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(How) Does Mutual Fund Dual Ownership Affect Shareholder and Creditor Conflict of Interest? Evidence from Corporate Innovation

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Abstract: We examine the impact of mutual fund dual ownership (i.e., simultaneous holdings of stocks and bonds of the same company by mutual fund families) on corporate innovation. Our findings indicate that dual ownership is positively associated with innovation quantity, quality, generality, and originality. This effect is mainly driven by non-index funds, which are more likely to be active monitors. Consequently, both stocks and bonds held by dual owners tend to generate higher returns, particularly for more significant, groundbreaking innovations. These results suggest that mutual fund dual ownership mitigates conflicts of interest between shareholders and creditors, thereby enhancing innovation and firm value. However, the relation between dual ownership and innovation turns negative during the recent financial crisis, suggesting that shareholder-creditor conflicts culminate in extreme financial distress, exacerbating dual holders' risk aversion, and hence, hindering corporate innovation.

Keywords: mutual fund dual ownership; corporate innovation; shareholder-creditor conflicts of interests; financial crisis

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1. Introduction

The purpose of this study is to examine whether and how mutual fund dual ownership impacts corporate innovation by affecting shareholder and debtholder conflicts of interest of the portfolio firms. Mutual funds have long been recognized for their substantial ownership in equity of publicly traded companies in the U.S., and as such, for their critical role in the governance of public companies through voice and/or exit. There has been a nascent trend over the recent years however for mutual fund families to simultaneously hold both stocks and bonds of the same portfolio company (Wang et al. 2021)—henceforth, mutual fund dual holdings and dual ownership refer to the equity ownership in the portfolio company by dual-holding mutual funds. For example, employing a sample of U.S.-based mutual funds during 2009–2013, Keswani et al. (2021) find that two out of five fund families are dual holders. Francis et al. (2022) document an upward trend in mutual fund dual holdings of U.S. publicly traded firms during 2002–2014.

In light of this increasing trend in mutual fund dual holdings, it begs the question of whether and how dual-holding mutual fund families coordinate their decisions on their portfolio firms. In particular, we examine whether such dual holdings can alleviate conflicts of interest between shareholders and bondholders in the sense of Jensen and Meckling (1976) and Myers (1977), and in turn impact corporate investment decisions such as innovation, which is long-term, risky but value-increasing, and highly susceptible to shareholder-bondholder conflicts of interest.

A priori, the answer is ambiguous. In addition to the increasing popularity of mutual fund dual holdings, there is growing literature documenting cross-subsidization and coordination within mutual fund families. Such findings include strategic resource allocation

and performance coordination across individual funds within a fund family in order to maximize the value of the family as a whole (Gaspar et al. 2006; Bhattacharya et al. 2013); co-movement, collaboration and information sharing between equity and bond funds to facilitate equity return forecast and future profits for the entire family (Auh and Bai 2020); a tendency of equity funds from dual-holding families to vote more in agreement with debtholders as the debt a fund family holds in a firm increases (Keswani et al. 2021); an inclination for targets with greater dual ownership to exhibit lower equity premia but higher abnormal bond returns, especially when dual holders benefit more from the appreciation of their bond holdings (Bodnaruk and Rossi 2016); and a capability of mutual fund dual holders to reduce shareholder-debtholder conflicts, alleviate the investee firms' underinvestment in tax avoidance aggressiveness, and mitigate the increased cost of borrowing due to aggressive tax avoidance (Francis et al. 2022). These findings suggest that equity and bond funds may coordinate in their decision-making to maximize the profits of the whole family. In turn, such coordination will likely alleviate conflicts of interest between stockholders and debtholders of the portfolio companies.

Focusing on dual holdings of stocks and syndicated loans by institutional investors other than mutual funds, prior studies show that institutional dual holdings mitigate conflicts of interest between shareholders and debtholders of the portfolio firms and improve corporate decision-making and outcomes. More specifically, dual ownership appears to be associated with lower yield spreads of syndicated loans (Jiang et al. 2010), lower dividend payment (Chu 2018), and lower patent quantity but patents with larger market value (Yang 2021).

However, unlike other institutional investors, mutual funds are subject to several unique attributes that may hinder coordination between individual fund managers and even exacerbate the conflicts of interest between stockholders and debtholders in the portfolio companies. First, mutual fund managers are driven by heightened financial incentives to make profits. They are typically paid management fees proportional to fund size and hence constantly pressured to deliver superior performance to attract investors who often chase (short-term) profits. Fund managers also face extraordinary competition from their peers, even within the same family (e.g., Brown et al. 1996; Kempf and Ruenzi 2007; Schwarz 2011). Second, equity and bond investors may have completely different investment objectives and risk tolerance, and individual fund managers are responsible for the fiduciary duty to their own investors (Goldstein et al. 2017; Greppmair et al. 2020). Finally, mutual funds may have other business relations with their portfolio companies, thereby facing other conflicts of interest that may prevent the coordination among funds, even within the same family. All these features may motivate fund managers to focus on value-maximizing strategies for their own funds rather than for the family. As a result, mutual fund dual holdings might not affect or even exacerbate shareholder-creditor conflicts in the portfolio companies.

Given the mixed arguments, we explore the effect of mutual fund dual holdings on conflicts of interest between stockholders and creditors by focusing on corporate investment decisions. In particular, using a sample of mutual fund families that hold both the stocks and bonds (i.e., dual holders) of U.S. firms during 1995–2010, we examine how dual ownership (defined as the percentage of stocks held by dual holders) affects corporate innovation as proxied by various patent and citations measures.

Firm investment such as innovation is intrinsically subject to shareholder-creditor conflicts of interest (Jensen and Meckling 1976; Myers 1977). These conflicts arise as shareholders, or managers on behalf of shareholders, may undertake actions that maximize shareholder wealth at the expense of creditors, such as overinvestment in risky but value-decreasing projects (i.e., asset substitution) or underinvestment in risky but positive net present value (NPV) projects due to their subordinated cash flow claims (i.e., debt overhang problem). However, shareholder-creditor conflicts of interest can be substantially mitigated if investors hold both the firm's equity and debt securities (Jensen and Meckling 1976; Jensen 1986) because dual holders can internalize the decreases in shareholder value arising

from the underinvestment problems, or the decreases in debtholder value due to asset substitution. And these mitigating effects should be increasing in the equity ownership of dual holders.

We find that dual ownership enhances a firm's future patent quantity and quality as proxied by patent count, citations, generality, and originality. This positive effect is primarily driven by non-index mutual fund dual holders, which are more likely to be active monitors of a firm rather than passive indexers. These results are consistent with the hypothesis that dual ownership promotes both quantity and quality of corporate innovation by mitigating stockholder-bondholder conflicts of interest.

Consequently, we find that both stocks and bonds held by dual owners tend to generate higher returns, particularly for higher quality, higher impact, and more radical breakthrough innovations, and for inventions that have more profound and broader impacts on future innovation (i.e., higher generality and originality scores). These results lend further support to the hypothesis that dual ownership mitigates shareholder-creditor conflicts of interest, thereby reducing overinvestment in marginal and less impactful inventions while encouraging investment in risky, more valuable, higher-impact innovations, thereby creating greater returns for both shareholders and bondholders.

Further investigation shows that the positive relationship between dual ownership and corporate innovation only holds for the normal, non-crisis period of 2003–2006. In contrast, dual ownership is negatively associated with the firm's ability to innovate in the financial crisis period of 2007–2010. These results are consistent with the notion that dual owners suffer extraordinary risk aversion due to their bond holdings during the extremely uncertain, risky crisis period when the trust in corporations, institutions, and the whole economy deteriorates. More specifically, the financial crisis is a period where firms face severe financial distress, which exacerbates the conflicts between shareholders and bondholders, and the degree of alignment provided by dual ownership may be overshadowed by the strong divergence in shareholder and creditor objectives. As a result, dual owners may serve to discourage risk-taking, even those risky, positive NPV projects like patenting innovation (i.e., debt overhang problem). Our evidence suggests that the conflicts of interest between stock- and bond-holders culminate during the financial crisis period, thereby exaggerating dual owners' risk aversion, deterring corporate innovation, and failing to increase shareholder or bondholder values.

