COMMON OWNERSHIP AND CORPORATE INNOVATION STRATEGY

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Abstract

It is empirically challenging to test the effect of common ownership on corporate innovation as the observed impact of common ownership on corporate innovation is a net effect due to two offsetting powers: technological spillover and market stealing. This paper tends to mitigate that issue by investigating the impact of common ownership on the strategic features of corporate innovation. We analyze the effect of common ownership on corporate innovation activities using stacked difference-in-differences analyses based on events of financial institutional mergers and acquisitions. We find no significant effect of common ownership on research and development (R&D) expenditures, patent applications, and citations, whereas we find a positive effect of common ownership on exploitative innovation strategy. Our findings suggest that the weak market-stealing effect of exploitative innovation incentivizes common owners to encourage a higher weight of exploitative innovation among innovation outputs. Our study contributes to the current literature in three ways. First, it provides new evidence of the anti-competitive effect of common ownership. Second, it empirically examines competing theoretical predictions of common ownership impacts on corporate innovation. Third, it identifies common ownership as one of the determinants for variations of innovation strategy.

Keywords: Corporate Ownership, Financial Institutions, Corporate Innovation

Authors' individual contribution: Conceptualization — X.C., S.G., and T.H.S.; Methodology — X.C., S.G., and T.H.S.; Formal Analysis — X.C.; Writing — X.C.; Visualization — X.C.

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1. INTRODUCTION

Studies on institutional common ownership are booming, whereas the effects of common ownership on corporate innovation activities are still controversial. Chiao et al. (2021) find that common ownership of rivals deters corporate innovation, while other studies suggest that common ownership may have a positive or negative effect on corporate innovation based on the structure of the market (Antón et al., 2021) or type of institutional investors (Borochin et al., 2020). It is difficult to get a consistent and robust empirical result because, theoretically, the observed impact of common ownership on corporate innovation is a net effect due to two offsetting powers: technological spillover and market stealing (Bloom et al., 2013; Antón et al., 2021). As a result, common owners debate on whether innovation helps add value to the portfolio: on the one hand, innovation is beneficial to the portfolio value, as the innovators in the same portfolio could more easily access the innovation outputs from others; on the other hand, innovation may lead to new products and more intensive market competition, thereby leading to a lower portfolio value.

Our study aims to mitigate the empirical challenge by investigating the impact of common ownership on the strategic features of corporate innovation. Corporate innovation output can be categorized into two distinct strategies: exploration and exploitation. Exploration requires new knowledge, while exploitation is based on existing knowledge. The two innovation strategies have different effects on new product initiation and market entry (Balsmeier et al., 2016). Exploration positively affects new products and market developments, which leads to costly promotions and price wars with incumbents, whereas exploitation does the opposite. These two categories of innovation strategies help disentangle the confounding effects of technological spillover and market stealing: the market stealing effect is minimal for exploitation.

Our analyses show that the increments of common ownership have no significant effect on corporate research and development (R&D) investment, patent applications, and patent citations. Instead, common ownership significantly relates to an increased percentage of exploitative patents. We further identify the relationship between common ownership and innovation strategy with an event study based on financial institutional mergers and acquisitions, and the results still hold. Our findings suggest that the common holding of competitors' equities encourages peaceful exploitative innovation but suppresses destructive exploratory innovation.

Regarding empirical methodology design, the panel regressions test the association between common ownership and corporate innovation activities at the firm-year level. To mitigate the confounding effects of other factors, we control determinants for corporate innovation documented in other literature (e.g., capital-labor ratio, firm age), firm-fixed effects for unobservable potential factors, and time-fixed effects for confounding time trends. The standard errors are clustered at the industry level in case that potential industry-level shock make firm-level innovation activities correlate with each other within the industry. For robustness tests, we construct the measure of common ownership based on different industry identifications (i.e., two-digit SIC, and text-based industry classification). We find consistent results that common ownership has no significant associations with R&D, the number of patent applications, and the average citations received, but is significantly related to innovation strategy.

To further exclude reverse causality between common ownership and innovation activities, we run difference-in-differences (DiD) regressions based on 40 mergers and acquisitions (M&As) of financial institutions from 1992 to 2006. M&As of financial institutions lead the acquirers to hold more firms in their portfolio, thereby causing mechanical increments of common ownership. The M&As of financial institutions are not likely to be mainly driven by the purpose of affecting corporate innovation activities and strategies; thus, they can be used as plausibly exogenous shocks for common ownerships. We follow Azar et al.'s (2018) method to identify the treated group by checking the *ex-ante* implied changes of common ownership for each firm. We follow Gormley and Matsa's (2011) method to stack the data sample of multiple events so that the results are not biased by observations treated by other events before/after the event of interest. The results of DiD are consistent with the panel regressions. To validate the results of DiD analyses, we also implement placebo tests to check the parallel trend assumption.

The contributions of our findings are threefold. First, it echoes current studies on the anti-competitive effect of common ownership (Azar et al., 2018; Azar et al., 2022). Enhanced exploitative innovation caused by increments of common ownership indicates that institutional shareholders prefer to enjoy a quiet life with fewer new product launches and market entries. Second, it empirically tests the theories about the effects of common ownership on corporate innovation. Theoretical studies (López & Vives, 2017; Antón et al., 2021) predict that the direction of common ownership impacts on corporate innovation is not constant but depends on the tradeoff between internalization of technological spillovers and market stealing effects. Our study empirically demonstrates that common ownership can significantly improve the type of innovation with minimal market-stealing effects. Third, it also contributes to innovation literature by identifying common ownership as one of the determinants for variations of corporate innovation strategy.

The paper proceeds as follows. Section 2 discusses the related literature and develops the hypotheses for this study. Section 3 reviews the data sample, explains the constructions of variables, and presents descriptive statistics of the variables. Section 4 presents the empirical methodologies and results. Section 5 discusses the results. Section 6 concludes the paper.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Literature review

A long list of theoretical literature has implied the negative effect of common ownership on competition (e.g., Bresnahan & Salop, 1986; Reynolds & Snapp, 1986; Gordon, 2003; Azar, 2017). Recent empirical studies provide evidence on that in banking and airline industries (Azar et al., 2018; Azar et al., 2022) and suggest that common ownership could affect market competition indirectly by influencing financial policies and corporate governance (e.g., Schmalz, 2018; Antón et al., 2023). Evaluation of the common ownership's effects on corporate innovation activities is another important channel to test its impact on market competition, as corporate innovation has long been recognized as essential for corporate competitive advantages and sustainable growth (Porter, 1992).

The literature on the determinants of corporate innovation is voluminous (see He & Tian, 2018). The variation of ownership structure is one of the drivers for corporate innovation changes (e.g., Brav et al., 2018; Chemmanur et al., 2023; Kostovetsky & Manconi, 2020). This paper examines a more general form of ownership measurement, i.e., institutional common ownership within the industry, which includes both passive and active institutional investors' holdings to construct the variables. Past empirical studies about institutional impacts on corporate innovation imply that diversified portfolio holdings could improve corporate innovation by internalizing the technological spillovers between firms in the same portfolios. However, theoretical studies predict that the direction of common ownership effect on innovation is not constant. López and Vives (2017) argue that common ownership can increase a firm's incentives to increase innovation only when spillover effects are high enough. Antón et al. (2021) further predict that the direction of common ownership effect on corporate innovation depends on the tradeoff of technological spillovers and business-stealing effects. It is thus an empirical question to answer what the net effect of common ownership on corporate innovation is.

