9. Innovation

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Introduction

Innovation – the production and diffusion of new goods and services (Schumpeter 1934) – introduces a difficult tradeoff for competition policy. Competitive markets drive profits to zero. Innovators must incur a fixed cost to invent and bring to market new things, which followers do not have to pay in full. Who, therefore, has the incentive to invent? And without rents for innovators, or an alternatively suitable policy, is a strict competition policy just trading off static efficiency against dynamic sloth? Moving back one step, are we sure this tradeoff even exists?

Arguments about the link between competition policy and innovation, and therefore between competition policy and economic growth, have raged for nearly a century since Schumpeter's famous argument for the benefit of market power for innovators. Indeed, Aghion and Tirole (1994) call the relationship between market structure and innovation the second most studied question in all of industrial organization, after the connection between market structure and profit. Yet both theoretically and empirically, many key debates remain unsettled. Do monopolies and oligopolies actually do more R&D and bring more new products to market than firms in competitive markets? If current market power and future innovation are under consideration, should acquisitions of innovative young firms or future competitors be permitted? Which types of firms are likely to innovate and which are likely to free-ride on the innovation of others? How do the public sector contributions to innovation through direct financing, universities, and procurement affect these tradeoffs? In this chapter, we restrict attention to one subset of these questions: how does the competitiveness of an industry affect the rate of innovation, and what does this mean for competition policy?

Market structure and innovation in theory

Consider first the theory of the tradeoff between market concentration and innovation. The Schumpeterian argument appears incontrovertible, that concentrated markets may be more innovative as a result of innovator market power. Innovation is costly, yet it constitutes the "most powerful engine for progress" (Schumpeter 1942). The initial inventor or researcher pays a fixed cost of innovating either entirely or more substantially than followers, since copying an existing idea is generally easier than creating it. In a perfectly competitive product market, even in the long run, price will not exceed the average cost of potential entrants. How, then, is the initial inventor to cover their costs? And if they cannot, who will do the innovating?[1] As a result, we should tolerate market power from anticompetitive tying, first mover advantage, scale economies, secrecy in methods, and acquisitions of rivals, or even create market power through formal intellectual property.[2] Worse yet, when the property right to an innovation is uncertain (Lemley and Shapiro 2005) and impossible for the inventor to exploit themselves, the imperfect market for selling inventions makes it all the more important to permit important inventors to be large in their product market (e.g., Arora, Fosfuri, and Gambardella 2004).

Despite its seemingly self-evident nature, this argument is not as straightforward as it might appear. Potential inventors may *sell* their invention to other users, including other producing firms in the case of an invention that improves productivity. Arrow (1962) argues that the former effect means innovation may be higher in a competitive market. Consider an innovator whose invention lowers production costs of some downstream good by one dollar. In any downstream market structure, monopolized or competitive, producers will pay up to a dollar per unit produced for that invention. However, since competitive downstream markets produce a higher quantity of output than monopolized ones, the "market size" is larger under competition, and hence so is the incentive to innovate. Note the difference from the Schumpeterian setting: when market power distorts the size of the market one produces innovation for, it harms innovation. An alternative interpretation of this argument is that incumbents with market power can have less incentive to do cost-reducing innovation because the quantity of product they sell is less than that of a competitive market, and less incentive to replace their existing products because they are earning rents on those current products and care only for the difference between future profits and this status quo.

A similar effect is seen when we consider competitive dynamics, as in Aghion et al.'s (2005) and Lee's (2005) famed Inverted U model.[3] Potential inventors face competition in existing and future markets, in which case innovation may affect profits by changing the nature of that competition indirectly. Consider two oligopolists selling computer chips. When one firm is far ahead technologically from the other, its incentive to innovate is dulled: replacing one chip with a better one only gives profit from the marginal quality difference. However, when both firms are neck and neck, the incentive to innovate is also dulled, since these inventions give the inventor neither a big enough technological lead to charge a big premium nor a big enough lead to cause rivals to give up trying to catch up with their own inventions. Hence the Inverted U – incentives to innovate are particularly high when they allow the inventor to escape current and future competition. A world of pure monopoly lacks this incentive to race away from rivals, hence is less innovative. Put another way, monopolists value the status quo more than entrants, who not only "replace" their existing product with a better one but also seize market share from rivals by innovating. Trying to gain, or avoid, that seizure of market share is a strong inducement to bring new things to market.[4]

Even Schumpeter's basic argument is not as straightforward as it may seem at first glance. Schumpeter (1934) claims that permitting innovators to retain market power allowed for larger firms. Larger firms can hire more diversified R&D staff, who are more efficient (Axiom 1), and are more likely to be able to use the quasi-random output of research since they sell in more product lines (Axiom 2). As a result of these properties, Schumpeter claimed, large firms will do more R&D per unit of production.

