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Comment Michael D. Whinston

It is a pleasure to discuss a chapter of Carl's. The chapter focuses on an important but quite specific issue concerning innovation, namely the anti-

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trust review of mergers in innovative industries. In the chapter, Carl makes two basic points: first, he argues that a merger's likely effects on innovation can often be discerned despite the seemingly negative lesson from the recent R&D and growth literatures, in which the level of innovation has no clear relation to the level of competition. Second, Carl suggests some principles that he feels can usefully guide such merger reviews. Here I will discuss these points in turn.

Let's start with the "complex relationship" between the level of competition and the rate of innovation, upon which the R&D and growth literatures have recently focused. What drives this complexity? In fact, you can see an important source of it by thinking about Arrow (1962) and Schumpeter (1942). Roughly speaking, there are two different times at which we might be concerned with market structure: ex ante (before the innovation) and ex post (after the innovation). Arrow showed that ex ante market structure is important, and that greater ex ante competition encourages innovation. The reason is simple: more ex ante competition destroys profits in the ex ante state, which gives firms a greater incentive to innovate to escape from that state. Schumpeter instead argued that competition is bad for innovation, but did so focusing on ex post market structure: destroying profits ex post reduces firms' incentives to innovate to get into that state. In essence, in the more recent models in this literature, competition is changed in *both* ex ante *and* ex post states. Because of this, things get complicated, and this tension between ex ante and ex post effects shows up in the varied effects observed in a lot of the literature.

Carl nicely illustrates this point in his discussion of the Aghion et al. (2005) paper. In that paper, the meaning of "less competition" is that there is less intense pricing rivalry when firms are in the neck-and-neck state in which they have the same technological capabilities. The neck-and-neck state is the ex post state when we look at R&D by the trailing firm when one firm is ahead and the other is behind,[1] but it is the ex ante state when we think about the R&D that occurs when the two firms are neck and neck. As a result, there are two opposing effects of more intense competition on innovation: an increase in innovation in the neck-and-neck state but a reduction in the state in which one firm is ahead. This fact then leads to an inverted U-shaped relationship between competition and innovation, where innovation is greatest at intermediate levels of competition. The reason for the inverted U is that the industry tends to spend more of its time in the state in which innovation is lowest, because that is the state firms tend not to move out of. Specifically, when there is little competition, there is little innovation in the neck-and-neck state, and a lot in the state where one firm is behind. As a result, firms are much more likely to be in the neck-and-neck state, which

1. Aghion at al. assume that a leader cannot be more than one step ahead; as a result, only the follower will do R&D in this state.

means that if we increase competition the (average) response of innovation is dominated by the response in the neck-and-neck state, which is positive. Similar reasoning implies that when competition is high in this sense, the industry is much more likely to be in the state where one firm is behind, so an increase in competition will reduce R&D on average.

While this inverted U-shaped relationship is certainly interesting and useful for understanding what we see in industry data, does it mean that we cannot predict the likely effects of a merger in an innovative industry? Carl argues no, and I agree. A key reason is that if you are thinking about mergers, the comparative statics exercise that is of interest to you—how this merger will affect the rate of innovation and welfare—differs from the comparative statics exercise that is conducted in this literature. To shamelessly plug some of my own work, a few years ago Ilya Segal and I wrote a paper (Segal and Whinston 2007) on antitrust in innovative industries. There we focused primarily on exclusionary behavior rather than on mergers, but a similar issue came up. We put the point as follows:

> The growth literature often considers how changes in various parameters will affect the rate of innovation, sometimes even calling such parameters measures of the degree of "antitrust policy". . . . Here we are much more explicit than is the growth literature about what antitrust policies toward specific practices do. This is not a minor difference, as our results differ substantially from those that might be inferred from the parameter changes considered in the growth literature. As one example, one would get exactly the wrong conclusion if one extrapolated results showing that more inelastic demand functions lead to more innovation (e.g., Aghion and Howitt 1992) to mean that allowing an incumbent to enhance its market power through long-term contracts leads to more innovation. (Segal and Whinston 2007, 1704)

Let's consider two examples to illustrate how the presence of a seemingly "complex relationship" between competition and R&D need not prevent definitive answers to specific competition policy questions. Consider first the model with Ilya. It was a quality ladder model of innovation similar to those in the growth literature. There was an entrant—if successful in its R&D, the entrant came in and competed for one period before displacing the incumbent monopolist. The entrant would then be an uncontested monopolist until he himself ultimately faced a successful new entrant and was displaced.