It is empirically challenging to test the effects of common ownership on corporate innovation because the two offsetting effects of technological spillover and market stealing are confounded. Chiao et al. (2021) find that common ownership deters corporate innovation, while other studies find that whether common ownership has a positive or negative effect on corporate innovation depends on the structure of markets (Antón et al., 2021) and the types of institutional investors (Borochin et al., 2020). Our study works in a different way to mitigate the empirical challenge by investigating the strategic features of corporate innovation output, as these categories of innovation strategies help disentangle the technological spillover and market stealing effects. In particular, different types of innovation strategies have different effects on market competition. Balsmeier et al. (2016) find that exploratory innovation leads to commercial success by initiating new products and acquiring more market shares, while exploitative innovation has the opposite effect, thereby leading to a minimal market-stealing effect. Therefore, our study on innovation strategies, especially the exploitative strategy, can plausibly exclude the confounding market-stealing effect.

Borochin et al. (2020) also study the effects of common ownership on innovation strategy as one of their additional tests. Their analyses are in different subsamples based on market competition levels and the types of financial institutions. Our paper studies the overall sample with complete analyses, including robustness checks and identification tests, to test the common ownership effect on innovation strategy, and provides insight into its implication for anti-competitive effects due to common ownership.

2.2. Hypotheses development

Theoretical studies (Antón et al., 2021; López & Vives, 2017) predict that the direction of common ownership impacts on corporate innovation is based on the net effects of internalization of technological spillover and market cannibalization. In particular, under common ownership with the presence of technological spillovers, innovation in one firm not only generates benefits for itself but also for technologically connected firms owned by the same shareholders. It motivates the shareholders to encourage corporate innovation and between-firm communication. However, cost reductions and output increments caused by innovation can steal market share and profits away from competitors. When a shareholder owns innovative competitors, the business stealing effect will disincentivize innovation in portfolio firms.

Therefore, when the internalization of technological spillovers has a similar magnitude as the business stealing effects, the positive and negative effects on corporate innovation will offset each other. Under that situation, we hypothesize that:

$H1_0$: Common ownership has no significant net effect on corporate innovation.

When the internalization of technological spillovers has a stronger effect than the business stealing effects, the alternative hypothesis will be:

H1a: Common ownership has a positive net effect on corporate innovation.

When the business stealing effects dominate, the alternative hypothesis will be:

H1b: Common ownership has a negative net effect on corporate innovation.

Two main strategies of innovation are exploration and exploitation. Exploratory innovation requires new knowledge to meet the needs of emerging markets, which takes a longer time to realize payoffs and is of higher uncertainty. In contrast, exploitative innovation improves existing technology to satisfy current customers, which is faster to realize payoffs and less risky. Balsmeier et al. (2016) show consistent results that exploration leads to new products and increment in market shares. In comparison, exploitation improves existing products and services, which helps to maintain current customers and stabilize the current market structure. Because of exploratory (exploitative) innovation's strong (weak) market-stealing effects, common owners tend to suppress exploration but encourage exploitation. We therefore hypothesize that:

H2: Common ownership increase (decrease) corporate exploitative (exploratory) innovation.

3. DATA AND SAMPLE OVERVIEW

3.1. Data sources

The National Bureau of Economic Research (NBER) patent database[1] as of 2010 provides annual patent-level information from 1976 to 2006. The relevant variables are constructed based on information on the patent assignee (the entity, such as the firm that owns the patent), the patent's application and grant year, the number of citations received by the patent, and the patents cited by each patent.

Firm-level accounting data and market prices are obtained from the CRSP/Compustat Merged database on Wharton Research Data Services (WRDS). The information about mergers and acquisitions of financial institutions, including announcement date, effective date, acquirer, and target name, is accessible in Capital IQ. Ownership data is collected from the Thomson-Reuters Institutional Holdings (13F) Database[2], which provides institutional common stock holdings and transactions, as reported on Form 13F filed with the SEC. It includes all US holdings of publicly traded firms by institutional investors that managed

[1] https://sites.google.com/site/patentdataproject/Home
[2] A limitation of this dataset is that holdings of individual owners are unobservable. Inspection of proxy statements of all firms in particular industries such as airlines and banking suggest that the stakes individual shareholders own in large publicly traded firms are rarely significant enough to substantially alter the measure of common ownership concentration at industry level (Antón et al., 2021).

more than \$100 million from 1980. We only keep the fund families with holdings of at least 0.5% for each firm based on the assumption that the institutional shareholders with less than 0.5% ownership of a company have no significant control of the company's management (Azar et al., 2018).

3.2. Variable construction

3.2.1. Innovation

The inputs to corporate innovation activities are generally measured by annual R&D expenditures. For the missing values of R&D, we replace them with zero. We scale the R&D with total assets to make it more comparable between firms of different sizes.

The output of innovation activities can be captured by the number of patent applications at the firm-year level. The innovation literature generally considers the new patents on the application date instead of the grant date. Hall et al. (1984) empirically show the simultaneity between patent application and R&D investment, while there is, on average, a 2-year lag between patent application and its eventual grant.

The quality of innovation activities can be measured by the number of subsequent lifetime citations. The main limitation of this measure is the truncation issues. First, a patent starts to get citations after the grant date instead of the application date, and there is a significant delay in between. Second, the new patents, in general, get fewer citations even though they are essentially more influential than the aged patents because it takes time to accumulate the citations. Hall et al. (2001) construct a patent-level "weight factor" to reflect the accumulations of citations for different types of patents throughout their lifetime. The factor has become the standard procedure to adjust the number of citations in empirical studies on corporate innovation.

A firm's innovation strategy can be measured by the extent to which the new patents are exploratory or exploitative. This proxy is proposed by Manso (2011) and further extended by Almeida et al. (2013) and Custódio et al. (2019). A patent is considered exploitative if at least 80% of its citations are based on the existing knowledge of the firm, whereas a patent is exploratory if at least 80% of its citations are based on new knowledge. Existing knowledge includes all the patents that the firm invented and all the patents that were cited by the firm's patents filed over the past five years. The two categories are not exhaustive. Following other empirical studies on innovation strategy (e.g., Gao et al., 2014; Brav et al., 2018), we construct the percentage of exploitative/exploratory new patents among all the applications of new patents at the firm-year level. The ratio of exploitation/exploration is indicative of whether a firm's innovative strategy relies heavily on existing knowledge or focuses on exploring new technologies.

3.2.2. Common ownership

We use the firm-level C-index as a measure of common ownership, which has been employed by Lewellen and Lowry (2021). Specifically, for a given institutional investor of a firm, we first calculate the product of the fractional ownership by the institution in the firm and the ownership by the institution in peer firms and then take the sum of these products across all institutions that hold shares in the firms. In particular, for a pair of firms j and k, we can get the firm-pair level cross-ownership measure as below:

$$\sum_{i=1}^{I} \beta_{ij}\beta_{ik} \tag{1}$$

where, i denotes the institutions that are holding both firms j and k, I denotes the number of the institutions that are holding both firms j and k, and β_{ij} is the percentage of all shares of firm j held by shareholder i. For a given firm j, we then consider all its peers within the industry, and get C-index as the weighted average of all the cross-ownership measures for firm j and its peers:

$$C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik} \tag{2}$$

where, k denotes all the other firms in the same industry with firm j, K denotes the number of peers within the industry, w_k represents the weight of each rival firm k among the peers based on its market capitalization. The industry is classified by three-digit SIC codes from CRSP. For robustness tests, the C-index is also constructed based on two-digit SIC and 10K-text-based industry classifications of Hoberg and Phillips (2016)[3].