Intriguingly, the two axioms do not actually imply that monopolists innovate more. There are two problems. First, as pointed out by Rodriguez (1979), Axiom 1 implies increasing returns to hiring R&D workers, which implies that the marginal product of researchers exceeds the average product. If the market for R&D workers is competitive, with workers paid their marginal product, there does not exist a finite wage for researchers. For this reason, assume Axiom 3, which is implied by Axioms 1 and 2, instead: if the number of researchers and other workers grows positively at the same rate, then the average R&D output per worker increases. Even this alternative does not rescue the Schumpeterian mechanism. Since firms will hire research workers until their marginal product equals their wage, large profit-maximizing firms will only hire more R&D workers than small firms if the *marginal* product of R&D workers is larger when the firm is larger. But our axioms were about whether large firms, or monopolists, have more efficient R&D on average, not on the margin, and there is no a priori link between the two concepts.

Given the importance of dynamic competition, of the differential link between current profits and profits from innovation for entrants versus incumbents, of the need for theoretical care about R&D productivity on the margin rather than on average, it is perhaps unsurprising that our original question – is market power good for innovation? – has led us into a theoretical morass.

Empirics of the market structure and innovation debate

Empirically, there are substantial difficulties in identifying the link between market structure and innovation. The most pressing is the one that binds in all industrial organization problems: market structure is endogenous. But beyond identification, even measurement is difficult. "Innovation" per se cannot be quantified. Instead, we use proxies like the number of patents, the citation-weighted number of patents (Jaffe, Trajtenberg, and Henderson 1993), direct R&D inputs, or counts of new product introductions. Ought these figures be divided for firm size, itself endogenous to both innovation and market structure? With a measure of innovation selected, how should competition be measured: business dynamism, Herfindahl indices, markup estimates, or something else? There are many reasonable, yet different, choices to be made here, and no shortage of attempts to empirically test Schumpeter's idea (Cohen 2010, provides a useful survey).

Contrary to the simple Schumpeterian story, it is devilishly difficult to find any compelling evidence of a link between market structure and innovation. Gilbert (2006) provides a comprehensive review of the early literature, noting, as we have above, that many researchers conflate the firm size-innovation link for the market

competitiveness-innovation one. More recent studies have applied clever identification and measurement ideas, still finding little in the way of a relationship. Kang (2023) looked at the dissolution of cartels as an endogenous change in market structure, finding that cartelized industries were more innovative. Lampe and Moser (2010), however, find that lax New Deal tolerance of industrial collusion via patent pools decreased the amount of R&D performed in newly "cartelized" industries. Likewise, Autor et al. (2020) use trade-induced changes in competition to find that more competition decreases R&D in the United States, while Bloom, Draca, and Reenen (2016) use similar trade shocks to competition to find that innovation increases in Europe in response to the shock.

Dynamic structural models of R&D competition have, like their reduced-form cousins, also found no general agreement on the question of whether less competitive markets innovate more. Goettler and Gordon (2011) examine competition between AMD and Intel in a structural quality ladder model, finding that Intel would have pursued more innovation were it a monopolist due to the higher post-innovation rents. Foreclosing nearly half the market otherwise available to AMD maximizes consumer surplus, since increased innovation by Intel makes up for the decreased consumer surplus of higher prices. On the other hand, Igami (2017), looking at hard disk drives, finds that incumbents with existing market power in the 1980s and 1990s declined to innovate at the same rate as entrants since sales of innovative products cannibalized existing ones. Igami and Uetake (2020), modeling a dynamic game of innovation and competition in hard disk drives with the possibility of merger, find that innovation rises as we move from monopoly to triopoly, with firms trying to escape competition through innovation. With more than three firms, though, the effect is difficult to sign, since lower post-innovation rents and higher exit probabilities in the more competitive environment make escaping short-run competition less valuable.

These conflicting results may not reflect a theoretical conflict if the inverted U logic holds. The estimated margin of increased competition in different empirical studies may reasonably lead to different effects of competition on innovation. When firms are very similar with little pricing power post-innovation, a decrease in competition should increase innovation; when a new product is enough to deter rivals from trying to catch up, present competition maximizes innovation; and when a technological leader is so far ahead that innovation merely cannibalizes its own existing monopoly rents, a decrease in competition again increases innovation. Shapiro (2011) argues that a similar intuition may hold more broadly. He claims that markets which are more contestable through innovation will see more innovation, and that contestability may not match exactly to static market structure.[5] The issue, of course, lies in defining contestability in a non-tautological way: if competition through innovation is the source of future, long-lasting rents, then firms have an incentive to do it, but what are the conditions under which the antecedent is true?[6]

Market power through acquisition

The most contentious area of competition policy concerns acquisitions by and of innovative firms. Organic growth in market power, and small buyouts, rarely trigger antitrust intervention (e.g., Wollmann 2019). Business dynamism has slowed since 1980 particularly in the United States, with an increasing share of profits and high-productivity workers at superstar firms, and a lower rate of entry by new businesses who use progressively less frontier knowledge to compete (Akcigit and Ates 2023). Acquisitions may present a concern here because the probability an innovative startup is acquired rather than having an IPO has risen rapidly since the 1990s, while at the same time the technology firms most active in the acquisition market face progressively weaker product market competition (Ederer and Pellegrino 2023).[7]

Cunningham, Ederer and Ma (2021) present an influential model of "killer acquisitions," whereby technological leaders acquire inventions that may represent future competition. Just as the Arrovian replacement effect means monopolists may have less incentive to innovate than firms in a more competitive market, monopolists also have more to gain from halting the release of new technologies which compete against their existing products. Empirically, they find that when pharmaceutical companies acquire another firm, drugs in development with a similar target and method of action to an existing therapy in

the acquirer's portfolio are 30% less likely to be developed than non-competing drugs.