In this setting we asked whether allowing incumbents to deter entry through exclusive contracts with buyers would encourage or discourage innovation. (The question was motivated in part by the *Microsoft* case, where Microsoft wrote partially exclusive contracts with buyers and providers of complementary goods.) Exclusive contracts reduce the number of buyers who are free to purchase from an entrant, which tends to reduce innovative effort by prospective entrants. However, once an entrant displaces

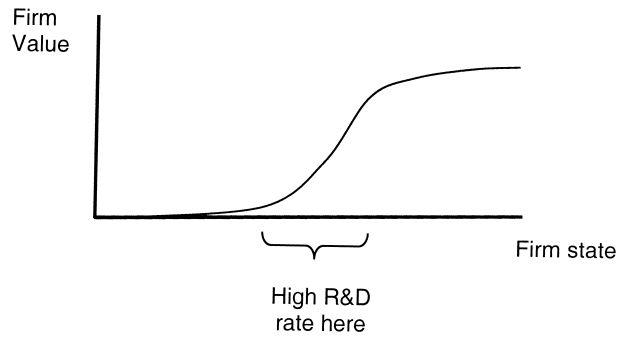

Figure 7C.1 A firm's value function in the Pakes-McGuire model

the incumbent and becomes the new monopolist, it is more profitable if it can deter entry, so allowing such deterrence could also raise the incentive to innovate. As a result, it might seem like one cannot say anything about which way the overall effect comes out. Nonetheless, we showed that fairly generally the use of exclusives lowers the rate of innovation (and both consumer and aggregate surplus).

Now consider a different dynamic model of innovation due to Pakes and McGuire (1994) (see also Ericson and Pakes 1995). In this model, there is a differentiated product oligopolistic industry in which, in each period, firms engage in price competition and can also invest in stochastic product improvement. Both entry and exit are also possible. A firm's value function in this model typically looks as in figure 7C.1, where the horizontal axis measures the firm's state (innovation can increase a firm's state, which raises its product's value to consumers) and the vertical axis measures the firm's value. The graph of the value function in the figure holds the states of the firm's rivals fixed.

As can be seen in the figure, the value function is S-shaped: relatively flat at low and high states, with a steep section in the middle. Innovation will be high when the firm is in a state at which this curve is steep (the returns to product improvement are then large). The steep section is like the neck-and-neck state in Aghion et al. (2005). Although Pakes and McGuire do not do this, I think if you actually looked at this model and had a bunch of these industries in different states, you likely would get an inverted U-shaped relationship between the rate of innovation and the intensity of competition. At the very least, the relationship would be "complex."

Nonetheless, when Pakes and McGuire simulate the effect of a merger in the Markov perfect equilibrium of their model, its impact on consumers is very clear. Table 7C.1 shows the levels of industry profit, consumer surplus, and aggregate surplus in three cases: the first best, the oligopolistic Markov perfect equilibrium, and a fully collusive outcome. The fully col-

Table 7C.1 **Profit, consumer surplus, and aggregate surplus in the Pakes-McGuire model**

	Industry profit	Consumer surplus	Aggregate surplus
First best			377
Markov perfect equilibrium	70	301	369
Collusion (industry-wide merger)	218	115	332

lusive outcome can be thought of as the result of an industry-wide merger (including all potential entrants). The first-best aggregate surplus is 377. There is a small loss in aggregate surplus in the Markov perfect equilibrium: consumer surplus is 300 and industry profit is 70. (This is an industry where, on average, three or four firms are active.) With the industry-wide merger, aggregate surplus falls 10 percent compared to the Markov perfect equilibrium and consumers do really badly: their surplus falls by almost two-thirds. (The rate of innovation also falls dramatically.) Thus, despite any general complexity of the relation between the level of competition and the rate of innovation, this merger is evidently very bad for consumers. Gowrisankaran (1995) also finds negative effects on consumers (and a reduction in R&D) in a closely-related model when he allows for (endogenous) nonindustry-wide mergers.[2]

In summary, I think Carl is completely correct in his first point: while the R&D and growth literatures that exhibit "complex" (inverted U-shaped) effects are certainly interesting and valuable contributions, they are often not on point, or only partially so, for the questions we want to ask when evaluating mergers in innovative industries.