Our findings are robust to controlling for additional managerial attributes and board governance variables shown in previous studies to affect innovation (He and Hirshleifer 2022; Griffin et al. 2021; Bolton and Zhao 2022). Finally, our results remain robust after we address potential endogeneity using the dynamic panel General Method of Moments (GMM) estimation.

Our study makes several contributions to the literature. First, we contribute to the nascent literature (e.g., Wang et al. 2021; Francis et al. 2022) exploring the effects of mutual fund dual holdings on shareholder-creditor conflicts of interest and corporate decisions. Existing studies have primarily focused on dual holdings of stocks and syndicated loans by institutional investors (other than mutual funds) and examined the effects of institutional dual holdings on firms' shareholder-creditor conflicts. For instance, Jiang et al. (2010) show that the presence of non-commercial banking institutional dual holders (i.e., both stockholder and creditor of the borrowing firm) is associated with lower yield spreads of syndicated loans, consistent with the hypothesis that dual holdings mitigate conflicts of interest between stock- and debt-holders. Chu (2018) finds that dual holders pay out lower dividends, especially for financially distressed firms, consistent with shareholder-creditor conflicts motivating firms to pay out more dividends at the expense of creditors. Yang (2021) documents that dual ownership in the syndicated loan market is associated with fewer patents but, on average, patents with higher market value, supporting the notion that shareholder-creditor conflicts lead to risk-shifting, and dual holders can partially mitigate this problem.

Mutual fund dual holdings provide a unique laboratory that enables us to further investigate the effects of dual ownership on shareholder-creditor conflicts and firm investment. As aforementioned, heightened financial incentives, divergent objectives, and intensified competition motivate mutual fund managers to focus on performance-maximizing strategies that may hinder coordination within a dual-holding family. Therefore, it remains an empirical question as to whether mutual fund dual holdings can mitigate shareholder-creditor conflicts. If we document significant evidence in the case of mutual funds, this would provide even stronger support for the impact of dual holdings on shareholder-creditor conflicts and shed new light on the controversy regarding the roles dual holders play in corporate investment decisions.

Second, we contribute to the literature investigating the effect of institutional investors on corporate governance, managerial monitoring, and corporate actions, including forced CEO turnovers, CEO compensation, mergers and acquisitions, firm risk-taking, innovation, and earnings management.[1] In particular, our evidence shows that the positive impact of institutional dual ownership on corporate innovation and firm value creation is concentrated in active, non-index funds, which are more likely to be monitors rather than passive indexers. This lends further support to a recent growing literature debate on whether passive institutional investors are beneficial or detrimental to shareholders. For instance, using an index constitution as an identification strategy, Appel et al. (2016) find that an increase in passive institutional ownership increases board independence, whereas Schmidt and Fahlenbrach (2017), using the same strategy, show that increases in passive ownership are associated with worse M&A decisions and negative responses to appointments of independent directors of the firms. Schmidt and Fahlenbrach interpret their findings as consistent with the notion that passive investors frequently employ uniform rules-based monitoring techniques that are ineffective for more complex situations and may even impose additional costs on management in some cases. Our evidence suggests that, indeed, active dual ownership proves to play a more effective role in managerial monitoring than passive dual ownership.

Finally, we add to the growing literature on patent innovation by showing that mutual fund dual ownership makes an important determinant of innovation.[2] In particular, unlike Yang (2021), who documents that dual ownership in the syndicated loan market is associated with fewer but more valuable patents, we focus on the relationship between mutual fund dual ownership and corporate innovation. More interestingly, we find a positive (negative) effect on the innovation of mutual fund dual ownership in the pre- (post-) crisis period, indicating that mutual fund dual holders might play a different role than other institutional dual holders in corporate investment decisions such as innovation.

The remainder of the paper proceeds as follows. Section 2 reviews the literature and advances hypotheses. Section 3 describes the data. Section 4 examines the effect of mutual fund dual ownership on patent quantity, quality, generality, originality, and innovative efficiency. Section 5 investigates the relationship between innovation, dual holdings, and stockholder and bondholder returns. Section 6 explores the results in the financial crisis period versus non-crisis periods. We conduct robustness tests and discuss some potential limitations of this study in Section 7. Section 8 concludes.

2. Literature Review and Hypotheses Development

Ever since the seminal work of Jensen and Meckling (1976) and Myers (1977), shareholder-creditor conflict of interest has been the focus of many studies. In essence, this conflict arises as shareholders, or managers on behalf of shareholders, may undertake actions that maximize shareholder wealth at the expense of creditors, such as overinvestment in risky but value-decreasing projects, or asset substitution. Fully aware of this possibility, creditors take into account these expected costs of opportunistic behavior on the part of managers when negotiating debt contract terms and pricing. One potential solution to this conflict of interest, as proposed first in Jensen and Meckling (1976), is for some investors to hold both the firm's equity and debt securities. For example, compensating firm managers

with both equity and debt in the same proportion as the overall capital structure of the firm might reduce shareholder-creditor conflict of interest and better align their incentives. Furthermore, Jensen (1986) expands this hypothesis and suggests that the conflict of interest between security holders can be substantially mitigated if different securities are held by the same parties. By the same logic, the simultaneous holding of both equity and debt claims of the same firm by the same institutional investors (aka "dual holding") offers a unique setting to explore whether dual holding can help alleviate shareholder-credit conflict of interest.

However, institutional dual holding is a relatively recent phenomenon and therefore has not yet been widely examined. A few important and notable exceptions include Jiang et al. (2010), who show that syndicated loans with non-commercial banking institutional dual holders (i.e., both stock-holder and creditor of the borrower) are associated with lower loan yield spreads than those without, a finding consistent with the hypothesis that dual holding mitigates conflicts of interest between stock- and debt-holders, better align their incentives and as a result, lower the loan yield spreads. Conversely, Bodnaruk and Rossi (2016) analyze mergers and acquisitions (M&As) and find that targets with larger dual ownership are associated with lower M&A equity premia but higher abnormal bond returns, especially so when dual holders benefit more from the appreciation of their bond holdings. And dual holders are more likely to approve M&A deals. Bodnaruk and Rossi interpret their findings as consistent with the existence of coordination in decision-making within the dual holding financial conglomerates. Chu (2018) examines how shareholder-creditor conflict of interest would influence corporate payout policy. Employing an identification strategy that uses mergers between stockholders and creditors of the same firm as exogenous shocks to the shareholder-creditor conflict, Chu (2018) shows that firms pay out lower dividends when this conflict of interest is lower. This evidence is consistent with the notion that shareholder-creditor conflict motivates firms to pay out more dividends at the expense of creditors, an effect even more pronounced for financially distressed firms. Using the same identification strategy, Yang (2021) finds that dual ownership in the syndicated loan market is associated with fewer patents but, on average, patents with higher market value, supporting the notion that shareholder-creditor conflicts lead to risk-shifting and dual holders can partially mitigate this problem.

Our study aims to add to this thread of literature by exploring the effect of mutual fund dual holdings on stockholder-creditor conflict of interest and, consequently, its impact on corporate actions. In particular, using various patent and citation measures to gauge innovation and a sample of mutual funds who hold both the stocks and bonds (dual holders) of U.S. firms during 1995–2010, we examine how dual ownership (stock holdings of dual holders as a fraction of shares outstanding) affects corporate innovation.