It is obvious that the value of the C-index increases when β increases. In general, the value of the C-index increases 1) when the number of common owners increases within the industry, and 2) when each common owner holds more firms in the portfolio. Tables A.1 and A.2 in Appendix A provide numeric examples to demonstrate these features of C-index.

3.2.3. Control variables

When the common owners fully share firms' equities within the industry, the increment of the number of common owners within the industry will lead to a mechanical decrease of ownership fraction for each shareholder, and a smaller C-index (see Table A.3 in Appendix A). Therefore, the value of C-index can be confounded with the ownership structure of each firm. In particular, when there are a lot of institutional shareholders in a firm, each institutional shareholder's ownership will be diluted, and the C-index for this firm can be small. We follow He et al. (2019) to control the number of blockholders and the total percentage of institutional holdings for each firm to mitigate the confounding effects of ownership structure changes.

We control frequently used variables in other literature on innovation (e.g., Atanassov & Liu, 2020), including firm age, firm size, capital-to-labor ratio (K/L), leverage, tangibility, and profitability. We also control the Herfindahl-Hirschman index (HHI) at the industry level for the potential confounding effects of industry market concentration on corporate innovation.

[3] http://hobergphillips.usc.edu/. Hoberg and Phillips (2016) group firms with their own set of competitors by constructing time-varying product similarity measures based on text-based analysis of product descriptions in the 10K files.

3.3. Sample overview

We get 1,222,790 fund family-firm-year level observations from the 13F dataset to construct the C-index for each firm from the year 1980 to 2006 and then merge all the databases described in subsection 3.1 to form the master database with firm-year level observations. We exclude the firms in financial (SIC = 6), utilities (SIC = 49), and public sectors (SIC = 9) and all the innovation inactive firms. The innovation inactive firms are those that have no R&D expenditure or no patent applications throughout the entire sample period. The data sample in our study covers 27,772 firm-year level observations for 27 years from 1980 to 2006. We winsorize all the fundamental accounting variables at a 1% level. Table 1 reports summary statistics for the key variables used in the analysis.

Table 1. Summary statistics of the main variables

Variables	*N*	*Mean*	*St. Dev.*	*p1*	*Median*	*p99*
Fund family-firm-year level						
β	1222790	0.023	0.029	0.005	0.013	0.132
Firm-year level						
C-index	27772	0.002	0.002	0	0.001	0.011
RD/AT	27772	0.085	0.107	0	0.049	0.621
#new patent	27772	11.499	33.79	0	1	238
ave. citation	27772	12.313	16.03	0	7.588	86.068
ln(1 + #new patent)	27772	1.203	1.359	0	0.693	5.476
ln(1 + ave. citation)	27772	1.725	1.463	0	2.15	4.467
exploit%	27772	0.147	0.269	0	0	1
explore%	27772	0.312	0.386	0	0	1
%inst. holding	27772	0.389	0.25	0.014	0.365	0.932
ln(1 + #blockholders)	27772	0.702	0.561	0	0.693	1.792
ln(firm age)	27772	2.35	0.973	0	2.485	3.97
ln(K/L)	27300	3.439	0.88	1.564	3.348	6.035
ln(market value)	27772	5.504	1.986	1.669	5.315	10.837
leverage	27772	0.171	0.165	0	0.139	0.699
tangibility	27762	0.241	0.16	0.012	0.213	0.72
profitability	27713	0.077	0.202	-0.879	0.124	0.39
Industry-year level						
HHI	3104	0.218	0.224	0.001	0.145	0.924

C-index is the proxy of common ownership defined by $C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}$, where k denotes all the other firms in the same industry with firm j, K denotes the number of peers within the industry, w_k represents the weight of each rival firm k among the peers based on its market capitalization, i denotes the institutions that are holding both firm j and k, I denotes the number of the institutions that are holding both firm j and k, β_{ij} is the percentage of all shares of firm j held by shareholder i. The industry is classified by three-digit SIC codes from CRSP. *RD/AT* is R&D scaled by total assets. *#new patent* is the number of patent applications at the firm-year level. *Ave. citation* is the average subsequent citation for each patent at the firm-year level. The number of citations is truncation adjusted following Hall et al. (2001). explore% is the percentage of exploratory patents at the firm-year level. *exploit%* is the percentage of exploitative patents. *%inst. holding* is the total percentage of institutional holdings for each firm. *ln(1 + #blockholders)* is the natural logarithm of one plus the number of blockholders for each firm. Firm age is calculated by the current year minus the "birth year" of the firm, which is the earlier of the IPO year or the first year when it appears in the Compustat dataset. *K/L* is the capital-labor ratio measured by the net value of property, plant, and equipment (PPE) divided by the number of employees. *MV* is the market value. *Leverage* is measured by total debt divided by total assets. *Tangibility* is measured by net PPE divided by total assets. *Profitability* is measured by earnings before interest, depreciation, taxes, and amortization (EBITDA) divided by total assets. *HHI* is the Herfindahl-Hirschman index constructed based on firm market values within each three-digit SIC.

C-index in our data sample has a mean of 0.2%, a standard deviation of 0.2%, a 1st percentile of 0%, and a 99th percentile of 1.1%. In Table 2, we show three firms in our data sample with different C-indexes in the same industry (SIC = 283, Drugs) in the year 2000. This industry altogether has 203 firms in the year 2000. Balchem Corp has a C-index of 0.03%, which has 3 common owners that are holding 95 peer firms. ViroPharma has a C-index of 0.21%, which has 14 common owners that are holding 186 peer firms. Sepracor Inc. has a C-index of 1.1%, which has 28 common owners that are holding 175 peer firms. The values of C-indexes increase as the number of common owners and/or the number of peers in common owners' portfolios increase. It is consistent with the patterns in the numeric examples in Appendix A.

Table 2. Examples of firms with different C-indexes

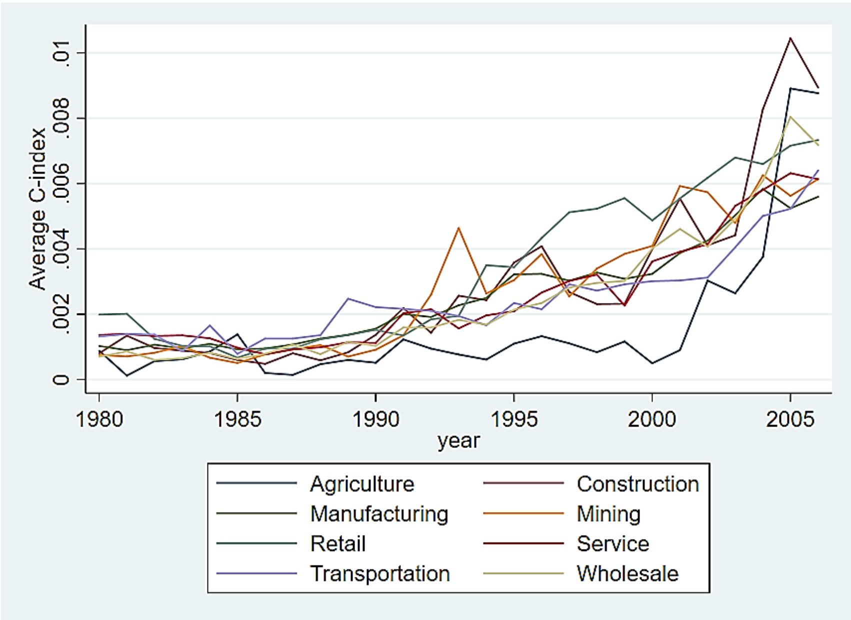
C-index	*Company*	*#com. owners*	*#com held peers*	*Ave. beta*	*Ave beta com held peers*
0.03%	Balchem	3	95	2.4%	2.3%
0.21%	ViroPharma	14	186	3.0%	2.6%
1.1%	Sepracor	28	175	2.4%	2.0%