Now to Carl's second point. Suppose a merger in an innovative industry faces antitrust review. What can we say about the merger's likely effects on innovation? Carl proposes some principles to aide such analysis. Perhaps it would be most useful if I discuss how I would think about the likely effects on innovation if I were looking at such a merger.[3] (One would also need to think about its overall effect on consumers.)

My starting point would be to assess how the merger changes the R&D incentives for the merging firms, holding fixed the R&D activities of the merging firms' rivals. Here one is assessing how the merger changes the degree to which the firms' profits respond positively to their level of inno-

2. It is worth noting that other interventions to increase "competition" need not be welfare-improving. For instance, Pakes and McGuire also simulate the effect of a rule limiting firms' market shares to be no greater than 65 percent. This rule reduces both consumer and aggregate surplus relative to the Markov perfect equilibrium.

3. Because Carl changed his statement of these principles in the revised draft of his paper, I have modified what follows somewhat from my discussion at the conference. The discussion that follows is, I think, broadly consistent with the approach Carl proposes in the final version of his chapter.

vation. Several factors go into this. The most important seems to me to be the degree to which the merger internalizes externalities arising from the merging firms' R&D. This R&D externality internalization effect of the merger could in principle be positive or negative. For example, in a quality ladder model there is an important positive externality across generations (each innovation enables later ones), so a merger could increase innovation incentives by internalizing this positive externality. On the other hand, in the Pakes and McGuire model, innovation creates only negative externalities across firms, so a merger will most likely reduce innovation incentives. But what is important to note, I think, is that this first critical factor is likely to be reasonably assessed by those reviewing the merger, and is unrelated to the factors contributing to the "complex" relationship just discussed. This is where the fact that we are focusing on the effect of a *merger,* not some other change in "competition," really matters.

Mergers also cause externalities on another set of market participants: consumers. Because the merger internalizes pricing externalities, it can alter the degree to which firms rather than consumers benefit from an innovation, and hence can alter firms' incentives to do R&D. This effect is related to the complex relationship discussed earlier, and is probably harder to assess. My own gut feeling is that in most (though not all) cases, this effect is likely to be less important than the R&D externality internalization effect.

Finally, this first step also needs to incorporate any efficiency effects in R&D production created by the merger.

A second concern is how the merging firms' rivals will react to this change. In particular, are R&D efforts strategic substitutes or strategic complements in the sense of Bulow, Geanakoplos, and Klemperer (1985)? If they are strategic complements and you dull innovation incentives for the merging firms, everyone's R&D goes down. If they are strategic substitutes, then the rivals will increase their R&D in response to the merging firms reducing theirs. In that case, it may seem that the overall effect is unclear. Typically, however, we expect that this countervailing effect does not overwhelm the direct effect—that the other firms do not expand their R&D enough to counterbalance the R&D contraction of the merging firms. Indeed, in most theoretical papers, this is just invoked as a standard assumption. Its import is that, if true, one only needs to look at the direct effect on the merging firms' R&D holding rivals' R&D efforts fixed to discern the overall effect on R&D.

Matters would be more complicated when innovative efforts are not one-dimensional. For example, a merger might enhance incentives for some types of R&D and reduce it for others. Or the R&D of the rivals may differ from that of the merging firms. Nonetheless, in many cases this way of thinking seems likely to get us fairly far in thinking about these issues.

To sum up, this is a worthwhile chapter that should help restore faith among those who need to evaluate mergers in innovative industries, and that also provides some guidance on how to do it.

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