Mutual fund dual holdings provide a unique laboratory that enables us to entertain competing hypotheses concerning the existence and magnitude of shareholder-creditor conflict of interest, as well as their impact on innovation. The first is the incentive alignment hypothesis. Dual holders are, in essence, bondholders who are also shareholders of the same firm; therefore, dual holders have more incentives than pure bondholders to monitor managers and deter actions that benefit bondholders at the expense of shareholders, such as underinvestment. This is because now, dual holders internalize (at least partially) the decreases in shareholder value arising from the underinvestment problems. Hence, if shareholder-bondholder conflicts are substantial enough to affect managerial behaviors and corporate investment decisions, one expects to see a decrease in potential underinvestment in long-term, risky, but value-increasing projects such as innovation as dual ownership increases. This decrease in potential underinvestment problems will, in turn, lead to larger shareholder value or returns; and this effect should be increasing in the equity ownership of dual holders. Therefore, our first hypothesis predicts:

H1. *Incentive Alignment Hypothesis*:

H1a. *A **positive** relationship between equity ownership of dual holders (aka "dual ownership") and innovation outcome, in particular high quality, high impact innovation.*

H1b. *A **positive** relationship between dual ownership and stock returns, via its effect on innovation.*

Furthermore, it is less likely for dual holders to be expropriated by shareholders now that they also hold equity in the firm and hence voting rights, compared to other creditors. As a result of this lower shareholder-creditor conflict enjoyed by dual holders, the costs of debt of the firm are expected to decline, all else being equal, leading to larger bond value or returns. And this effect should be larger for firms with larger dual ownership. Thus, the incentive alignment hypothesis also predicts:

H1c. *A **positive** relationship between dual ownership and bond returns, via its impact on innovation.*

As aforementioned, previous studies on dual holdings show that there are multiple aspects of the conflict between shareholders and debtholders. While the *Incentive Alignment Hypothesis* concentrates on resolving a specific aspect of the conflict of interest between debt holders and shareholders, i.e., the underinvestment problem, we also develop our second, alternative hypothesis to explore the effects of dual holdings on other aspects of the conflict between the two groups. For example, one could argue that now that the shareholder is simultaneously a debtholder, the dual holdings may weaken the monitoring role of debt, which encourages more risk-taking behavior in firm investment. That is, dual holdings may exaggerate the overinvestment problems associated with corporate innovation. And this overinvestment is expected to especially manifest itself in low value, low quality, and low impact innovation:[3]

H2. *Overinvestment Exaggeration Hypothesis:*

H2a. *A **positive** relationship between equity ownership of dual holders (aka "dual ownership") and innovation outcome, in particular low quality, low impact innovation.*

By definition, overinvestment in risky innovation leads to value destruction for shareholders and bondholders. Thus our second hypothesis also predicts the following:

H2b. *A **negative** relationship between dual ownership and stock returns, via its overinvestment effect on innovation.*

H2c. *A **negative** relationship between dual ownership and bond returns, via its overinvestment impact on innovation.*

Note that both hypotheses one and two predict a positive relation between dual ownership and innovation, however, they predict exactly opposite relations between dual ownership and stock and bond returns, i.e., the value effects of dual ownership.

The third hypothesis is the independence hypothesis, which predicts that dual holders or their equity holdings have no (or even reverse) impact on conflicts of interest between stockholders and creditors, thereby leading to no relation between dual ownership on innovation outcome, stock returns, and bond returns. As aforementioned, unlike other institutional investors, mutual funds are subject to several attributes that may prevent coordination between individual funds, even within the same family. These include strong financial incentives, disparate investment objectives, different client risk preferences, and heightened competition among peers. As such, mutual fund managers are motivated to seek strategies that maximize their profits, which may hinder coordination within a dual-holding family. Hence, the hypothesis states:

H3. *Independence Hypothesis:*

H3a. *Dual ownership should have no impact on innovation outcome.*

H3b. *Dual ownership should have no impact on stock returns.*

H3c. *Dual ownership should have no impact on bond returns.*

Therefore, the effect of dual ownership on shareholder-debtholder conflicts of interest, and in turn, on innovation and firm value is an empirical question. In this paper, we test these two competing hypotheses and aim to provide more insights into the above question.

3. Data

We retrieve patent and citation data from two data sources. The NBER patent and citation database compiled by Hall et al. (2002) contains detailed information on technological categories and covers the period 1976–2006. The patent and citation data constructed by Kogan et al. (2017) (henceforth KPSS data) ends in 2010 but does not have detailed technological class information.[4]

We obtain mutual fund ownership data from Morningstar, firm financial information from Compustat, stock return data from the Center for Research in Security Prices (CRSP), and bond return data from the Wharton Research Data Services (WRDS) Bond database. The sample period starts in 2003, when bond data are available, and ends in 2010, when the KPSS data end. The sample contains all firm–year observations in Compustat during 2003–2010 that have non-missing mutual fund ownership data. To mitigate sample selection bias, we follow Atanassov (2013) and He and Tian (2013) and assign zero value to firm–years with missing patent or R&D data, and include them in our regression analyses.

3.1. Patent Innovation Measures

We construct several innovation measures from both the NBER and KPSS patent and citation data. Specifically, we use KPSS data to construct our main variables of patent quantity and citations through 2010, and the NBER data to construct patent measures adjusted by technological categories through 2006.

Pats (through 2010) is the total number of patents applied for by a firm (and ultimately granted) in a calendar year. Consistent with Hall et al. (2002), the relevant year is the application or filing year, which is very close to the timing of the actual innovation rather than the grant year. Where available (through 2006) *Pats* is further divided by the average number of patents applied for across all firms in the same application year and the same U.S. Patent and Trademark Office (USPTO) technological class ($Pats_{TN}$), or the same Hall et al. (2002) technological category (henceforth HJT) to correct for the truncation bias in patent grants ($Pats_{TC}$). The truncation bias arises as patents have, on average, a two-year lag from application to grant date, and some patents that have been applied for may not have yet entered into the sample.[5] *Ln(1+Pats)* is the natural logarithm of one plus *Pats*. We also construct $Ln(1+Pats_{TN})$ and $Ln(1+Pats_{TC})$ analogously.

In addition to patent quantity, we also construct measures for patent quality. *Cites* is the total number of future citations received in life on all patents applied for (and ultimately granted to) a firm in an application year. Patents that are more heavily cited are viewed as having more impact or being more important. $Cites_{TN}$ ($Cites_{TC}$) equals *Cites* scaled by the citations received on all patents filed in the same USPTO class (HJT category) and the same application year to account for the fact that patents that are granted earlier may have received more citations than recent ones. *LnCite*, $LnCites_{TN,}$ and $Cites_{TC}$ are the logarithms of one plus *Cites*, $Cites_{TN}$, and $Cites_{TC}$.

Patent generality (*GEN*) captures how broadly the patent impacts future descendants. Specifically, *GEN* is defined as the average generality score across all patents applied for by a firm in a calendar year, where the generality score for each patent is constructed using USPTO technological classes as follows and bias-corrected as in Hall (2005):

$$Generality_i = 1 - \sum_j^{n_i} S_{ij}^2, \quad (1)$$

where S_{ij}; denotes the percentage of citations received by patent i that belongs to patent class j, out of ni patent classes. Note that the generality score equals one minus the Herfindahl index of citations received. A greater generality score indicates that a patent is cited by future patents in a wider set of technology fields, and thus has a more broad impact.

Patent originality (ORG) indicates how original or radical a patented innovation is relative to its predecessors. ORG is defined as the average originality scores across all patents applied for by a firm in a calendar year, where the originality score for each patent is constructed using USPTO class and bias-adjusted as in Hall (2005), and in the same manner as generality score, except that originality score refers to citations made rather than received. Thus, a greater originality score indicates that a patent cites previous patents in a wider set of technology fields, and therefore is more original and breakthrough. To control for industry trends and truncation bias in patent and citation data, we also use bias-adjusted measures of patent generality (GEN_{TN} and GEN_{TC}) and originality (ORG_{TN} and ORG_{TC}). Appendix A provides detailed definitions of these patent measures.

Innovation efficiency is measured based on both patent quantity and citations. $Ln\left(\frac{1+Pats}{1+R\&D}\right)$, $Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$, and $Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$ are defined as the logarithm of one plus $Pats$, $Pats_{TN}$, or $Pats_{TC}$ in the next year, divided by one plus current year R&D expenses. Analogously, we construct three citation-based innovation efficiency measures, including $Ln\left(\frac{1+Cites}{1+R\&D}\right)$, $Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$, and $Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$. Following prior literature, we assign zero to missing R&D when computing the denominator for innovation efficiency measures.