Firm-level C-index can be further aggregated across all firms in an industry to form an industry-level C-index:

$$Industry\ level\ C\_Index = \sum_{j=1}^{J} w_j \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}. \quad (3)$$

where, k, K, i, I, and w_k are defined the same as those in firm-level C-index. J denotes the number of all the firms within the industry, and w_j is the weight of firm j among all the firms in the industry based on market capitalization. We first generate the industry-level C-index at the level of three-digit SIC and then generate the equally weighted average of the industry-level C-index for eight sectors. The eight sectors are defined by two-digit SIC: 01–09 Agriculture; 10–14 Mining; 15–17 Construction; 20–39 Manufacturing; 40–48 Transportation; 50–51 Wholesale; 52–59 Retail; 70–89 services. The average C-indexes for the eight sectors from the year 1980 to 2006 are displayed in Figure 1. There are increasing trends for all the eight sectors' C-indexes, especially after the year 1990. The values of average C-indexes are different across sectors: Agriculture has the lowest C-index for most of the time, whereas industries such as Retail and Mining have relatively high C-indexes.

Figure 1. Cross-sectional and time-series variation of C-index by industry



4. EMPIRICAL METHODOLOGY AND RESULTS

4.1. Panel regressions and results

We run panel regressions to test the relations between corporate innovation activities and common ownership. The main regressions take the following form:

$$Innovation_{i,t} = \beta_0 + \beta_1 \cdot C\ Index_{i,t-1} + \beta_2 \cdot X_{i,z,t-1} + \alpha_i + \alpha_t + \epsilon_{i,t} \quad (4)$$

where, i denotes firm, z denotes industry, and t denotes year. $Innovation_{i,t}$ denotes different corporate innovation variables discussed in subsection 3.2.1 at the firm-year level, including corporate innovation input measured by R&D scaled by total assets, the quantity of corporate innovation output measured by the natural logarithm of new patent applications, the quality of corporate innovation output measured by the natural logarithm of average subsequent citations, and the fractions of exploratory/exploitative patents. $C\ Index_{i,t-1}$ denotes the measure of common ownership, C-index discussed in subsection 3.2.2 at the firm-year level. $X_{i,z,t-1}$ denotes all the control variables at the firm-year level and industry-year level, including the total fraction of institutional holdings, the natural logarithm of the number of blockholders, the natural logarithm of firm age, the natural logarithm of capital-labor ratio, the natural logarithm of market value, leverage, tangibility, profitability, and HHI. All explanatory variables are lagged one year to mitigate simultaneity. α_i denotes the firm fixed effects, which control for any observable or unobservable heterogeneity across firms that are potentially influential to innovation activities (e.g., the corporate culture that encourages innovation). The firm fixed effects enable us to rule out differences in corporate innovation activities and firm attributes as potential explanations for our results. α_t denotes the year fixed effects. The year-fixed effects rule out spurious associations between common ownership and corporate innovation activities due to their aggregate time trends. Standard errors are clustered at the industry level in case variations of firm-level innovation activities are correlated within industries because of industry-level technological innovation shocks or technological collaboration with peer firms in the industry.

Table 3 presents the regression results. Column 1 displays that there is no significant relation between common ownership and corporate innovation inputs measured by scaled R&D. Instead, the fraction of institutional holdings and the number of blockholders are significantly related to corporate innovation inputs. It implies that the ownership structure rather than the common ownership is influential to corporate innovation inputs. Columns 2 and 3 show that common ownership is neither significantly related to the number of corporate innovation outputs measured by the number of new patent applications nor to the quality of innovation output measured by average subsequent citations. However, Columns 4 and 5 demonstrate that common ownership is significantly positively related to the fraction of exploitative innovation, and significantly negatively related to the fraction of exploratory innovation. It implies that rather than affecting the inputs and outputs of corporate innovation, common ownership has a stronger impact on corporate innovation strategy. Based on the estimated coefficients of the C-index in regressions in Columns 4 and 5, on average, one standard deviation change (i.e., 0.2%) of the C-index is related to a 1.2% increase in exploitative innovation ratio and a 1% decrease of exploratory innovation ratio.

Table 3. Results of panel regressions: Common ownership and corporate innovation

Variables	*(1)* *RD/AT*	*(2)* *ln(1 + #new patent)*	*(3)* *ln(1 + ave. citation)*	*(4)* *exploit%*	*(5)* *explore%*
C-index	-0.102	-5.866	7.971	6.191***	-4.848**
	(0.491)	(0.479)	(0.259)	(0.000)	(0.013)
%inst. holding	-0.021***	-0.035	-0.061	-0.040	0.026
	(0.000)	(0.708)	(0.562)	(0.133)	(0.392)
ln(1 + #blockholders)	0.002*	-0.006	0.009	0.001	0.004
	(0.094)	(0.744)	(0.705)	(0.706)	(0.423)
ln(firm age)	-0.000	0.204***	-0.056*	0.026***	0.015
	(1.000)	(0.000)	(0.068)	(0.000)	(0.128)
ln(K/L)	-0.008***	0.012	0.057	0.012***	-0.009
	(0.000)	(0.774)	(0.109)	(0.010)	(0.329)
ln(market value)	-0.004***	0.212***	0.137***	0.019***	0.012**
	(0.005)	(0.000)	(0.000)	(0.000)	(0.012)
leverage	-0.041***	-0.021	0.043	0.036*	-0.040*
	(0.000)	(0.848)	(0.752)	(0.072)	(0.054)
tangibility	0.078***	0.157	-0.102	-0.013	0.061
	(0.004)	(0.415)	(0.501)	(0.676)	(0.185)
profitability	-0.079***	-0.290***	-0.121	-0.073***	0.034
	(0.000)	(0.000)	(0.224)	(0.001)	(0.237)
HHI	-0.013*	-0.077	-0.418*	0.010	-0.081
	(0.079)	(0.535)	(0.093)	(0.686)	(0.248)
Constant	0.136***	-0.432	0.983***	-0.055	0.233***
	(0.000)	(0.129)	(0.000)	(0.102)	(0.000)
Firm FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
Observations	23,885	23,885	23,885	23,885	23,885
R-squared	0.813	0.803	0.506	0.379	0.323

*Note: The numbers in parentheses are p-values. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.*

C-index is the proxy of common ownership defined by $C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}$, where k denotes all the other firms in the same industry with firm j, K denotes the number of peers within the industry, w_k represents the weight of each rival firm k among the peers based on its market capitalization, i denotes the institutions that are holding both firm j and k, I denotes the number of the institutions that are holding both firm j and k, β_{ij} is the percentage of all shares of firm j held by shareholder i. The industry is classified by three-digit SIC codes from CRSP. The dependent variables are *RD/AT*, *ln(1 + #new patent)*, *ln(1+ ave. citation)*, *exploit%*, and *explore%*. RD/AT is R&D scaled by total assets. It measures corporate inputs. *ln(1 + #new patent)* is the natural logarithm of one plus the number of new patent applications. It measures the quantity of corporate innovation outputs. *ln(ave. citation)* is the natural logarithm of one plus average subsequent citations. It measures the quality of corporate innovation outputs. *exploit%* is the percentage of exploitative patents, and *explore%* is the percentage of exploratory patents. These two ratios demonstrate whether corporate innovation strategy focuses on existing knowledge or exploring new technologies. *%inst. holding* controls the total fraction of institutional holdings. *ln(1 + #blockholders)* is the natural logarithm of one plus the number of blockholders. Firm and year fixed effects are controlled. Standard errors are clustered at the industry level.

