Innovation: The Bright Side of Common Ownership?

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PRELIMINARY AND INCOMPLETE. COMMENTS WELCOME.

Abstract

A firm's incentives to innovate deteriorate when other firms benefit from its R&D activities without incurring a cost. We show under which conditions common ownership of firms can mitigate this impediment to corporate innovation, and test the model's empirical predictions. Common ownership increases R&D when technological spillovers, as measured by firms' distance in technology space, are large relative to product market spillovers, as measured the firms' distance in the product market. Otherwise, costly innovation leads to more business stealing which is detrimental for common owners. Our results help inform the debate about the welfare effects of increased levels of common ownership concentration of U.S. firms.

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I Introduction

Research and development (R&D) is a key driver of economic growth and has been a major topic in the growth, productivity, and industrial organization literatures for many decades.[1] At the same time, the competitive landscape in which U.S. firms operate has changed dramatically due to increases in both product market concentration[2] and common ownership concentration.[3] Given that incentives to compete are tightly linked to incentives to innovate (d'Aspremont and Jacquemin, 1988; Aghion et al., 2005; Bloom et al., 2013), the question arises how firms' incentives to innovate depend on ownership structure, industry structure, and the interaction between the two. In this paper we address these questions to clarify our understanding of the drivers of corporate innovation.

We show theoretically and empirically under what conditions common ownership has a positive or a negative effect on R&D. The sign of the effect depends on the relative strengths of technological spillovers and business-stealing incentives. The intuition is simple: in the presence of technological spillovers innovation in one firm not only generates benefits in that firm, but also in closely technologically related firms which may be owned by the same shareholders. When these other firms are independently owned, however, technological spillovers may even reduce innovation incentives because other firms can free-ride on the first firm's innovation efforts.[4]

A second dimension of the tradeoff concerns the interaction between innovation and competition. Cost reductions afforded by R&D expenditures can help steal market share from competitors. When competitors are predominantly owned by separate groups of shareholders, this pro-competitive effect of innovation can be desirable for the innovating company's shareholders.

[1]See, for example, Brander and Spencer (1983), Spence (1984), Katz (1986), Grossman and Helpman (1991), or Aghion and Howitt (1992). Jones (2005) provides an extensive survey of these literatures.

[2]See, for example, "Too much of a good thing: Profits are too high. America needs a giant dose of competition," *The Economist*, March 26, 2016 and "The problem with profits: Big firms in the United States have never had it so good. Time for more competition," *The Economist*, March 26, 2016.

[3]See e.g. Roe (1990); Hansen and Lott (1996); Davis (2013); Azar (2012); Azar et al. (2015, 2016); Antón et al. (2016); Fichtner et al. (2016).

[4]The latter is a well-known impediment to innovation. See, for example, Bolton and Harris (1999).

However, when shareholders own both the innovator and the competitor, such business stealing is less desirable. Hence, common ownership can reduce incentives to innovate when the business stealing effect is stronger than the technological spillover effect.[5]

Because our theoretical predictions depend on the relative strengths of two competing effects, it is an empirical question whether common ownership has a bright side – namely fostering innovation – or whether (and under what conditions) the anti-competitive effects of common ownership dominate, thereby suppressing innovative activity. Moreover, an empirical investigation can test the theoretical comparative statics and thus help our understanding of the nuanced mechanics that govern firms' incentives to innovate under strategic competition and diversified ownership.

We present empirical tests that largely confirm the model predictions in a large panel of U.S. firms. Specifically, using the methodology pioneered by Bloom et al. (2013) to measure technology and product market spillovers and extending their data from 2001 to 2013 we document a positive relation between common ownership and innovation when technological spillovers are high. However, that relation is weaker when product market spillovers are high.

The remainder of this paper is structured as follows. Section III presents the model, which serves to guide the empirical analysis. Section IV describes the data. We present the empirical results in section V. Section VI concludes.

II Related Literature

This paper contributes to a large literature on the drivers of corporate innovation and a fast growing literature on common ownership. With respect to the theoretical part of our contribution, López and Vives (2016) is the most closely related paper. The authors derive conditions under which common ownership can increase innovation, output, and welfare in a Cournot setup in which all firms produce a homogeneous product. Our relative contribution is an extension of their model to allow for product differentiation to capture differential business stealing incentives

[5] Bloom et al. (2013) provide empirical evidence for the presence of these two distinct effects of R&D.

between firms based on their proximity in product market space.[6] We use this model to derive two important predictions which relate the sign of the common ownership effect on innovation to technological and product market spillovers.[7]

There is an extensive theoretical literature on the effects of cooperation and competition in R&D with spillovers, starting from the seminal articles of Brander and Spencer (1983), Spence (1984), Katz (1986), d'Aspremont and Jacquemin (1988), Kamien et al. (1992), Suzumura (1992) and Leahy and Neary (1997). One of this literature's primary objectives is to examine underprovision of R&D and the welfare effects of moving from a noncooperative to a cooperative regime in R&D. For example, d'Aspremont and Jacquemin (1988) show that, when spillovers are high enough, R&D cooperation (with subsequent competition at the output stage) leads to increased output, innovation, and welfare. Cooperative R&D enables firms to internalize their externalities and thus preserves the incentives to invest in R&D. In a similar context without R&D Farrell and Shapiro (1990) show that passive financial stakes may be welfare increasing in asymmetric oligopolies.