3.2. Dual Ownership

To construct measures of dual ownership, we first match stocks and bonds of the same company following the method of Bodnaruk and Rossi (2016). We then identify a mutual fund firm as a dual holder if its affiliated mutual funds simultaneously hold the same companies' stocks and bonds, and the bond exposure represents at least 5%, but no more than 95% of its overall stock and bond exposures to the company. Next, following Jiang et al. (2010), we refer to significant dual holders as those who hold at least 1% of the firm's stock outstanding or more than $2 million in value.

Our main variable of interest is dual ownership (*Dual*), defined as the fraction of the total number of shares outstanding held by dual owners for a firm at the year-end. Mutual funds ownership (*Pct*) is defined as the fraction of the total number of shares outstanding held by all mutual funds for a firm at the year-end. We also consider an alternative measure of dual ownership, namely the adjusted dual ownership (*Adj Dual*), defined as the sum of shares held by dual owners divided by the sum of shares held by all mutual funds for a firm at the year-end. More specifically, *Adj Dual* equals *Dual* divided by *Pct*.

3.3. Control Variables

Following previous studies, we include an extensive set of control variables in all of our regression models to control for industry- and firm-specific factors (e.g., Chemmanur and Tian 2018; He and Tian 2013; Aghion et al. 2013; Wang and Zhao 2015; Mayer et al. 2018; Bolton and Zhao 2022). These include firm size as proxied by market value of equity (LN_MV), research and development intensity (RD_Sale), investment opportunities proxied by capital expenditures (CAPX_AT), investment in tangible or fixed assets (PPE_AT), firm profitability as proxied by return on assets (ROA), capital structure (LEV), liquidity (CASH_AT), Tobin's q (Q), industry concentration or competition as proxied by Herfindahl Index and its square (HI and HI2), firm age (LN_AGE), and finally institutional ownership (Pct). All regression models include firm and year fixed effects. Appendix A provides detailed variable definitions.

3.4. Summary Statistics

Table 1 presents descriptive statistics on patent measures, dual ownership, returns, and control variables during 2003–2010. All variables are defined in Appendix A.

Table 2 presents the correlation coefficients among the key variables. Results using the USPTO and HJT classification-adjusted patent and citation metrics are similar. Thus we only report the unadjusted patent and citation metrics to save space. It appears that dual ownership is significantly and positively correlated with all four types of innovation measures, including patent count, citations, generality, and originality. This provides

preliminary evidence that dual ownership is positively related to innovative activities. We do notice that dual ownership is, however, negatively related to patent and citation efficiency measures. One potential explanation is that R&D enters into the denominators of those measures, rendering the interpretation of results ambiguous.

Table 1. Summary Statistics. This table provides summary statistics on the key variables. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A.

Variable	N	Mean	Median	Std Dev
Pats	14,959	1.7468	0.0000	9.5596
$Pats_{TN}$	14,959	0.5440	0.0000	2.7425
$Pats_{TC}$	14,959	0.1687	0.0000	0.8673
Cites	14,959	0.3343	0.0000	2.2505
$Cites_{TN}$	14,959	1.8321	0.0000	11.5030
$Cites_{TC}$	14,959	1.9023	0.0000	12.1407
Cites per Patent	14,959	0.0193	0.0000	0.1081
$Cites_{TN}$ *per Patent*	14,959	0.0996	0.0000	0.5594
$Cites_{TC}$ *per Patent*	14,959	0.0969	0.0000	0.5306
Ln(1+Pats)	14,959	0.2528	0.0000	0.7494
$Ln(1+Pats_{TN})$	14,959	0.1560	0.0000	0.5004
$Ln(1+Pats_{TC})$	14,959	0.0787	0.0000	0.2928
Ln(1+Cites)	14,959	0.0808	0.0000	0.4032
$Ln(1+Cites_{TN})$	14,959	0.1551	0.0000	0.7165
$Ln(1+Cites_{TC})$	14,959	0.1557	0.0000	0.7201
GEN	14,959	0.0008	0.0000	0.0064
GEN_{TN}	14,959	0.0020	0.0000	0.0168
GEN_{TC}	14,959	0.0023	0.0000	0.0190
ORG	14,959	0.0766	0.0000	0.2043
ORG_{TN}	14,959	0.1405	0.0000	0.4872
ORG_{TC}	14,959	0.1530	0.0000	0.4076
$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	14,959	−1.1576	-0.1178	1.5179
$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	14,959	−1.2552	-0.2390	1.5700
$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	14,959	−1.3310	-0.2731	1.6402
$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	14,959	−1.3288	-0.2523	1.6643
$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	14,959	−1.2568	-0.0962	1.6315
$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$	14,959	−1.2560	-0.0953	1.6325
Dual	14,959	0.0077	0.0000	0.0247
Pct	14,959	0.1485	0.1384	0.1134
Adj Dual	14,959	0.0357	0.0000	0.1097
LN_MV	14,959	5.7557	5.7150	1.9832
RD_Sale	14,959	0.5615	0.0013	3.4984
CAPX_AT	14,959	0.0464	0.0299	0.0529
PPE_AT	14,959	0.2468	0.1697	0.2258
ROA	14,959	0.0414	0.0979	0.2429
LEV	14,959	0.2038	0.1543	0.2195
CASH_AT	14,959	0.2272	0.1292	0.2437
Q	14,959	2.1174	1.5617	1.7093
HI	14,959	0.2326	0.1878	0.1838
HI2	14,959	0.0879	0.0353	0.1519
LN_AGE	14,959	2.4227	2.3979	0.9398

Table 2. Correlation Coefficients. This table provides correlation coefficients on the key variables. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. * denotes significance at the 5% level or better.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Ln(1+Pats)	1.00																	
2. Ln(1+Cites)	0.789 *	1.00																
3. GEN	0.442 *	0.653 *	1.00															
4. ORG	0.739 *	0.438 *	0.291 *	1.000														
5.$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	−0.137 *	−0.033 *	−0.003	−0.169 *	1.000													
6.$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	−0.365 *	−0.136 *	−0.039 *	−0.366 *	0.961 *	1.000												
7. Dual	0.123 *	0.093 *	0.037 *	0.085 *	−0.030 *	−0.058 *	1.000											
8. Pct	0.152 *	0.094 *	0.052 *	0.130 *	−0.188 *	−0.214 *	0.296 *	1.000										
9. LN_MV	0.289 *	0.198 *	0.081 *	0.192 *	−0.244 *	−0.302 *	0.315 *	0.599 *	1.000									
10. RD_Sale	0.004	−0.009	−0.008	0.030 *	−0.175 *	−0.163 *	−0.026 *	−0.069 *	−0.066 *	1.000								
11. CAPX_AT	−0.042 *	−0.023 *	−0.016 *	−0.051 *	0.174 *	0.172 *	0.024 *	0.070 *	0.096 *	−0.056 *	1.000							
12. PPE_AT	−0.001	0.002	−0.010	−0.011	0.169 *	0.154 *	0.143 *	0.116 *	0.117 *	−0.067 *	0.602 *	1.000						
13. ROA	0.025 *	0.025 *	0.000	−0.020 *	0.174 *	0.153 *	0.076 *	0.329 *	0.359 *	−0.387 *	0.152 *	0.214 *	1.000					
14. LEV	−0.009	−0.008	−0.009	−0.026 *	0.125 *	0.116 *	0.286 *	0.031 *	0.055 *	−0.037 *	0.085 *	0.308 *	0.047 *	1.000				
15. CASH_AT	0.027 *	0.003	0.015 *	0.068 *	−0.380 *	−0.358 *	−0.137 *	−0.114 *	−0.133 *	0.315 *	−0.207 *	−0.450 *	−0.423 *	−0.383 *	1.000			
16. Q	0.017 *	−0.005	−0.012	0.029 *	−0.176 *	−0.169 *	−0.101 *	−0.029 *	0.128 *	0.189 *	0.036 *	−0.186 *	−0.273 *	−0.125 *	0.378 *	1.000		
17. HI	−0.007	−0.004	−0.001	−0.004	0.098 *	0.091 *	−0.003	0.030 *	−0.061 *	−0.065 *	−0.127 *	−0.100 *	0.074 *	0.002	−0.118 *	−0.060 *	1.000	
18. LN_AGE	0.118 *	0.088 *	0.030 *	0.074 *	0.012	−0.019 *	0.108 *	0.148 *	0.201 *	−0.080 *	−0.016 * *	0.166 *	0.193 *	0.080 *	−0.290 *	−0.172 *	0.082 *	1.000

4. Dual Ownership and Innovation

In this section, we examine the effect of mutual fund dual ownership on corporate innovation. In Section 3.1, we perform the baseline regression analyses of innovation on dual ownership. In Section 3.2, we consider the alternative measure of dual ownership, namely the adjusted dual ownership. In Section 3.3, we conduct regression analyses separating dual ownership into index mutual fund dual ownership versus non-index fund dual ownership in a firm.