According to Antón et al.'s (2021) theory, the findings in Columns 1 to 3 have two possible implications: 1) the effects of technological spillover internalization are offset by the effects of market stealing, or 2) both effects do not work. However, the significant relationship between common ownership and innovation strategy implies that both effects work. Exploratory innovation is more likely to initiate new products (Balsmeier et al., 2016) and thus have stronger market stealing effects, whereas exploitative innovation is more "peaceful" and focuses on maintenance and improvements of existing products and services, which mainly has technological spillover effects. The market stealing effects of exploratory innovation could motivate common owners to suppress explorations and encourage exploitations of their holding firms to optimize their portfolio value. Overall, our results in Table 3 show that innovation-active firms with more institutional shareholders holding more peers within the industry are more likely to focus on exploitative patents rather than exploratory patents in their innovation strategies. This finding is consistent with

Antón et al.'s (2021) theory predicting that the effects of common ownership on corporate innovation are based on the dynamics between internalization of technological spillovers and market stealing effects.

4.2. Robustness tests and results

We implement several robustness tests for the results in subsection 4.1. We use the C-index based on three-digit SIC as a proxy of common ownership. However, it is possible that technological spillovers and market stealing effects could go beyond the boundary of industry defined by three-digit SIC to a wider market. Here, we construct a C-index based on two-digit SIC and redo the regressions in subsection 4.1. Table 4 displays similar results as those in Table 3. The relations between C-index and corporate innovation inputs and outputs are still insignificant. The direction of the association between C-index and exploitation/exploration ratio is the same as that in Table 3. The magnitudes and significances of the estimated coefficient of C-index on the exploitation/exploration ratio even improve.

Table 4. Results of robustness tests: C-index based on two-digit SIC

Variables	*(1) RD/AT*	*(2) ln(1 + #new patent)*	*(3) ln(1 + ave. citation)*	*(4) exploit%*	*(5) explore%*
C-index	0.022	-16.554	0.371	8.608***	-7.838***
	(0.931)	(0.167)	(0.959)	(0.000)	(0.000)
%inst. holding	-0.022***	0.013	-0.040	-0.048	0.030
	(0.000)	(0.904)	(0.778)	(0.134)	(0.482)
ln(1 + #blockholders)	0.001	-0.006	0.014	0.002	0.007
	(0.139)	(0.774)	(0.538)	(0.584)	(0.136)
ln(firm age)	0.000	0.197***	-0.055**	0.026***	0.015*
	(0.973)	(0.000)	(0.023)	(0.001)	(0.076)
ln(K/L)	-0.008***	0.019	0.062	0.013***	-0.007
	(0.000)	(0.718)	(0.141)	(0.001)	(0.511)
ln(market value)	-0.004***	0.211***	0.137***	0.017***	0.014**
	(0.002)	(0.000)	(0.000)	(0.003)	(0.011)
leverage	-0.040***	-0.032	0.026	0.031	-0.047**
	(0.000)	(0.828)	(0.871)	(0.167)	(0.016)
tangibility	0.075***	0.149	-0.135	-0.011	0.059
	(0.002)	(0.569)	(0.381)	(0.729)	(0.218)
profitability	-0.078***	-0.283***	-0.121	-0.065***	0.029
	(0.000)	(0.000)	(0.184)	(0.002)	(0.289)
HHI	-0.027*	-0.284	-0.615	-0.055	-0.092
	(0.079)	(0.195)	(0.365)	(0.497)	(0.656)
Constant	0.132***	-0.436*	0.941***	-0.043**	0.212***
	(0.000)	(0.096)	(0.000)	(0.044)	(0.001)
Firm FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
Observations	24,686	24,686	24,686	24,686	24,686
R-squared	0.815	0.803	0.505	0.377	0.321

*Note: Firm and year fixed effects are controlled. Standard errors are clustered at two-digit SIC level The numbers in parentheses are p-values. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.*

In addition to the C-index based on two-digit SIC, we also construct the C-index based on the 10K-text-based industry classifications of Hoberg and Phillips (2016). The industries of some conglomerate firms are hard to be described by SIC codes. Moreover, firms within an industry defined by SIC do not have to be competitors, while some of them supplement each other (e.g., SIC 282: Plastics Materials and SIC 283: Drugs). The industry classification named FIC developed by Hoberg and Phillips (2016) is based on the similarity of textual descriptions of products in 10K files. It can more accurately categorize firms as different groups of competitors based on the attributes of their products. Table 5 presents the results for regressions on the FIC300[17] C-index. Since the FIC codes are only available from the year 1996, the regressions are based on a subsample of firm-year observation for 11 years until the year 2006. In Table 5, common ownership is significantly related to innovation inputs measured by scaled R&D and quantity of innovation outputs measured by the number of new patent applications. However, since the significances lack robustness, we cannot claim that the negative directions imply that the market stealing effects could be stronger than the internalization of technological spillovers. The directions of relations between common ownership and innovation strategy measures are consistent with those in Tables 3 and 4. And the estimated coefficient of exploitation ratio keeps the 1% level significance. These findings provide additional evidence for the robust relationship between common ownership and innovation strategies.

[17] Hoberg and Phillips (2016) provides seven different industry classification codes: FIC25, FIC50, FIC100, FIC200, FIC300, FIC400, and FIC500. FIC300 categorizes firms in market into 300 industry groups.

Table 5. Results of robustness tests: C-index based on FIC300

Variables	(1) RD/AT	(2) ln(1 + #new patent)	(3) ln(1 + ave. citation)	(4) exploit%	(5) explore%
C-index	-0.676**	-23.588***	6.396	4.577***	-1.406
	(0.049)	(0.001)	(0.494)	(0.008)	(0.492)
%inst. holding	-0.012*	0.205	-0.287*	0.020	-0.053
	(0.051)	(0.126)	(0.071)	(0.537)	(0.152)
ln(1 + #blockholders)	-0.001	-0.023	0.077	-0.003	0.023*
	(0.711)	(0.470)	(0.146)	(0.695)	(0.061)
ln(firm age)	-0.011**	0.140*	-0.402***	0.010	-0.067***
	(0.031)	(0.087)	(0.000)	(0.530)	(0.000)
ln(K/L)	-0.002	-0.067	0.052	0.012	0.003
	(0.668)	(0.315)	(0.489)	(0.202)	(0.862)
ln(market value)	-0.012***	0.121***	0.112***	0.003	0.014**
	(0.001)	(0.000)	(0.004)	(0.697)	(0.024)
leverage	-0.053***	-0.014	-0.198	-0.003	-0.015
	(0.000)	(0.937)	(0.188)	(0.951)	(0.666)
tangibility	0.080**	0.369	-0.675**	-0.076	0.023
	(0.011)	(0.125)	(0.030)	(0.432)	(0.760)
profitability	-0.075***	-0.045	-0.083	-0.083***	0.056
	(0.003)	(0.717)	(0.443)	(0.002)	(0.214)
HHI	-0.018*	0.172**	0.080	0.011	0.023
	(0.062)	(0.038)	(0.510)	(0.608)	(0.353)
Constant	0.220***	0.303	2.038***	0.113**	0.325***
	(0.000)	(0.482)	(0.000)	(0.033)	(0.000)
Firm FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
Observations	9,636	9,636	9,636	9,636	9,636
R-squared	0.808	0.823	0.546	0.445	0.383

*Note: Firm and year fixed effects are controlled. Standard errors are clustered at the FIC300 level. The numbers in parentheses are p-values. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.*

Overall, we use different methods to construct common ownership and innovation variables. Most of the robustness tests show that common ownership measures are not significantly associated with innovation inputs and outputs, whereas are consistently and significantly related to innovation strategy.