Our main contribution, however, is an empirical investigation of the effect of common ownership in the presence of both technology and product market spillovers. The empirical literature on the determinants of corporate innovation is too voluminous to do justice in its entirety; see Jones (2005) for a review. Most closely related are studies on the effect of ownership structures on innovative activity. Aghion et al. (2013) relate institutional ownership to innovation. Similarly, Hoskisson et al. (2002) study the role of conflicting preferences of public pension fund and other institutional investors on innovation. Our paper conceptually differs in two respects. Not only has the type of owners with effective control changed dramatically, but the resulting ownership structure of industries has also changed. We hence study whether the co-ownership network across firms – rather than the ownership structure of a single firm in isolation – affects innovation. Bernstein

[6] We also show that our results extend to the case of Bertrand competition.

[7] Relative to standard models of competition under common ownership (e.g., O'Brien and Salop (2000)), our model allows for innovation with technological spillovers in addition to quantity choices. In our model, an investment in R&D not only reduces the firm's own costs, but also spills over to closely technologically related firms.

(2015) finds that going public reduces innovation activity. This finding can be interpreted in the context of our model and findings as the effect of increasing common ownership. Similarly, Itenberg (2015) finds that innovation has shifted from bigger to smaller firms over the past decades. Because common ownership has increased over the same time span, and more so for larger than for smaller firms, our analysis also suggests an economic reason for the facts first documented by Itenberg (2015).[8]

Methodologically, our paper is most closely related to Bloom et al. (2013) who measure technological and product market spillovers and document their impact on innovation. Their approach builds on prior work by Jaffe (1988) who assigns firms to technology and product market space, but does not examine the distance between firms in both these spaces. Similarly, Branstetter and Sakakibara (2002) empirically examine the effects of technology closeness and product market overlap on patenting in Japanese research consortia. We investigate how the relation between common ownership and innovation varies with the measures of technological and product market spillovers that these authors propose.

III Model and Hypothesis Development

A Setup

The following stylized model analyzes how common ownership, product market competition, and innovation interact.

A1 Product Market Competition

There are n firms which engage in differentiated Cournot or Bertrand competition. In the main part of the paper we focus on the Cournot competition case where quantity choices are

[8] Less closely related is a literature in management and finance on the effects of acquisitions on innovation and vice versa (Hitt et al., 1991, 1996; Bena and Li, 2014), as well as a literature on the link between innovation, firm creation, and asset prices (Bena et al., 2016). Interestingly, none of the papers in the finance literature studies the role of shareholder diversification across competitors on innovation.

strategic substitutes. However, our results for Bertrand competition (see Appendix) where prices are strategic complements are essentially identical. The firms face symmetric inverse demand functions given by

$$P_i(q_i, q_j) = A - bq_i - a\sum_{j\neq i}^{n} q_j, \tag{1}$$

where $i = 1, 2, ..., n$ and $b > a > 0$. Thus, the firm's action choice has a greater impact on the demand for its own product than do any single of its rivals' actions.[9] Moreover, a measures product homogeneity or product market spillovers. If a is small the firms' products are quite distinct and thus expanding output (or lowering prices) does not steal much market share from competing firms. On the other hand, if a is large the product varieties produced by the firms are quite similar and thus business stealing is more relevant.

Firm i has a marginal cost of c_i

$$c_i = \bar{c} - x_i - \beta\sum_{j\neq i}^{n} x_j \tag{2}$$

Firm i can lower its marginal cost from $\bar{c}$ either by investing in innovation x_i at a cost $\frac{\gamma}{2}x_i^2$ or by the innovative investments of other firms which benefit the firm because of technological spillovers. The strength of these technological spillovers is captured by β.

The profits of firm i are given by

$$\pi_i = q_i(A - bq_i - a\sum_{j\neq i}^{n} q_j - c_i) - \frac{\gamma}{2}x_i^2. \tag{3}$$

Firms choose quantities and innovation simultaneously.[10]

[9] Although we assume linear demands, the main results of our model generalize to nonlinear demand functions.

[10] We obtain qualitatively similar results when firms make innovation investments before choosing quantities (or prices).

A2 Owners

There are n owners. To simplify the exposition, we assume that they are symmetric such that owner i owns a majority stake in firm i and additional (equal) shares in the remaining $n-1$ firms. Lopez & Vives (2016) show that, when the ownership stakes are symmetric, firm i's problem is to maximize

$$\phi_i = \pi_i + \lambda \sum_{j \neq i}^{n} \pi_j \tag{4}$$

where the value of λ depends on the type of ownership and corresponds to what Edgeworth (1881) termed the "coefficient of effective sympathy among firms". This coefficient λ captures the degree of common or cross ownership.

B Analysis and Comparative Statics

Each firm's reaction functions for quantity and innovation choices under Cournot competition are given by

$$q_i = \frac{1}{2b}\left[A - (\bar{c} - x_i - \beta \sum_{j \neq i}^{n} x_j) - a(1+\lambda) \sum_{j \neq i}^{n} q_j\right] \tag{5}$$

$$x_i = \frac{1}{\gamma} q_i + \lambda \beta \sum_{j \neq i}^{n} q_j \tag{6}$$

Solving for the symmetric equilibrium we obtain

$$q^* = \frac{A - \bar{c}}{2b + a(n-1)(1+\lambda) - \frac{\tau B}{\gamma}} \tag{7}$$

$$x^* = \frac{\tau}{\gamma} q^* \tag{8}$$

where $\tau = 1 + \lambda\beta(n-1)$ and $B = 1 + \beta(n-1)$.