4.1. Baseline Regressions of Innovation on Dual Ownership

To examine the relationship between dual ownership and subsequent corporate innovation, we employ the following regression analysis

$$Innovation_{i,t+1} = \alpha_t + \gamma_i + \beta Dual_{i,t} + \delta X_{i,t} + \varepsilon_{i,t+1} \quad (2)$$

where $Innovation_{i,t+1}$ measures innovative activities of firm i in year $t + 1$, including various metrics of the patent count, citations, generality, and originality, $Dual_{i,t}$ refers to mutual fund dual ownership in firm i at the end of year t, X contains all control variables shown in prior literature to affect innovation, and α_t and γ_i are year and firm fixed effects, respectively. If dual ownership leads to declines in innovation, we expect a negative β. Alternatively, if dual ownership promotes innovative activities, a positive β is anticipated.

Following prior literature (e.g., Atanassov (2013) and Chemmanur and Tian (2018)), we include firm fixed effects so that we are able to directly test whether and how the variation of dual ownership *within* a firm is associated with the subsequent variation in innovation. Further, our empirical analyses may be subject to endogeneity issues between dual ownership and innovation due to omitted, unobservable firm characteristics that might drive both dual ownership and innovation jointly. Firm fixed effects can mitigate this endogeneity concern arising from unobservable, firm-specific, time-invariant, omitted variables.[6]

4.1.1. Patent Quantity and Citations

Table 3 provides baseline regression results of innovation on dual ownership. Panel A analyzes patent counts and citations. To account for the skewness of patent quantity as shown in Table 1, the dependent variables in models 1–3 of Panel A are the natural logarithm of one plus the total number of patents applied for by (and ultimately granted to) a firm during calendar year $t + 1$ (Ln(1+$Pats$)), and the natural logarithm of one plus the two bias-adjusted patent count, Ln(1+$Pats_{TN}$) and Ln(1+$Pats_{TC}$), respectively. The t-statistics (in parentheses) are corrected for firm-level clustering. Models 1–3 of Panel A show that dual ownership is significantly and positively related to all future patent quantity measures, even after controlling for mutual fund ownership (Pct). Specifically, a one standard deviation increase in $Dual$ (2.47%) is associated with increases of 4.63 (Ln(1+$Pats$), 2.85 (Ln(1+$Pats_{TN}$)), and 1.36 (Ln(1+$Pats_{TC}$)) percentage points. Given the sample means of 0.253 (Ln(1+$Pats$), 0.156 (Ln(1+$Pats_{TN}$)), and 0.079 (Ln(1+$Pats_{TC}$)), these changes translate into economically significant increases of 18.33%, 18.27%, and 17.26% from the respective mean values, respectively. Notably, Pct is significant and negative, suggesting that mutual fund ownership does not necessarily promote innovation; it is dual ownership that fosters corporate innovative activities the most.

The coefficient estimates for control variables are largely consistent with prior literature that uses a common set of controls (e.g., He and Tian 2013; Wang and Zhao 2015; Mayer et al. 2018; Bolton and Zhao 2022). Firm size is positive and significant, consistent with the notion that larger firms are more capable of generating greater in-house R&D and innovation owing to greater resources and talent, fewer takeover threats, and more flexibility in business operations. ROA and Tobin's q are negative, suggesting that firms with better performance or higher market valuation generate fewer innovations. This result might be driven by the collinearity between ROA and Tobin's q as both measures capture firm performance. Finally, patents are positively related to asset tangibility (PPE_AT) and firm age.

Table 3. Baseline Regressions of Innovation on Dual Ownership. This table presents baseline regression results of various innovation measures on dual ownership. Panel A analyzes the number of patents and total citations received in life, Panel B analyzes patent generality and originality, and Panel C analyzes innovation efficiency. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations						
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
Dual	**1.876 *** **	**1.154 *** **	**0.550 *** **	**1.058 *** **	**1.572 *** **	**1.688 *** **
	(5.76)	**(5.49)**	**(4.82)**	**(4.53)**	**(3.93)**	**(4.24)**
Pct	−0.780 ***	−0.534 ***	−0.262 ***	−0.444 ***	−0.738 ***	−0.785 ***
	(−7.19)	(−7.61)	(−6.89)	(−5.71)	(−5.53)	(−5.91)
LN_MV	0.124 ***	0.075 ***	0.034 ***	0.074 ***	0.112 ***	0.114 ***
	(9.30)	(8.68)	(7.36)	(7.70)	(6.84)	(6.96)
RD_Sale	0.001	0.000	0.000	0.001	0.002	0.002
	(0.48)	(0.30)	(0.13)	(0.32)	(0.58)	(0.57)
CAPX_AT	0.164	0.055	0.021	−0.130	−0.134	−0.149
	(0.95)	(0.49)	(0.34)	(−1.05)	(−0.63)	(−0.70)
PPE_AT	0.241 **	0.145 *	0.031	0.064	0.093	0.080
	(2.08)	(1.94)	(0.77)	(0.77)	(0.65)	(0.57)
ROA	−0.208 ***	−0.113 ***	−0.048 ***	−0.139 ***	−0.222 ***	−0.229 ***
	(−4.17)	(−3.50)	(−2.76)	(−3.90)	(−3.63)	(−3.77)
LEV	−0.025	0.014	0.004	0.001	−0.020	−0.005
	(−0.48)	(0.42)	(0.21)	(0.02)	(−0.31)	(−0.07)
CASH_AT	0.033	0.017	−0.007	−0.043	−0.026	−0.032
	(0.55)	(0.43)	(−0.35)	(−0.98)	(−0.34)	(−0.43)
Q	−0.028 ***	−0.015 ***	−0.006 ***	−0.012 ***	−0.021 ***	−0.022 ***
	(−4.60)	(−3.67)	(−2.82)	(−2.65)	(−2.83)	(−2.93)
HI	0.241	0.138	0.049	0.343*	0.130	0.281
	(0.99)	(0.87)	(0.57)	(1.96)	(0.43)	(0.94)
HI2	−0.344	−0.220	−0.106	−0.329**	−0.187	−0.332
	(−1.48)	(−1.46)	(−1.30)	(−1.97)	(−0.65)	(−1.17)
LN_AGE	0.283 ***	0.220 ***	0.114 ***	0.202 ***	0.303 ***	0.320 ***
	(7.74)	(9.32)	(8.91)	(7.72)	(6.74)	(7.15)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Value	5.69	6.24	7.64	2.23	2.57	2.67
(*p*-value)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Adj Rsq	0.593	0.619	0.673	0.277	0.328	0.341
Obs	14,959	14,959	14,959	14,959	14,959	14,959
Panel B: Generality and Originality						
	GEN	**GEN$_{TN}$**	**GEN$_{TC}$**	**ORG**	**ORG$_{TN}$**	**ORG$_{TC}$**
Dual	**0.012 *** **	**0.030 *** **	**0.035 *** **	**0.331 *** **	**0.848 *** **	**0.628 *** **
	(2.78)	**(2.71)**	**(2.77)**	**(3.06)**	**(2.88)**	**(2.90)**
Pct	**−0.004 *** **	**−0.011 *** **	**−0.012 *** **	**−0.115 *** **	**−0.412 *** **	**−0.217 *** **
	(−2.87)	**(−3.08)**	**(−2.87)**	**(−3.20)**	**(−4.19)**	**(−3.01)**
LN_MV	0.001 ***	0.002 ***	0.002 ***	0.023 ***	0.067 ***	0.043 ***
	(3.78)	(3.73)	(3.73)	(5.20)	(5.52)	(4.84)
RD_Sale	−0.000	−0.000	−0.000	0.001	0.004 **	0.002
	(−0.10)	(−0.07)	(−0.08)	(1.38)	(2.16)	(1.25)
CAPX_AT	−0.000	−0.000	−0.000	0.041	0.292*	0.108
	(−0.18)	(−0.03)	(−0.03)	(0.72)	(1.86)	(0.94)
PPE_AT	−0.001	−0.002	−0.003	0.119 ***	0.297 ***	0.226 ***
	(−0.71)	(−0.51)	(−0.75)	(3.09)	(2.83)	(2.94)