4.3. Identification and results

The results of panel regressions in subsections 4.1 and 4.2 provide evidence of the association between common ownership and corporate innovation strategy. However, these findings cannot exclude the possibility of reverse causality. It is possible that common owners intentionally search for and invest in firms with the tendency to lower explorations and/or increase exploitation in their innovation strategies. These firms could adjust their innovation strategies for reasons other than variations of common ownership. Therefore, we design an event study based on financial institution mergers and acquisitions (M&As) to verify the causality between variations of common ownership and innovation strategy changes.

We use M&As of financial institutions as plausibly exogenous shocks for common ownership. M&As of financial institutions let the acquirers hold more firms in their portfolios, thereby leading to a mechanical increment of common ownership for the firms in portfolios of acquirers and targets. This experiment design satisfies the exclusion condition. The reasons for financial institutional M&As are complex but are not likely to be mainly driven by the intentions to affect corporate innovation activities and strategies. In addition, we collect multiple events to test the average effects of the shocks. Even if some of the M&As could be mainly driven by purposes for affecting the corporate innovation of portfolio firms, they cannot have significant impacts on the overall average result. Thus, there are limited endogeneity issues for using financial institutions' M&As to study corporate innovation.

We follow He and Huang (2017) to find the events of financial institutional mergers and acquisitions in 15 years from 1992 to 2006 from the Capital IQ dataset. The selection requirements are as follows:

- The merger is between two 13F institutions (or their parent firms) in the financial sector (with primary SIC codes in the 6000 to 6999 range) and was announced during the period between 1992 and 2006;
- The merger is completed within one year after the initial announcement;
- The target institution stops filing 13F forms within one year after the completion of the deal.

Altogether, we collect 40 events from year 1992 to 2006. To exclude the impacts of events before the year 1992, we also find the events from 1983 to 1991. The names of acquirers and targets, announcement dates, and effective dates are listed in Appendix B.

We follow Azar et al.'s (2018) method to identify the treated group by checking the ex-ante implied changes of common ownership for each firm. First, we calculate the counterfactual C-index in the year before the announcement year of M&As as if the M&As had already happened at that time. Then, the differences between the counterfactual C-indexes and real C-indexes are defined as "implied changes in C-index" (*Δ*C-index). We group the firms based on their *Δ*C-index: the ones in the top tercile of *Δ*C-index are treated firms, and the ones in the bottom tercile of ΔC-index are controlled firms.

Appendix B shows that there have been M&A events in consecutive years. Therefore, the treated firms in the last years may become controlled firms in the current year. However, the treatment effects from the events will last for years; the current control group is likely to be contaminated by previous events. To mitigate the distortions due to consecutive events, we follow Gormley and Matsa's (2011) method to stack the data sample of multiple events. First, we consider each event year separately. A 5-year pre- and post-event window is set around each event year. Any controlled observations that are treated by other events within the window are dropped. A data sample for the specific event year is then constructed, and all the treated and controlled observations in that sample are considered as the same "cohort". Then, we stack all the constructed data samples for different event years into one dataset.

Since the treated firms are exposed to higher common ownership increments due to the financial institutional M&As, we expect that these events will lead the treated firms to have a higher increase in exploitative patent percentage and a higher decrease in exploratory patent percentage. We run the following DiD regression to test our expectations:

$$Innovation_{ict} = \beta_0 + \beta_1 \cdot Treatment_{ic} \times Post_{tc} + X_{ic,t-1} + \alpha_{ic} + \alpha_{tc} + \epsilon_{ict} \quad (5)$$

where, i denotes firm, c denotes cohort, and t denotes year. $Treatment_{ic}$ denotes the dummy for treated firms. $Post_{tc}$ denotes the dummy for post-event periods. $X_{ic,t-1}$ are control variables including firm age and firm size. We intentionally exclude other control variables that are vulnerable to the exogenous common ownership variations. The firm-cohort and time-cohort fixed effects are controlled. Standard errors are clustered at the industry level. The results of the DiD analysis are shown in Table 6. Again, we cannot find a significant relation between innovation inputs/outputs and the interaction term. However, the estimated coefficient of *Treatment*Post* for exploitation percentage is positive and significant at a 1% level, suggesting that the exogenous increment of common ownership due to financial institutional M&As will cause an increment in the percentage of exploitative patents. The mean C-index for the treatment group after the event increases by 0.12%, while the mean C-index for the control group after the event increases by 0.04%. The estimated value of *Treatment*Post* is 0.024. It implies that one standard deviation (0.2%) change in C-index will lead to a 6% increase in the exploitation ratio. The magnitude estimated here is larger than that estimated in subsection 4.1.

Table 6. Results of DiD analysis

Variables	*(1) RD/AT*	*(2) ln(1 + #new patent)*	*(3) ln(1 + ave. citation)*	*(4) exploit%*	*(5) explore%*
*Treatment*Post*	0.001	-0.033	0.009	0.024***	-0.012
	(0.690)	(0.173)	(0.789)	(0.002)	(0.199)
ln(firm age)	0.005	0.064**	-0.159***	0.058***	-0.032**
	(0.280)	(0.030)	(0.000)	(0.001)	(0.011)
ln(market value)	-0.011***	0.120***	0.124***	0.006	0.021***
	(0.000)	(0.000)	(0.000)	(0.267)	(0.002)
Constant	0.147***	0.388***	1.415***	0.009	0.259***
	(0.000)	(0.000)	(0.000)	(0.867)	(0.000)
Firm-cohort FE	Y	Y	Y	Y	Y
Time-cohort FE	Y	Y	Y	Y	Y
Observations	76,730	76,730	76,730	76,730	76,730
R-squared	0.841	0.855	0.578	0.484	0.399

*Note: The firm-cohort and time-cohort fixed effects are controlled. Standard errors are clustered at the industry level. The numbers in parentheses are p-values. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.*

One of the crucial conditions for DiD to hold is the assumption of parallel trends between the treatment and control groups in the pre-event periods. We verify this assumption in two ways. First, we directly compare the average pre-event growth of the exploitative patent percentage and the exploratory patent percentage between treatment and control firms during windows of five years before the events. The results are presented in Table 7. The large p-values reject the hypothesis that the mean growths in the control and treatment groups are the same.

Table 7. Results of parallel trend tests

Mean growth of	*Control*	*Treatment*	*Difference*	*p-value*
exploit%	0.016	0.016	0	0.958
explore%	-0.009	-0.006	-0.003	0.641

Second, we implement placebo tests to check pre-event trends. We use the third year before events as the "pseudo-event" period and redo the DiD analysis during the five-year pre-event window symmetrically around the "pseudo-event" year. The results are presented in Table 8. The interaction terms between the treatment dummy and the post-period dummy are insignificant. We also use the fourth year before events as the "pseudo-event" year and also get insignificant interaction terms. The results help to rule out the potential existence of pre-event trends.