First, equilibrium innovation x^* is proportional to equilibrium quantity q^* and is also increasing in τ which itself is increasing in λ. Thus, if quantity q^* is increasing in the degree of common ownership λ then innovation x^* will also be increasing in common ownership. Innovation, however, in comparison receives an additional kick through τ because of the technological spillovers which common ownership internalizes. As a result, common ownership will increase equilibrium innovation for parameter values for which common ownership will decrease equilibrium quantity. Second, higher product homogeneity a reduces equilibrium quantity and also equilibrium innovation. This is the well-known business stealing effect of common ownership: As λ increases it raises the impact of a in the denominator in equation (7) and this lower equilibrium quantity may also lead to lower equilibrium innovation if the technology spillover effect of common ownership is not sufficiently strong to counteract it.

More generally, how does common ownership λ affect equilibrium quantity and innovation? The following proposition states our findings more formally.

Proposition 1. *Denote β' as the positive solution to $1+\beta(n-1)-\frac{a\gamma}{\beta}=0$. The comparative statics of equilibrium quantity q^* and innovation x^* with respect to common ownership λ are characterized by 3 regions.*

(i) If $\beta \leq \frac{a}{2b+a(n-1)}$, then $\frac{\partial q^*}{\partial \lambda} < 0$ and $\frac{\partial x^*}{\partial \lambda} \leq 0$.

(ii) If $\frac{a}{2b+a(n-1)} < \beta \leq \beta'$, then $\frac{\partial q^*}{\partial \lambda} \leq 0$ and $\frac{\partial x^*}{\partial \lambda} > 0$.

(iii) If $\beta > \beta'$, then $\frac{\partial q^*}{\partial \lambda} > 0$ and $\frac{\partial q^*}{\partial \lambda} > 0$.

While our model makes predictions about the equilibrium quantity as well our primary empirical focus is on how the equilibrium level of innovation varies with the level of common ownership. Therefore, the first two parts of Proposition 1 which determine the threshold above which common ownership increases innovation, are instructive. In particular, product market and technology spillovers jointly determine the sign of the common ownership effect on innovation as the following corollary illustrates.

Corollary 1. *Common ownership λ can decrease or increase innovation.*

(i) If product market spillovers are large, $a > \frac{2b\beta}{1-\beta(n-1)}$*, common ownership* λ *decreases equilibrium innovation* x^**. If product market spillovers are small,* $a \leq \frac{2b\beta}{1-\beta(n-1)}$*, common ownership* λ *increases equilibrium innovation* x^**.*

(ii) If technology spillovers are large, $\beta > \frac{a}{2b+a(n-1)}$*, common ownership* λ *increases equilibrium innovation* x^**. If technology spillovers are small,* $\beta > \frac{a}{2b+a(n-1)}$*, common ownership* λ *decreases equilibrium innovation* x^**.*

Corollary 1 illustrates that without knowledge of industry and technological characteristics common ownership has an ambiguous effect on innovation. Depending on the relative strengths of (i) the business stealing and (ii) the technology spillover effect common ownership can either decrease or increase equilibrium innovation. However, the corollary also makes precise predictions under what conditions common ownership has a negative or a positive effect on innovation. Common ownership should decrease innovation if a is sufficiently large relative to β, whereas common ownership should increase innovation if the opposite is the case. In other words, we expect common ownership to decrease (increase) innovation when product market spillovers are large (small) and technology spillovers are small (large). These predictions provide theoretical guidance for our empirical analysis.

IV Data

In this section, we investigate the empirical relationship between common ownership, product market competition, and innovation. Specifically, we are interested in how innovation inputs (R&D expenditures) and outputs (the number of patents, citation-weighted value of patents, and stock market value of patents) depend on the extent to which the firm is controlled by shareholders that have significant stakes in related firms, and on the extent to which the innovation is expected to spill over to other, potentially also commonly owned firms.

To that end, we construct the following four outcome variables. XRDFNEW is the level of inflation-adjusted R&D expenditures as reported in Compustat. We modify the variable only insofar as we impute missing values with a 0 if and only if at some point in the history of that company R&D was positive. This is the proxy we use for innovation inputs. As for outputs, we use the following three variables from Kogan et al. (forthcoming). Log(1+Tcw) is the logarithm of 1 + citation-weighted value of patents. Log(1+Tsm) is the logarithm of of 1 + total stock market value of patents. Finally, Log(1+fNpats) is the logarithm of 1 + number of patents.

The key explanatory variables are defined as follows. First, CO denotes two alternative measures of common ownership. For each company and year, we measure which fraction of the set of "other" companies is beneficially owned by the top five shareholders where the set of "other" companies is defined in various ways detailed below. We hereby aggregate the holdings of the top five owners for each firm, whereas we value-weight the other holdings by their market cap. Next, we rank-transform the common ownership variable.