Table 3. *Cont.*

Panel B: Generality and Originality						
	GEN	**GEN_{TN}**	**GEN_{TC}**	**ORG**	**ORG_{TN}**	**ORG_{TC}**
ROA	−0.002 ***	−0.004 **	−0.005 ***	−0.039 **	−0.099**	−0.071 **
	(−2.88)	(−2.52)	(−2.85)	(−2.37)	(−2.20)	(−2.16)
LEV	0.000	−0.000	−0.000	−0.009	−0.072	−0.016
	(0.06)	(−0.04)	(−0.02)	(−0.53)	(−1.51)	(−0.46)
CASH_AT	−0.001	−0.003	−0.003	0.031	0.110**	0.062
	(−1.38)	(−1.45)	(−1.44)	(1.52)	(2.00)	(1.53)
Q	−0.000 **	−0.000 **	−0.001 **	−0.008 ***	−0.024 ***	−0.015 ***
	(−2.54)	(−2.29)	(−2.51)	(−3.90)	(−4.25)	(−3.78)
HI	0.008 ***	0.021 **	0.024 **	0.083	0.405 *	0.152
	(2.65)	(2.51)	(2.53)	(1.02)	(1.83)	(0.93)
HI2	−0.007 **	−0.017 **	−0.020 **	−0.097	−0.379 *	−0.181
	(−2.31)	(−2.17)	(−2.18)	(−1.25)	(−1.80)	(−1.17)
LN_AGE	0.002 ***	0.004 ***	0.005 ***	0.017	0.132 ***	0.028
	(3.27)	(3.24)	(3.26)	(1.41)	(4.00)	(1.16)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Value	1.17	1.17	1.19	3.11	1.87	3.08
(*p*-value)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Adj Rsq	0.051	0.049	0.056	0.396	0.212	0.392
Obs	14,959	14,959	14,959	14,959	14,959	14,959
Panel C: Innovation Efficiency						
	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$
Dual	**1.803 *** **	**1.102 *** **	**0.441 ** **	**1.024 *** **	**1.492 *** **	**1.637 *** **
	(4.88)	**(4.09)**	**(2.16)**	**(3.39)**	**(3.47)**	**(3.82)**
Pct	**−1.116 *** **	**−0.857 *** **	**−0.580 *** **	**−0.772 *** **	**−1.066 *** **	**−1.113 *** **
	(−9.05)	**(−9.52)**	**(−8.52)**	**(−7.66)**	**(−7.44)**	**(−7.79)**
LN_MV	0.034 **	−0.017	−0.058 ***	−0.014	0.021	0.022
	(2.24)	(−1.54)	(−6.95)	(−1.09)	(1.17)	(1.27)
RD_Sale	−0.008 ***	−0.008 ***	−0.009 ***	−0.008 ***	−0.007**	−0.007 **
	(−3.05)	(−4.52)	(−6.19)	(−4.01)	(−2.45)	(−2.47)
CAPX_AT	−0.013	−0.098	−0.124	−0.303 *	−0.284	−0.303
	(−0.06)	(−0.68)	(−1.14)	(−1.88)	(−1.24)	(−1.33)
PPE_AT	0.134	0.032	−0.078	−0.032	−0.012	−0.011
	(1.02)	(0.33)	(−1.08)	(−0.30)	(−0.08)	(−0.08)
ROA	0.080	0.183 ***	0.250 ***	0.138 ***	0.064	0.057
	(1.42)	(4.45)	(8.00)	(2.98)	(0.98)	(0.86)
LEV	−0.108 *	−0.067	−0.078 **	−0.080	−0.096	−0.086
	(−1.79)	(−1.53)	(−2.35)	(−1.64)	(−1.38)	(−1.23)
CASH_AT	0.231 ***	0.222 ***	0.201 ***	0.153 ***	0.173 **	0.173 **
	(3.35)	(4.39)	(5.26)	(2.71)	(2.16)	(2.16)
Q	0.016 **	0.029 ***	0.038 ***	0.031 ***	0.023 ***	0.022 ***
	(2.25)	(5.76)	(9.90)	(5.51)	(2.85)	(2.78)
HI	0.391	0.232	0.122	0.460 **	0.236	0.364
	(1.41)	(1.15)	(0.79)	(2.03)	(0.73)	(1.13)
HI2	−0.448 *	−0.282	−0.144	−0.404 *	−0.252	−0.372
	(−1.70)	(−1.46)	(−0.98)	(−1.87)	(−0.82)	(−1.22)
LN_AGE	0.310 ***	0.244 ***	0.147 ***	0.235 ***	0.323 ***	0.339 ***
	(7.46)	(8.05)	(6.41)	(6.93)	(6.70)	(7.05)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
F-Value	22.97	48.43	94.29	43.12	19.30	19.50
(*p*-value)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Adj Rsq	0.872	0.936	0.967	0.929	0.850	0.852
Obs	14,959	14,959	14,959	14,959	14,959	14,959

Models 4–6 of Panel A analyze patent citations. Patent citations capture how important or impactful a patented innovation is for its descendants. The more citations received on the patents, the more impact these patents exert on future innovation, and the greater the social value generated. The dependent variables in models 4–6 of Panel A are, respectively, the natural logarithm of one plus the total number of citations received in life on all patents filed for by (and ultimately granted to) a firm in year t+1 (Ln(1+$Cites$)), and the two bias-adjusted citation measures, Ln(1+$Cites_{TN}$) and Ln(1+$Cites_{TC}$). We find that dual ownership (*Dual*) is significantly and positively related to all three citation measures. Given the sample means of 0.081 (Ln(1+$Cites$)), 0.155 (Ln(1+$Cites_{TN}$), and 0.156 (Ln(1+$Cites_{TC}$)), a one standard deviation increase in *Dual* (2.47%) amounts to increases of 32.34% (Ln(1+$Cites$)), 25.03% (Ln(1+$Cites_{TN}$), and 26.78% (Ln(1+$Cites_{TC}$)), respectively, from the sample means, which is both statistically and economically significant. The coefficient estimates on control variables are consistent with prior findings.

Overall, regression results regarding patent quantity and citations suggest that dual ownership not only encourages more patent activities but also, more importantly, high-quality and high-impact innovation.

4.1.2. Patent Generality and Originality

Patent generality measures how broadly a patent influences future inventions. A higher generality score indicates that a patent receives citations from future patents across a wider range of technology fields, while a lower score suggests that a patent's contribution is rather concentrated in a fairly narrow set of technical classes. Models 1–3 in Panel B of Table 3 examine patent generality, where the dependent variable is patent generality (GEN), and the two bias-corrected generality scores (GEN_{TN} and GEN_{TC}), respectively, as defined in Appendix A. We find that dual ownership is positively and significantly related to all generality measures, and the coefficient estimates are both statistically and economically significant. A one standard deviation increase in dual ownership (2.47%) translates into increases of 37.05% (GEN), 37.05% (GEN_{TN}), and 37.59% (GEN_{TC}) from their respective sample means of 0.001, 0.002, and 0.002. Our results suggest that dual ownership fosters more impactful innovation, which exerts a fundamental, critical, and broad impact on future inventions across many fields of technology.