Table 8. Results of Placebo tests

Variables	*(1) explore%*	*(2) exploit%*
*Treatment*Pseudo Post*	0.009	0.003
	(0.322)	(0.585)
Constant	0.327***	0.144***
	(0.000)	(0.000)
Firm-cohort FE	Y	Y
Time-cohort FE	Y	Y
Observations	50,267	50,267
R-squared	0.435	0.529

*Note: Firm-cohort and time-cohort fixed effects are controlled. Standard errors are clustered at the industry level. The numbers in parentheses are p-values. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.*

Overall, the results based on the event study show that an increase in common ownership induced by financial institutions M&As leads to a higher percentage of exploitative innovation in firms' patent output. Since the variation of common ownership due to financial institutions M&As is plausibly exogenous, and we also rule out potential pre-event trends, the findings allow us to get closer to a causal interpretation of the positive relation between common ownership and corporate innovation strategy. It suggests that our main results are unlikely to be driven by omitted time-varying factors that influence both common ownership and corporate innovation strategy.

5. DISCUSSION OF THE RESULTS

It is empirically difficult to test the effect of common ownership of competitors on corporate innovation because, in theory, the technological spillover effect and market stealing effect may offset each other. We cannot find robust significant associations between common ownership and measures of innovation input and output, which provides an ambiguous implication: either common ownership have no significant impact on innovation activities, or the technological spillover effect and market stealing effect do offset each other. Our following tests for innovation strategy as the outcome of interest demonstrate robust significance. The findings eventually help us answer the question: Yes, common ownership does significantly affect corporate innovation. The insignificance of measures of innovation input and output is due to the offset of the technological spillover effect and market stealing effect. The robust significance of innovation strategy, especially exploitative strategy, is because exploitative innovation strategy has little market-stealing effect. The results also provide new evidence for the anti-competitive effect of common ownership: Common owners tend to encourage peaceful exploitative innovation and suppress exploratory innovation that could lead to new products and market entry.

To construct the measure of common ownership of competitors, a crucial step is to identify the firms in the same industry. Studies about common ownership use different ways to classify the industries but do not explain why (e.g., Lewellen & Lowry, 2021 use 3-digit SIC; He & Huang 2017; Borochin et al., 2020 use 4-digit SIC). Among these different types of industry codes, the 10-k text-based code developed by Hoberg and Phillips (2016) is better as it measures the similarity between products. In contrast, as we discussed in subsection 4.2, SIC fails to categorize conglomerate companies and sometimes even incorporates upstream and downstream firms rather than rivals in the same group. We use 3-digit SIC in my baseline regressions and try 2-digit SIC and 10-K text-based classification in robustness tests. The direction, magnitude, and statistical significance vary for coefficients of some innovation variables when using different industry classifications, which implies that different industrial classifications may completely alter the analysis results. However, other studies often ignore to test the robustness of their results based on different industry identifiers.

Lewellen and Lowry (2021) examine different empirical designs to identify the effects of common ownership. They find that the frequently used event study method, i.e., the Blackrock-BGI merger during 2008–2009, is problematic as the impact of the financial crisis is confounded with the impact of the merger. A better way is to use a broad set of financial institutional mergers outside of the 2008–2009 period. Our identification strategy exactly follows this way. However, this method is still not perfect as multiple events spread out in each year, and effects from multiple events may convolute with each other. To further mitigate this concern, we construct stacked event samples by dropping observations affected by other events (Gormley & Matsa, 2011). The drawback of a stacked sample is the reduction of sample size.

The institutional equity holding data to construct common ownership variables is from the Thomson-Reuters Institutional Holdings (13F) database. Multiple studies have expressed concerns about the data quality. For example, Anderson and Brockman (2016) examine the data sample from 2008 to 2012 and claim "significant reporting errors," including incorrectly reported holdings and market prices. Although the data sample in our study ends in 2006, we cannot exclude the potential issues reported by Anderson and Brockman (2016). Despite the potential issues, the 13F database is still the most widely used financial institutional holding data as it covers most of the companies back to 1980.

6. CONCLUSION

This study empirically examines theoretical predictions of common ownership effects on corporate innovation. We show that common ownership is not significantly associated with R&D, patent quantity, and patent quality, but is significantly related to the percentage of exploitative/exploratory innovation. Our findings suggest that the market-stealing effect of exploratory innovation potentially reduces the value of common owners' portfolios. Therefore, common holders tend to suppress exploratory innovation but encourage exploitative innovation. This finding provides new evidence for the anti-competitive effect of common ownership.

There are some potential limitations of this study. First, the identification strategy based on financial institutional mergers can be influenced by other simultaneous events (e.g., financial crisis). Although we try to mitigate the concern by using a broad set of mergers outside of the 2008–2009 period, the consecutive events may still influence each other. Second, the Thomson-Reuters Institutional Holdings (13F) database, the data we use to construct the common ownership variables, may have some potential reporting mistakes.

It is still a developing area to investigate the impact of common ownership on corporate innovation activities. Future studies may look into the potential channels through which common owners can influence innovation performance and study the relationships other than competitors (e.g., suppliers and customers, creditors and debtors) in the portfolios. Because of the potential reporting errors in the Thomson-Reuters Institutional Holdings (13F) database, scholars can try to use other financial institutional holding databases to revisit this topic.

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APPENDIX A. THE FEATURES OF C-INDEX VALUE

In a hypothetical industry, there are three firms and three institutional investors. Noticing that institutional investors are not the only shareholders, we do not have to assume the institutions share all firm equity. Here, we assume all βs equal 2%, which is the average value of β in our data sample. Assuming each common owner holds only two firms and all the firms in the industry have the same market capitalization, Table A.1 shows how the values of C-indexes change when the number of common owners changes. In the first row of Table A.1, each institution solely holds a different firm. In the second row of Table A.1, Institution 1 is holding both Firm 1 and Firm 2, whereas both Institutions 2 and 3 are holding different firms. In the third row of Table A.1, both Institutions 1 and 2 are holding two firms, and Institution 3 is only holding Firm 3. In the last row of Table A.1, all three institutions are holding two firms. Table A.1 demonstrates that the values of C-indexes for all firms increase as the number of common owners increases in the hypothetical industry.

Table A.1. C-index for different numbers of common owners in the industry

This table displays the values of the C-index for each firm when the number of common owners within hypothetical industry changes. There are three institutional shareholders and three firms in this industry. All three firms have the same market capitalization. β_{ij} denotes the percentage of ownership of institutional investor i in firm j. The C-index for firm j is defined as $C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}$, where I denotes the number of institutional investors in the industry, K denotes the number of peers to firm j within the industry, and w_k is the weight of firm k among all the peers to firm j based on peer firms' market capitalizations.

β_{11}	β_{12}	β_{13}	β_{21}	β_{22}	β_{23}	β_{31}	β_{32}	β_{33}	#Com. owners	$Cindex_1$	$Cindex_2$	$Cindex_3$
2%	0%	0%	0%	2%	0%	0%	0%	2%	0	0	0	0
2%	2%	0%	0%	2%	0%	0%	0%	2%	1	0.02%	0.02%	0
2%	2%	0%	0%	2%	2%	0%	0%	2%	2	0.02%	0.04%	0.02%
2%	2%	0%	0%	2%	2%	2%	0%	2%	3	0.04%	0.04%	0.04%

In another hypothetical industry, there are two institutional investors and four firms. We still assume all βs equal 2% and all the firms in the industry have the same market capitalization. Table A.2 shows how the values of C-indexes change when the number of firms in each common owner's portfolio changes. In the first row of Table A.2, Institution 1 is holding Firms 1 and 2, and Institution 2 is holding Firms 3 and 4. In the second row of Table A.2, Institution 1 is holding Firms 1, 2, and 3, and Institution 2 is holding Firms 2, 3, and 4. In the third row of Table A.2, both institutions are holding all four firms. As the number of firms in each shareholder's portfolio increases, the values of C-indexes for all the firms increase.