The alternative measure is defined as follows. For the HJL measure, for each pair of companies and for each shareholder we first compute the following ownership ratio.

$$\frac{\text{ownership of the shareholder in firm 1} \times \text{ownership of the shareholder in firm 2}}{\text{ownership of the shareholder in firm 1} + \text{ownership of the shareholder in firm 2}}$$

We then sum this variable across all shareholders for each pair firm-pair. Finally, we aggregate the measure for each firm across all pairs, equal-weighting each pair.

Throughout our analysis we use the following set of controls:

- HHI is the rank-transformed Herfindahl-Hirschman Index of market concentration defined as the sum of the squares of the market shares. We compute it using sales, defined at the industry-level. Industries are defined at the 4-digit level using SIC codes from the CRSP data base, SIC codes from Compustat, or NAICS codes, alternatively.

- Logmef is the log of 1 + the market value of the company, whereas we adjust for inflation as in Brav et al. (2014).

- Logkl is the capital-labor ratio, computed as log of 1 + the ratio of PPENT / EMP. PPENT is Plant Property and Equipment, and Emp is number of employees; see Aghion et al. (2013); Hall et al. (2001); Gompers and Metrick (2001).
- Logage is the log of 1 + firm's age, again as in Brav et al. (2014).
- SPILLTECH and SPILLSIC are technological and product market spillovers, as defined in Bloom et al. (2013).

Summary statistics (for the sample for which SPILLSIC is not missing for comparability) are provided in Table 1.

V Empirical Hypotheses, Methodology, and Results

In this section, we analyze how R&D and innovation activity of firms depends on the degree to which the firms are commonly owned, how that relation depends on the extent to which innovations spill over to other firm, and how the aforementioned relations depend on product market competitiveness, as measured by the industry structure.

A Empirical Hypotheses

The theoretical model presented in section III showed that common ownership can have a positive or a negative effect on innovation, depending on parameters. Specifically, the model predicts that the correlation between common ownership and innovation increases in the level of technological spillovers, but decreases the closer the firms are in product space. Whereas the model also makes predictions about the sign of the common ownership coefficient as a function of parameters, these predictions do not have a clear correspondence with the reduced-form empirical methods we employ. We therefore do not offer tests that measure correlations between common ownership and innovation in a broad cross-section or time-series of the data, but focus on fixed-effect panel regressions instead. The results we obtain should therefore not be interpreted as globally valid relations between common ownership and innovation; instead, we aim to provide locally valid estimates that help understand to which extent small variations in common ownership change innovation inputs and outputs, and to which extent the intuition gained from the model is useful for understanding patterns in the data.

To be clear about what we are testing, however, we state the empirical null hypothesis as:

- *H0: Common ownership has no effect on innovation activity.*

By contrast, the alternative hypotheses are:

- *H1: Common ownership has a non-zero effect on innovation activity.*
- *H1-spilltec: The correlation between common ownership and innovation increases with the level of technological spillovers.*
- *H1-spillsic: The correlation between common ownership and innovation increases with the level of product market spillovers.*

B Baseline Empirical Methodology

In our first set of analyses, we estimate, for each of the four outcome variables (R&D inputs as well as three innovation output measures) how innovation depends on common ownership conditional on the industry structure (as measured by HHI and HHI^2), the size of the firm, capital intensity, and age. (All these variables are computed as previously defined in section IV.) Formally, the baseline regression is

$$Innovation_{ijt} = \beta \cdot CO_{ijt} + \gamma_1 \cdot HHI_{jt} + \gamma_2 \cdot HHI^2_{jt} + \gamma_3 \cdot X_{ijt} + \sum_x \gamma_x \cdot \eta_x + \varepsilon_{ijt}$$

where firms are indexed by i, industries by j, and years by t, and β is the coefficient of interest. X_{ijt} is the vector of control variables $logmef_{ijt}$, $logkl_{ijt}$, $logage_{ijt}$. η_x with $x \in \{i, j, t\}$ are firm industry, and year fixed effects. CO$_{ijt}$ measures to which extent the largest and most powerful shareholders of firm i are also beneficial owners of other firms that are connected to firm i. Firms can be connected either because they benefit from any innovation activities of firm i, and/or because they are natural competitors of firm i. Standard errors are clustered at the firm level.

Because we are interested in how the common ownership coefficient β depends on technological spillovers between firms, we conduct these regressions separately for three "buckets" of the lowest, medium, and highest tercile of spillover levels (indexed 1, 2, and 3). To give a sense on how results depend on the (inherently imperfect) industry classifications, we report each set of regressions for each of three alternative industry definitions: SIC (CRSP), SIC (Compustat), and NAICS codes.

C Baseline Empirical Results

C1 Common Ownership, Innovation, and Technology Spillovers

We begin our analysis by examining the impact of common ownership and technology spillovers on innovation inputs (R&D expenses) as the outcome variable. Table 2 Panel A reports the results for XRDFNEW, the level of inflation-adjusted R&D expenditures, using the value-weighted measure of common ownership. Throughout all of our specifications which distinguish between different levels of technological spillovers as well as three separate industry definitions common ownership is positively associated with R&D expenditures, even after differencing out industry-fixed, time-fixed, and firm-fixed level effects. Furthermore, in accordance with our theoretical analysis the positive relation between common ownership and R&D is increasing in the degree of technological spillovers: depending on the industry definition, common ownership in the middle and top tercile of technology spillovers has roughly double and quadruple the correlation with R&D expenditures as in the bottom tercile. Formally, the results in this panel reject the empirical null hypothesis, and provide support for the alternative hypotheses *H1* and *H1-spilltec*. (We test hypothesis H1-spillsic later.)