Patent originality captures the fundamental nature of a patent relative to its predecessors. A higher score represents a more radical, breakthrough innovation rather than a marginal one. Models 4–6 in Panel B of Table 3 provide regression results of patent originality measures. The dependent variables are ORG, ORG_{TN}, and ORG_{TC}, respectively, as defined in Appendix A. *Dual* is significantly and positively related to all three measures of originality. A one standard deviation increase in *Dual* (2.47%) amounts to a 10.67% increase in ORG from its sample mean of 0.077, a 14.91% increase in ORG_{TN} (sample mean = 0.141), and a 10.14% increase in ORG_{TC} (sample mean = 0.153). Our results provide robust evidence that greater dual ownership is associated with more original and radical innovation.

Overall our findings suggest that dual ownership is significantly and positively associated with not only patent quantity but also important and breakthrough innovation that exerts a fundamental and broad impact on future patents.

4.1.3. Patent Innovation Efficiency

Thus far, we have shown that dual ownership fosters corporate innovation by increasing future innovation output as measured by patent count and, more importantly, increasing high-impact, high-quality innovation as measured by citations, generality, and originality. In this section, we explore the relationship between dual ownership and innovation efficiency rather than output.

Panel C of Table 3 provides regression results of innovation efficiency on dual ownership. We measure innovation efficiency as the ratio of innovation output (patent counts or citations) to innovation input (R&D expenses). Models 1–3 analyze patent quantity per R&D dollar spent, where the dependent variables are the natural logarithm of one plus

patent counts in year $t + 1$ over one plus R&D expenditures in year t ($Ln\left(\frac{1+Pats}{1+R\&D}\right)$) and the two bias-adjusted quantity efficiency measures ($Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$ and $Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$), respectively. Across all three models, dual ownership is significant and positive in explaining future innovation efficiency. Again, mutual fund ownership is negative and significant, suggesting that *Dual* does not simply proxy for the effects of overall institutional ownership.

Models 4–6 of Panel C in Table 3 examine innovation efficiency based on the citation outcome. The dependent variables are $Ln\left(\frac{1+Cites}{1+R\&D}\right)$, $Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$, and $Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$, respectively, as defined in Section 3.1 and Appendix A. We find that dual ownership is significantly and positively related to future innovation efficiency as measured by the number of future citations received per R&D dollar spent today. Thus, our evidence suggests that besides enhancing innovation output, dual ownership also promotes corporate innovation via stimulating innovative efficiency and increasing R&D productivity.

In sum, our baseline evidence suggests that dual ownership promotes corporate innovation by enhancing patent quantity, quality, generality, originality, and innovative efficiency. This result is robust after controlling for the overall impact of mutual fund ownership.

4.2. Alternative Measures of Dual Ownership

In this section, we conduct robustness tests using alternative measures of dual ownership, namely the adjusted dual ownership (*Adj Dual*). *Adj Dual* is defined as the ratio of dual ownership (*Dual*) to total mutual fund ownership (*Pct*) in a firm. Thus, this adjusted measure gauges the level of dual ownership relative to the total ownership by all mutual funds and automatically controls for the effects of mutual fund ownership. Table 4 provides regression results where we replace *Dual* with *Adj Dual*. We find robust evidence that across all 18 models except for $Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$, *Adj Dual* is significantly and positively related to future patent counts, citations, generality, originality, and innovative efficiency measures. Table 4 lends further confidence to our baseline regression results.

Table 4. Alternative Measures of Dual Ownership: Regressions of Innovation on Adjusted Dual Ownership. This table presents regression results of various innovation measures on adjusted dual ownership. Panel A analyzes the number of patents and total citations received in life, Panel B analyzes patent generality and originality, and Panel C analyzes innovation efficiency. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants and control variables are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations						
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
Adj Dual	**0.439 *** **	**0.275 *** **	**0.140 *** **	**0.281 *** **	**0.437 *** **	**0.440 *** **
	(5.77)	**(5.60)**	**(5.27)**	**(5.16)**	**(4.67)**	**(4.73)**
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.591	0.617	0.672	0.275	0.327	0.339
Obs	14,959	14,959	14,959	14,959	14,959	14,959
Panel B: Generality and Originality						
	GEN	**GEN$_{TN}$**	**GEN$_{TC}$**	**ORG**	**ORG$_{TN}$**	**ORG$_{TC}$**
Adj Dual	**0.003 *** **	**0.008 *** **	**0.009 *** **	**0.074 *** **	**0.179 *** **	**0.137 *** **
	(3.13)	**(3.09)**	**(3.08)**	**(2.91)**	**(2.60)**	**(2.71)**
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.051	0.049	0.056	0.396	0.211	0.392
Obs	14,959	14,959	14,959	14,959	14,959	14,959

Table 4. *Cont.*

Panel C: Innovation Efficiency						
	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$
Adj Dual	**0.381 *** **	**0.218 *** **	**0.066**	**0.233 *** **	**0.366 *** **	**0.378 *** **
	(4.40)	**(3.45)**	**(1.38)**	**(3.30)**	**(3.64)**	**(3.77)**
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.871	0.936	0.966	0.929	0.849	0.851
Obs	14,959	14,959	14,959	14,959	14,959	14,959

4.3. Index versus Non-Index Dual Ownership

In this section, we examine the effect of dual ownership on corporate innovation, separating whether the dual ownership pertains to index mutual funds or non-index funds. We create a pair of variables as follows. *Index Dual* (*Non-Index Dual*) is defined as the proportion of the total number of shares outstanding held by dual owners who are (are not) index mutual funds. We conjecture that if dual ownership has any (active) impacts on corporate innovative activity, we expect to observe such impacts only in the non-index mutual funds rather than the index funds, as the latter are rather passive investors. We again control for mutual fund ownership (*Pct*), along with all other control variables and firm and year fixed effects.

Indeed, Table 5 shows consistent evidence that only *Non-Index Dual* is significantly and positively related to future firm innovation. This positive effect is robust across all 18 models, consistent with our hypothesis that dual owners may actively engage in monitoring and/or advising roles, and dual ownership exerts stimulating impacts on firms' innovative activity.

Table 5. Index versus Non-Index Dual Ownership. This table presents regression results of various innovation measures on index vs. non-index dual ownership. Index (Non-Index) Dual is defined as the fraction of the total number of shares outstanding held by dual owners who are (are not) index mutual funds. Panel A analyzes the number of patents and total citations received in life, Panel B analyzes patent generality and originality, and Panel C analyzes innovation efficiency. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations						
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
Index Dual	6.843 **	4.121 **	1.202	0.352	5.757	6.054
	(2.21)	(2.06)	(1.11)	(0.16)	(1.52)	(1.60)
Non-Index Dual	**1.760 *** **	**1.071 *** **	**0.480 *** **	**1.117 *** **	**1.536 *** **	**1.652 *** **
	(5.18)	**(4.88)**	**(4.03)**	**(4.58)**	**(3.68)**	**(3.98)**
Pct	−0.775 ***	−0.529 ***	−0.257 ***	−0.445 ***	−0.736 ***	−0.783 ***
	(−7.13)	(−7.55)	(−6.77)	(−5.72)	(−5.52)	(−5.90)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.593	0.619	0.673	0.277	0.328	0.341
Obs	14,959	14,959	14,959	14,959	14,959	14,959

Table 5. *Cont.*

Panel B: Generality and Originality						
	GEN	**GEN_{TN}**	**GEN_{TC}**	**ORG**	**ORG_{TN}**	**ORG_{TC}**
Index Dual	−0.030	−0.086	−0.094	1.006	2.938	1.566
	(−0.74)	(−0.81)	(−0.79)	(0.98)	(1.05)	(0.76)
Non-Index Dual	**0.013** ***	**0.034** ***	**0.038** ***	**0.311** ***	**0.851** ***	**0.587** ***
	(2.90)	**(2.92)**	**(2.92)**	**(2.75)**	**(2.77)**	**(2.60)**
Pct	−0.004 ***	−0.012 ***	−0.012 ***	−0.114 ***	−0.412 ***	−0.215 ***
	(−2.88)	(−3.10)	(−2.88)	(−3.17)	(−4.19)	(−2.97)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.051	0.049	0.057	0.396	0.212	0.392
Obs	14,959	14,959	14,959	14,959	14,959	14,959
Panel C: Innovation Efficiency						
	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$
Index Dual	4.979	2.186	−0.289	−0.390	5.423	4.851
	(1.42)	(0.85)	(−0.15)	(−0.14)	(1.33)	(1.19)
Non-Index Dual	**1.767** ***	**1.098** ***	**0.448** **	**1.123** ***	**1.507** ***	**1.665** ***
	(4.58)	**(3.90)**	**(2.10)**	**(3.56)**	**(3.36)**	**(3.72)**
Pct	−1.113 ***	−0.855 ***	−0.579 ***	−0.774 ***	−1.067 ***	−1.114 ***
	(−9.03)	(−9.51)	(−8.50)	(−7.68)	(−7.44)	(−7.80)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.872	0.936	0.967	0.929	0.850	0.852
Obs	14,959	14,959	14,959	14,959	14,959	14,959

Taken together, we find consistent and robust evidence that dual ownership fosters corporate innovation, including patent quantity, quality, originality, generality, and innovative efficiency. Further, this positive effect of dual ownership on innovation is concentrated in non-index mutual funds, which may play an active role in monitoring and advising corporate managers in their investment decisions, in particular innovative activities.

