/vol16/is>>.

⁴⁰ *Ibid* at 730.