We now turn to the relation between common ownership and innovation outputs. Table 2 Panel B reports the results for logTcw, the citation-weighted value of patents held by a firm. The results here are less statistically significant, but point in the same direction. Common ownership continues to be associated with higher innovation activity, but only significantly so for firm-year observations in the highest SPILLTEC tercile. In other words, the bright side of common ownership only manifests when the co-owned entities are sufficiently close in technology space. Hence, whereas we can reject *H0* in favor of *H1* only for the SIC(Compustat) and NAICS industry definitions and/or only for the high-SPILLTEC tercile, there is weak support for *H1-spilltec* throughout, as judged by the difference in point estimates across SPILLTEC categories.

Similar patterns emerge in Table 2 Panel C and D which report the impact of common ownership on the total stock market value of patents and the total number of patents respectively. More specifically, the total stock market value of patents common ownership is consistently positively related to innovation. The correlation is also greater when technology spillovers increase. In contrast, for the total number of patents the innovation-enhancing effect of common ownership only consistently exists in the higher-spilltec terciles. The point estimates increase across SPILLTEC buckets, however, so the common ownership effect is significantly more pronounced when technology spillovers are higher.

Taken together this evidence points towards a positive relationship between innovation and common ownership both for innovation inputs and outputs and particularly when there are large technology spillovers – *H0* is rejected in favor of *H1* and *H1-spilltec.*

C2 Common Ownership, Innovation, Technology and Product Market Spillovers

Figure I takes our analysis one step further by investigating how the above results differ across various categories of product market spillovers. The figure reports the coefficient on common ownership from regressions similar to those reported above, but does so separately for nine subsets of the data. The subsets arise from splitting the data into terciles across the SPILLSIC (columns) and SPILLTEC (rows) dimensions. Comparing coefficients in the same row across the three tercile columns allows us to investigate the impact of product market spillovers on the relationship between common ownership and innovation. Moving across the three rows in a given column illustrates the effect of technology spillovers on the relationship between common ownership and innovation. As before, we use both innovation inputs and outputs as outcome variables.

C2.1 Innovation Inputs

We first examine the comparative statics across SPILLTEC buckets, that is by comparing coefficient estimates across rows. For R&D expenditures, technology spillovers increase the innovation-enhancing effect of common ownership at all levels of product market spillovers, as predicted by the theory. As before, the estimated coefficients are substantially larger for medium and high than for low technology spillovers. However, this effect is particularly pronounced for high product market spillovers where the estimated coefficients increase from 15.47 to 118.6 for SIC (CRSP), 17.12 to 103.5 for SIC (Compustat) and 17.43 to 106.2 for NAICS. There is no significant effect of common ownership on innovation for firms that are located in the medium or high SPILLTEC and low to medium SPILLSIC terciles. Some point estimates are even negative. When interpreting these results, the reader should note that a lower level of significance in this figure compared to the tables presented earlier are significantly greater, given that the sample is cut in three.

So far, the predictions are broadly consistent with the theoretical predictions. Interestingly, however, there is no evidence for the innovation-reducing effect of common ownership due to business stealing. To the contrary, higher product market spillovers seem to be associated with a more positive relationship between common ownership and R&D expenditures. In short, more commonly-owned firms spend more on R&D when technology spillovers are greater *and* when product market spillovers are greater. But do these firms also *obtain more* innovation outputs from these expenditures?

C2.2 Innovation Outputs

Broadly speaking, the association between common ownership and innovation seems to be somewhat weaker for the innovation output measures than for the input measure discussed above, as judged by the fraction of significantly positive correlations in the lower nine matrices presented in the Figure, compared to the upper three. The null hypothesis cannot be rejected in a majority of cases. However, on average, the effect still seems to be positive. Moreover, the broad pattern persists that the positive association between common ownership and innovation is greater for higher levels of technology spillovers. Most interestingly, however, there is also some evidence for alternative hypothesis *H1-spillsic*, namely that the innovation-enhancing effect of common ownership decreases with the level of product market spillovers: moving across columns (representing SPILLSIC terciles), the estimated coefficients on common ownership tend to be lower for the "high" category. This is most clearly the case for all industry definitions and innovation output measures in the low technology spillover tercile.

C3 Discussion

Taken together, we find fairly strong support for the model's predictions that (i) there is an effect of common ownership on innovation and that (ii) the innovation-enhancing effect of common ownership increases with the level of technology spillovers. The story is more complicated for the comparative statics with respect to product market spillovers, however: whereas more commonly-owned firms seem to spend more money on R&D in markets with greater levels of product market spillovers, these expenditures do not seem to get translated into innovation outputs in an effective way. To the contrary, innovation outputs are less related to common ownership the higher the level of product market spillovers. Hence, given how inefficient the greater R&D expenditures seem to be spent, there is unlikely to be a business stealing effect from these resources spent.