Table A.2. C-index for different numbers of firms in portfolios

This table displays the values of C-indexes for each firm when the number of firms in each common owner's portfolio changes. There are two institutional shareholders and four firms in this industry. All four firms have the same market capitalization. β_{ij} denotes the percentage of ownership of institutional investor i in firm j. The C-index for firm j is defined as $C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}$, where I denotes the number of institutional investors in the industry, K denotes the number of peers to firm j within the industry, and w_k is the weight of firm k among all the peers to firm j based on peer firms' market capitalizations.

β_{11}	β_{12}	β_{13}	β_{14}	β_{21}	β_{22}	β_{23}	β_{24}	#Port. firms	$Cindex_1$	$Cindex_2$	$Cindex_3$	$Cindex_4$
2%	2%	0	0	0	0	2%	2%	2	0.013%	0.013%	0.013%	0.013%
2%	2%	2%	0	0	2%	2%	2%	3	0.026%	0.052%	0.052%	0.026%
2%	2%	2%	2%	2%	2%	2%	2%	4	0.08%	0.08%	0.08%	0.08%

However, if common owners fully share the equities of the firms within the industry, the fraction of ownership for each institutional investor will mechanically decrease when the number of common owners increases. Assuming a hypothetical industry, in which there are two firms and institutional shareholders equally share all the ownership of each firm, Table A.3 shows the values of the C-index of firm j when the number of common owners increases. As the number of common owners in the industry increases, the values of C-indexes decrease.

Table A.3. C-index for common owners fully sharing ownership of portfolio firms

This table displays the values of C-indexes for each firm when the number of common owners within the industry changes. There are two firms in this industry. The common owners equally share all the equities of the firms in the industry. Both firms have the same market capitalization. β_{ij} denotes the percentage of ownership of institutional investor i in firm j. The C-index for firm j is defined as $C\ index_j = \sum_{k=1}^{K} w_k \sum_{i=1}^{I} \beta_{ij}\beta_{ik}$, where I denotes the number of institutional investors in the industry, K denotes the number of peers to firm j within the industry, and w_k is the weight of firm k among all the peers to firm j based on peer firms' market capitalizations.

#Com. owners	$\beta_{i1}, \forall i$	$\beta_{i2}, \forall i$	$Cindex_j$, j = 1,2
50	2%	2%	2%
100	1%	1%	1%
200	0.5%	0.5%	0.5%
1000	0.1%	0.1%	0.1%

APPENDIX B. MERGERS AND ACQUISITIONS AMONG FINANCIAL INSTITUTIONS

This table reports the mergers and acquisitions of financial institutions from 1990 to 2006 studied in our paper. Following He and Huang (2017), the selection requirements are as follows: 1) The merger is between two 13F institutions (or their parent firms) in the financial sector (with primary SIC codes in the 6000 to 6999 range) and announced during the period between 1990 and 2006. 2) The merger is completed within one year after the initial announcement. 3) The target institution stops filing 13F forms within one year after the completion of the deal. The announcement date, effective date, acquirers, and targets are listed below.

Announcement date	*Effective date*	*Acquirer*	*Target*
12/3/2006	7/2/2007	Bank of NY Trust	Mellon Bank
10/31/2006	12/4/2006	Morgan Stanley	FrontPoint
5/19/2005	8/4/2005	Transamerica Invt Mgmt	WestCap Investors
8/26/2004	1/31/2005	BlackRock	StateStreet Research & Mgmt
5/26/2004	1/3/2005	Wells Fargo & Co	Strong Capital MGMT, Inc.
10/27/2003	4/1/2004	Bank of America	Fleet Boston
8/26/2003	8/26/2003	Wells Fargo & Co	Benson Associate
10/18/2000	2/14/2001	Allianz Dresdner	Nicholas-Applegate
10/25/2000	4/10/2001	Franklin Resources	Fiduciary Trust Intl
9/13/2000	12/31/2000	JP Morgan & Co	Chase Manhattan
6/20/2000	10/2/2000	AXA Financial	Sanford C Berstein
3/14/1999	10/1/1999	Fleet Boston Corporation	BankBoston Corp
2/15/1999	7/6/1999	Credit Suisse Asset Mgmt	Warburg Pincus Asset Mgmt
7/20/1998	12/31/1998	SunTrust Banks Inc.	CRESTAR BANK
4/13/1998	9/30/1998	NationsBank Corp	BankAmerica Corp
4/6/1998	10/8/1998	TRAVELERS INC	Citicorp
11/5/1997	12/1/1997	Pimco Advisors LP	Oppenheimer & Co LP
3/20/1997	8/1/1997	First Bank System Inc.	U S Bancorp
1/20/1997	5/20/1997	Mellon Bank Corporation	Ganz Capital Mgmt Inc
12/30/1996	6/2/1997	Banc One Corporation	Liberty Bancorp Inc.
9/6/1996	12/12/1996	First Union Corporation	Keystone Invt Mgmt Co
7/10/1996	10/31/1996	LGT Asset Mgmt Inc.	Chancellor Capital Mgmt
6/25/1996	11/1/1996	Franklin Resources Inc.	Heine Securities Corp
8/7/1995	2/16/1996	First Bank System Inc.	FirsTier Financial Inc.
6/19/1995	1/2/1996	First Union Corporation	First Fidelity Bancorp
6/16/1995	6/16/1995	TCW Group Inc	Continental Asset Mgmt
4/13/1995	8/30/1995	Barclays Bank Plc	Wells Fargo Nikko Investment
2/21/1995	11/30/1995	Fleet Financial Group Inc.	Shawmut Natl Corp
11/28/1994	4/12/1995	KeyCorp	Spears Benzak Salomon
3/6/1994	6/30/1994	First Union Corporation	Evergreen Asset Mgmt
11/3/1993	8/15/1994	Banc One Corporation	Liberty Natl B&T/Louisvl
10/18/1993	7/1/1994	First Union Corporation	Lieber & Co
9/20/1993	5/31/1994	Marshall & Ilsley Corp	Valley Trust Co/Wisc
11/23/1992	7/22/1993	Equitable Companies Inc.	Alliance Capital Mgmt
9/14/1992	5/21/1993	Mellon Bank Corporation	Boston Company Inc.
9/9/1992	7/13/1993	Bank of Boston Corp	Multibank Financial Corp
3/18/1992	10/15/1992	NBD Bancorp Inc.	INB Financial Corp.
12/30/1991	11/2/1992	Banc One Corporation	Affiliated Bksh/Colorado
9/16/1991	7/23/1992	PNC Financial Corp	First Natl Bank/Penn
7/15/1991	12/31/1991	Chemical Banking Corp.	Manufacturers Hanover Co
5/4/1988	12/26/1988	Boatmen's Bancshares Inc.	Centerre Bancorp
7/31/1987	2/29/1988	PNC Financial Corp	Central Bancorp
4/27/1987	11/1/1987	Sovran Financial Corp	Commerce Union Bank
3/18/1987	1/1/1988	Fleet Finl Group	Norstar Trust Company
6/30/1986	2/27/1987	PNC Financial Corp	Citizens Fidelty Bk & Tr
12/21/1983	7/1/1984	Chase Manhattan Corp	Lincoln First Banks Inc.