Acquisitions can be beneficial for innovation in other cases. The possibility of exit by acquisition allows small startups without the complementary assets to bring a product to market at scale to nonetheless fund innovation (Rasmusen 1988) – indeed, it is precisely this type of acquisition of novel drugs by large pharmaceutical companies that spurs the biotech revolution (e.g., Gans, Hsu and Stern 2002). Furthermore, just as with any vertical merger, synergies along the value chain and the avoidance of transaction costs or double marginalization may lead a producer to acquire their innovative supplier.

Bryan and Hovenkamp (2020) model innovative firms who can sell to technological leaders, technological laggards, or both on a nonexclusive basis. Without restriction from competition policy, the innovators not only license to technological leaders (maximizing joint surplus, but not overall welfare), they also distort their direction of innovation to help leaders pull further ahead. Over time, this pattern endogenously monopolizes industry, weakening the bargaining power of future innovators and hence slowing the rate of innovation. A policy limiting the exclusive license of novel technology by leaders solves this problem while still allowing all efficiency-enhancing licenses to proceed. Callender and Matouschek (2021) find a similar distortion away from novelty in invention by small firms which might be acquired by technological leaders. Letina, Schmutzler, and Seibel (2021) model the decision of how much to invent, and what to invent, for both entrants and potential acquirers, showing that the antitrust motive for intervention in "killer acquisitions" may be weaker than in other types of acquisitions because of the equilibrium ex ante incentives to innovate. Kamepalli, Rajan, and Zingales (2020) show theoretically and empirically that with network effects and consumer switching costs, consumers will consider the future viability of products or platforms they use. Since they understand that technological leaders have an incentive to kill competing products after acquisition in some cases, in equilibrium, products in this "kill zone" do not attract consumers in the first place. Empirically, venture capital investment falls substantially in areas similar to that pursued by firms which are acquired by leaders like Google and Facebook, but not following acquisition by other non-leading incumbents.

Conclusion and future directions

What market structure maximizes innovation? Theoretically, the question is poorly formed without specifying the cause of the given market structure and ambiguous even if we permit various types of exogenous changes. Empirically, evidence is no better. Indeed, if any contracts are permitted between firms, it is always in the interest of market leaders to buy any new technology – joint surplus is maximized by the monopolist in any technological setting (Gilbert and Newbery 1982). The question of when we should permit market power for innovative reasons is even harder to answer when we vary factors not considered in this entry, such as the ability of different firms to appropriate at different rates the surplus of their invention (e.g., Arora, Belenzon, and Sheer 2021, on the declining appropriability of basic research and concomitant decline in the rate of private sector basic research). Nonetheless, there is sufficient evidence, theoretical and empirical, that the rate of innovation responds to economic incentives, and in particular responds to the change in pre- and post-innovation profits. There is also sufficient evidence that a competition policy which maximizes static competition leaves substantial welfare on the table by discouraging useful innovation. That said, the exact contours of how to balance the two, especially in fast-moving fields like artificial intelligence startups, are very difficult to specify without knowing particular details of the economic setting in question.[8]

Notes

1. See also Dasgupta and Stiglitz (1980) for an early attempt to formalize Schumpeter's intuition.
2. While theorists often use "patent" as offhand for a barrier to replication of an invention by rivals, empirical evidence suggests that other methods tend to be the most common method of gaining market power from innovation. See, for instance, the "Carnegie survey" (Cohen, Nelson, and Walsh 2000), showing that formal IP is relatively uncommon as a primary method of protection outside of industries like pharmaceuticals, and

Sampat (2018) for a review of the evidence on patents more broadly.

3. Scherer (1967) was the earliest to point out the inverted U stylized fact, that middling levels of competition have more innovation than pure monopoly or pure competition.
4. See also Gilbert and Newbery (1982) and Reinganum (1983) for theoretical arguments that monopolists have higher willingness to pay for innovation which protects their monopoly than entrants due for innovation that helps them compete.
5. Marshall and Parra (2019) examine this proposition theoretically, using the profit gap between leaders and laggards as the relevant contestability standard. Even here, however, the details of the product market game between different innovators affect the link between "contestability" and innovation.
6. Gilbert and Greene (2014) note that the judiciary has found it difficult to find usable standards for competition policy in these conflicting economic studies.
7. Competition in this case is measured not by markups, but by a text-based measure of product similarity. See Pellegrino (2023) for details.
8. See Tirole (2023) for a fruitful discussion of the digital industry antitrust issues most in need of rigorous investigation.

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