VI Conclusion

In this paper we showed that, in theory, common ownership of within-industry competitors can increase incentives to innovate when technological spillovers are sufficiently large and product market spillovers are sufficiently low. On the other hand, common ownership can also decrease innovation because common owners find business stealing between commonly owned companies undesirable. The ambiguity in theoretical predictions thus poses an interesting empirical question about the sign and magnitude of the average effect of common ownership on innovation. We then used our theoretical model's predictions to investigate how the relationship between common ownership and innovation depends on the relative strength of technological and product market spillovers.

Empirically, we found that common ownership has a positive effect on innovation input and output when innovation spillovers to other firms are relatively large compared to the firms' distance in the product market.

These findings inform an active debate on whether welfare-enhancing effects of common ownership outweigh the previously empirically documented negative effects of common ownership on firms' incentives to compete. Given that a positive effect on innovation which we model as an efficiency increase in this paper, is a necessary condition for common ownership to positively affect welfare, our findings are a necessary ingredient in the argument against regulatory interventions in the common ownership debate. A more subtle insight, however, is that the cross-sectional differences across industries in our findings suggest that antitrust policy with respect to common ownership (as recently discussed by Posner et al. (2016)) may benefit from targeting some industries more intensely than others. Anti-competitive effects of common ownership are likely mitigated or even outweighed in the presence of substantial technological spillovers.

These recommendations are subject to various caveats and limitations of our study, however. So far, our empirical work only shows correlation evidence but not identification of the predicted effects of common ownership on innovation. Establishing a causal link is subject to ongoing work.

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Tables

Table 1. Summary Statistics for Key Variables.
We report distributional characteristics of our key variables, conditioning on the sample without missing SPILLSIC. Variable definitions are given in section IV.

Variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Innovation Variables					
xrdfnew	36065	141.57	379.42	0.00	1895.71
logTcw	20633	2.85	1.62	0.69	7.16
logTsm	20633	2.75	2.38	0.03	8.83
logfNpats	20633	2.22	1.49	0.69	6.34
fNpats (Number of Patents)	6502	36.49	91.16	1.00	568.00
Spillovers (Bloom et al. Variables)					
Log_gspilltec	36118	10.73	1.05	6.18	12.93
Log_gspillsic	36118	9.69	1.63	1.77	12.77
Firm Characteristics					
logkl	35518	3.45	0.94	0.26	6.90
logmef	35920	6.01	2.18	1.27	10.57
logage	36118	2.64	1.00	0.00	4.23
Industry Concentration Measures					
HHI (rank-transformed)	32752	0.31	0.28	0.00	1.00
Firm level Common Ownership Measures					
Original					
EW_CO5	34693	0.0270	0.0229	0.0004	0.0998
VW_CO5	34693	0.0341	0.0295	0.0001	0.1286
$HJL1\_ew$	34515	0.0302	0.0249	0.0001	0.1001
$HJL2\_ew$	34515	3.7235	3.0866	0.0142	11.9286
Rank-transformed					
EW_CO5	34693	0.5013	0.2894	0.0012	1.0000
VW_CO5	34693	0.5010	0.2891	0.0019	1.0000
$HJL1\_ew$	34515	0.5026	0.2891	0.0012	1.0000
$HJL2\_ew$	34515	0.5024	0.2886	0.0012	1.0000

Table 2. Common Ownership and Innovation as a Function of Technological Spillovers – Baseline Results.
The table shows regressions represented by equation B. Standard errors are clustered at the firm level. Variable definitions are given in section IV.

	Panel A: xrdfnew								
Industry definition	SIC(CRSP)			SIC(Compustat)			NAICS		
SPILLTEC tercile	low	med	high	low	med	high	low	med	high
CO	14.33***	32.62**	52.47**	12.26***	30.18**	46.92**	12.00***	28.72**	45.58**
	(3.326)	(2.406)	(2.525)	(3.842)	(2.440)	(2.334)	(3.884)	(2.297)	(2.234)
HHI	3.403	93.77**	-181.5	27.13	60.87	131.7	10.17	167.5*	36.04
	(0.277)	(2.073)	(-1.483)	(0.747)	(1.342)	(0.972)	(0.619)	(1.768)	(0.260)
HHI2	-1.438	-148.6*	221.3*	-25.76	-60.82	-145.9	-12.47	-170.0**	-36.15
	(-0.141)	(-1.859)	(1.759)	(-0.798)	(-1.377)	(-1.207)	(-0.749)	(-2.106)	(-0.269)
logmef	7.440***	24.73***	54.63***	7.468***	23.75***	53.84***	7.513***	24.54***	53.80***
	(4.250)	(3.312)	(5.473)	(4.010)	(2.992)	(5.682)	(4.238)	(3.004)	(5.592)
logkl	5.772**	-0.649	49.01***	5.131**	-1.964	43.48**	4.917**	-0.655	43.86**
	(2.504)	(-0.0607)	(2.602)	(2.483)	(-0.197)	(2.502)	(2.565)	(-0.0653)	(2.467)
logage	-1.334	13.39	33.51**	0.458	14.64	34.20**	0.680	14.60	33.27**
	(-0.317)	(0.853)	(2.096)	(0.142)	(1.137)	(2.387)	(0.214)	(1.073)	(2.192)
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of gvkeyn	784	902	783	783	916	808	778	912	804
Observations	8,407	8,420	8,403	9,058	9,053	9,042	8,932	8,947	8,930
R-squared	0.129	0.083	0.192	0.142	0.069	0.173	0.145	0.072	0.176

Table 2. Common Ownership and Innovation as a Function of Technological Spillovers – Baseline Results.
The table shows regressions represented by equation B. Standard errors are clustered at the firm level. Variable definitions are given in section IV.

	Panel B: logTcw								
Industry definition	SIC(CRSP)			SIC(Compustat)			NAICS		
SPILLTEC tercile	low	med	high	low	med	high	low	med	high
CO	0.103*	0.134*	0.184**	0.0604	0.107	0.203**	0.0567	0.103	0.187**
	(1.735)	(1.879)	(2.283)	(0.937)	(1.639)	(2.561)	(0.912)	(1.598)	(2.334)
HHI	-0.702*	0.124	0.333	0.0809	0.313	0.361	-0.587	0.473	-0.0938
	(-1.883)	(0.382)	(0.776)	(0.211)	(0.935)	(0.645)	(-1.249)	(1.311)	(-0.167)
HHI2	0.775**	-0.113	-0.159	-0.0109	-0.239	-0.259	0.662	-0.386	0.0125
	(2.179)	(-0.322)	(-0.359)	(-0.0280)	(-0.707)	(-0.472)	(1.394)	(-0.994)	(0.0231)
logmef	0.108***	0.0600**	0.135***	0.0991***	0.0683***	0.154***	0.0944***	0.0659**	0.155***
	(3.456)	(2.215)	(4.165)	(3.458)	(2.589)	(4.933)	(3.368)	(2.530)	(4.843)
logkl	0.163***	0.0646	0.0163	0.158***	0.0554	0.0239	0.157***	0.0510	0.0238
	(2.937)	(1.257)	(0.216)	(2.988)	(1.032)	(0.330)	(2.979)	(0.960)	(0.325)
logage	0.0719	0.195***	0.486***	0.0961	0.221***	0.468***	0.0779	0.219***	0.474***
	(0.959)	(3.470)	(6.902)	(1.370)	(4.155)	(7.089)	(1.092)	(3.963)	(7.075)
Firm-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of gvkeyn	777	757	551	793	779	579	783	780	573
Observations	4,903	4,902	4,894	5,260	5,252	5,242	5,193	5,194	5,181
R-squared	0.073	0.058	0.190	0.068	0.057	0.183	0.070	0.060	0.182

Table 2. Common Ownership and Innovation as a Function of Technological Spillovers – Baseline Results.
The table shows regressions represented by equation B. Standard errors are clustered at the firm level. Variable definitions are given in section IV.

	Panel C: logTsm								
Industry definition	SIC(CRSP)			SIC(Compustat)			NAICS		
SPILLTEC tercile	low	med	high	low	med	high	low	med	high
CO	0.303***	0.303***	0.324***	0.255***	0.280***	0.327***	0.253***	0.284***	0.322***
	(4.895)	(4.572)	(4.192)	(3.993)	(4.502)	(4.333)	(4.075)	(4.609)	(4.223)
HHI	-0.363	-0.276	-0.0417	-0.177	0.0923	0.477	-0.644	-0.156	-0.0964
	(-1.103)	(-0.944)	(-0.121)	(-0.402)	(0.281)	(1.115)	(-1.407)	(-0.438)	(-0.227)
HHI2	0.363	0.318	0.208	0.0903	-0.0830	-0.264	0.666	0.337	0.153
	(1.151)	(0.982)	(0.618)	(0.206)	(-0.252)	(-0.658)	(1.495)	(0.949)	(0.351)
logmef	0.557***	0.539***	0.693***	0.545***	0.537***	0.713***	0.542***	0.531***	0.709***
	(15.68)	(18.44)	(21.32)	(16.97)	(18.75)	(22.58)	(17.38)	(18.72)	(21.85)
logkl	0.166***	0.189***	0.223***	0.147***	0.161***	0.225***	0.146***	0.158***	0.221***
	(3.324)	(3.532)	(4.133)	(2.881)	(2.888)	(4.221)	(2.870)	(2.849)	(4.091)
logage	0.0426	0.147**	0.382***	0.0595	0.166***	0.360***	0.0462	0.151***	0.359***
	(0.612)	(2.237)	(6.846)	(0.905)	(2.723)	(6.822)	(0.694)	(2.658)	(6.751)
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of gvkeyn	777	757	551	793	779	579	783	780	573
Observations	4,903	4,902	4,894	5,260	5,252	5,242	5,193	5,194	5,181
R-squared	0.498	0.499	0.653	0.486	0.488	0.650	0.490	0.492	0.650

Table 2. Common Ownership and Innovation as a Function of Technological Spillovers – Baseline Results.
The table shows regressions represented by equation B. Standard errors are clustered at the firm level. Variable definitions are given in section IV.

	Panel D: logfNpats								
Industry definition	SIC(CRSP)			SIC(Compustat)			NAICS		
SPILLTEC tercile	low	med	high	low	med	high	low	med	high
CO	0.110**	0.108*	0.217***	0.0611	0.0918	0.227***	0.0575	0.0880	0.211***
	(2.027)	(1.705)	(2.733)	(1.033)	(1.577)	(2.889)	(1.025)	(1.528)	(2.657)
HHI	-0.485	0.0991	0.0999	0.0241	0.360	0.493	-0.549	0.219	0.116
	(-1.558)	(0.341)	(0.234)	(0.0611)	(1.104)	(0.890)	(-1.359)	(0.684)	(0.215)
HHI2	0.501	-0.0175	0.0934	-0.0237	-0.292	-0.390	0.605	-0.113	-0.291
	(1.637)	(-0.0551)	(0.215)	(-0.0576)	(-0.896)	(-0.733)	(1.400)	(-0.330)	(-0.553)
logmef	0.0913***	0.0353	0.111***	0.0817***	0.0406*	0.131***	0.0777***	0.0379*	0.133***
	(3.475)	(1.485)	(3.491)	(3.334)	(1.805)	(4.245)	(3.283)	(1.711)	(4.187)
logkl	0.129***	0.0456	0.0510	0.123***	0.0370	0.0575	0.121***	0.0381	0.0551
	(2.725)	(0.979)	(0.732)	(2.627)	(0.770)	(0.841)	(2.619)	(0.800)	(0.800)
logage	0.0928	0.212***	0.496***	0.111*	0.242***	0.474***	0.0959	0.238***	0.480***
	(1.388)	(3.941)	(7.257)	(1.755)	(4.811)	(7.406)	(1.507)	(4.585)	(7.407)
FirmFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of gvkeyn	777	757	551	793	779	579	783	780	573
Observations	4,903	4,902	4,894	5,260	5,252	5,242	5,193	5,194	5,181
R-squared	0.117	0.099	0.243	0.106	0.098	0.234	0.112	0.101	0.232

Figure I. Common Ownership and Innovation as a Function of Technological Spillovers and Product Market Spillovers.

This table shows the CO (common ownership) coefficient and t-stats of regressions similar to those in Table 2 Panels A-D, whereas the regressions are run separately for subsamples, sorted by terciles of SPILLTEC (distributed vertically) and SPILLSIC (distributed horizontally), for each of the outcome variables (R&D expenses XRDFNEW), citation-weighted patents (logTcw), stock market value of patents (logTsm), and number of patents (logfNpats)), and for each of three industry definitions (SIC CRSP, SIC Compustat, NAICS). Variable definitions are given in section IV.

		Industry def.	SIC CRSP			SIC Compustat			SIC NAICS		
		SPILLSIC level	Low	Medium	High	Low	Medium	High	Low	Medium	High
XRDFNEW	SPILLTEC level	Low	6.543***	28.25	15.47**	6.588***	22.40	17.12**	6.133***	20.88*	17.43***
			3.509	1.619	2.288	3.726	1.636	2.555	3.46	1.706	2.619
		Medium	2.959	8.181	75.31**	4.910	-3.909	78.69***	5.060	-4.708	74.59**
			0.508	0.979	2.19	1.128	-0.444	2.696	1.325	-0.534	2.454
		High	21.26	47.60	118.6***	34.50	33.96	103.5***	35.14	34.67	106.2***
			0.722	1.207	3.668	1.016	0.959	3.408	1.016	0.911	3.388
logTcw	SPILLTEC level	Low	0.231***	0.0747	0.0193	0.106	0.107	-0.106	0.118	0.0952	-0.0602
			2.81	0.779	0.135	1.189	1.156	-0.762	1.427	1.023	-0.413
		Medium	-0.0376	0.0140	0.0601	-0.0244	0.0281	0.0698	-0.00869	0.0141	0.0460
			-0.257	0.193	0.495	-0.186	0.388	0.616	-0.0643	0.197	0.415
		High	0.232	0.107	0.154*	0.388**	0.0629	0.169*	0.371*	0.0610	0.152*
			1.457	0.831	1.684	2.016	0.524	1.901	1.805	0.5	1.653
logTsm	SPILLTEC level	Low	0.292***	0.195*	0.211*	0.208***	0.171	0.139	0.202***	0.166	0.144
			3.661	1.666	1.695	2.591	1.465	1.159	2.628	1.48	1.225
		Medium	0.0809	0.117	0.173	0.158	0.105	0.175	0.179	0.0963	0.163
			0.686	1.455	1.301	1.42	1.246	1.391	1.626	1.128	1.306
		High	0.382***	0.160	0.208**	0.424**	0.164	0.185**	0.393**	0.151	0.196**
			2.77	1.297	2.414	2.612	1.459	2.22	2.342	1.344	2.317
logfNpats	SPILLTEC level	Low	0.226***	0.0704	0.152	0.123	0.0835	-0.0191	0.123*	0.0768	0.00308
			3.182	0.793	1.498	1.579	0.921	-0.187	1.71	0.876	0.029
		Medium	0.0224	-0.0472	0.0413	0.0491	-0.0246	0.0598	0.0670	-0.0522	0.0408
			0.165	-0.76	0.377	0.398	-0.386	0.612	0.526	-0.818	0.415
		High	0.193	0.121	0.235***	0.338**	0.0968	0.235***	0.309*	0.0874	0.219**
			1.386	0.986	2.619	2.028	0.862	2.724	1.837	0.764	2.455