5. Innovation, Dual Ownership, and Returns

Thus far, we have shown that dual ownership is significantly and positively related to future corporate innovation. In this section, we explore the value effects of dual ownership via its impact on corporate innovation. More specifically, we study the effect of dual ownership on stock and bond returns, respectively, through its impact on innovation. We analyze returns to shareholders in the first section and returns to bondholders in the second section.

5.1. Returns to Shareholders

It has long been recognized that innovation enhances a firm's competitiveness and viability, creating long-term value. Dual owners care about innovation not because they care about the social benefits innovation may bring, but because innovation can generate higher returns for their investment, depending on their relative of stock versus debt holdings. Prior literature has documented a positive relationship between innovation and firm value (Hall (2000) and Blundell et al. (1999)). For example, Hall et al. (2005) find that both patents and patent citations significantly affect market value in a positive way. Pakes (1985) and Griliches (1990) report that both R&D expenditures and patents are positively related to firms' market value. For a sample of U.S. biotechnology start-ups, Lerner (1994) shows that patent count is positively associated with market value.[7] Thus, dual ownership may help

increase firm value by enhancing innovation quantity and quality. As a result, increases in firm value may bring higher investment returns to dual owners.

To more accurately assess the impact of dual ownership on shareholder value, we follow prior literature and use buy-and-hold abnormal stock returns (*BHAR*) minus the value-weighted average return on a matched size, market-to-book, and momentum portfolio.[8]

We now examine the impact of dual ownership on stockholder returns (via its effect on innovation) by estimating the equation as follows:

$$BHAR_{i,t+1} = \alpha_t + \gamma_i + \beta_1 Dual_{i,t} + \beta_2 Innovation_{i,t+1} + \beta_3 Innovation_{i,t+1} \times Dual_{i,t} + \delta X_{i,t} + \varepsilon_{i,t+1}, \quad (3)$$

where *BHAR* is daily buy-and-hold stock returns minus the value-weighted average returns on a matched size, book-to-market, and momentum portfolio over the next 365 calendar days, following current fiscal year-end, *Dual* is dual ownership, *Innovation* is one of the innovation measures, *X* contains all control variables, and α_t and γ_i are year and firm fixed effects, respectively.

Our variable of interest is the interaction term between innovation measures and dual ownership, i.e., $Innovation \times Dual$. A positive β_3 is consistent with dual ownership enhancing shareholder value through its positive effect on innovation and a negative β_3 suggests otherwise.

Table 6 reports the regression results of Equation (3). Consistent with extant literature, the majority of patent measures are significantly positively related to shareholder returns. Overall, the coefficients on *Dual* are also significant and positive, suggesting a positive effect on stock returns. The coefficient estimates on the interaction terms between innovation and *Dual* are significant and positive for the six generality and originality measures, suggesting that dual owners enhance shareholder value by increasing innovation quality, in particular those radical and breakthrough rather than marginal innovations, and those generating more profound, fundamental and broader impacts on future inventions. The coefficient estimates on control variables are consistent with prior studies. For example, *BHAR* is negatively related to market capitalization, ROA, leverage, cash-to-assets ratio, and firm age.

Table 6. Dual Ownership, Innovation, and Stock Returns. This table presents regression results of one-year buy-and-hold abnormal stock returns on the interaction term of dual ownership and various innovation measures. Panel A analyzes the number of patents and total citations received in life, Panel B analyzes patent generality and originality, and Panel C analyzes innovation efficiency. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations

Dep Var = BHAR	**Innovation Measures**					
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
Innovation	0.118 ***	0.173 ***	0.254 ***	0.154 ***	0.059 ***	0.060 ***
	(4.81)	(4.32)	(3.27)	(3.99)	(2.69)	(2.67)
Dual	0.728	0.826 *	0.921 **	0.765 *	0.842 *	0.828 *
	(1.61)	(1.85)	(2.08)	(1.76)	(1.93)	(1.90)
Pct	−0.813 ***	−0.823 ***	−0.856 ***	−0.863 ***	−0.882 ***	−0.879 ***
	(−5.75)	(−5.82)	(−6.07)	(−6.19)	(−6.31)	(−6.29)
Dual * Innovation	**0.379**	**0.416**	**0.388**	**0.573**	**0.291**	**0.307**
	(1.38)	**(1.00)**	**(0.53)**	**(1.39)**	**(1.12)**	**(1.20)**
Pct * Innovation	−0.268 **	−0.425 **	−0.584 *	−0.222	−0.064	−0.072
	(−2.48)	(−2.41)	(−1.72)	(−1.27)	(−0.64)	(−0.71)

Table 6. *Cont.*

Panel A: Patents and Citations						
Dep Var = BHAR	**Innovation Measures**					
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
LN_MV	−0.596 ***	−0.594 ***	−0.590 ***	−0.594 ***	−0.591 ***	−0.591 ***
	(−33.22)	(−33.09)	(−32.94)	(−33.21)	(−33.00)	(−33.00)
RD_Sale	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004
	(−1.17)	(−1.16)	(−1.14)	(−1.16)	(−1.16)	(−1.16)
CAPX_AT	0.245	0.255	0.257	0.275	0.268	0.268
	(1.04)	(1.09)	(1.10)	(1.17)	(1.14)	(1.14)
PPE_AT	0.184	0.190	0.206	0.201	0.204	0.206
	(1.19)	(1.23)	(1.34)	(1.30)	(1.33)	(1.33)
ROA	−0.045 ***	−0.046 ***	−0.047 ***	−0.046 ***	−0.047 ***	−0.047 ***
	(−5.10)	(−5.21)	(−5.32)	(−5.25)	(−5.32)	(−5.30)
LEV	−0.191 ***	−0.198 ***	−0.205 ***	−0.194 ***	−0.201 ***	−0.201 ***
	(−2.66)	(−2.77)	(−2.86)	(−2.72)	(−2.81)	(−2.81)
CASH_AT	−0.275 ***	−0.279 ***	−0.280 ***	−0.277 ***	−0.278 ***	−0.279 ***
	(−3.37)	(−3.42)	(−3.43)	(−3.39)	(−3.41)	(−3.42)
Q	0.058	0.059	0.063	0.065	0.061	0.061
	(0.73)	(0.75)	(0.80)	(0.82)	(0.78)	(0.78)
HI	−0.009	−0.002	−0.001	−0.040	−0.006	−0.016
	(−0.03)	(−0.01)	(−0.00)	(−0.13)	(−0.02)	(−0.05)
HI2	−0.010	−0.015	−0.017	0.010	−0.020	−0.011
	(−0.03)	(−0.05)	(−0.06)	(0.04)	(−0.07)	(−0.04)
LN_AGE	−0.217 ***	−0.223 ***	−0.218 ***	−0.232 ***	−0.220 ***	−0.221 ***
	(−3.39)	(−3.47)	(−3.41)	(−3.63)	(−3.43)	(−3.45)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.259	0.258	0.257	0.260	0.257	0.257
Obs	12,597	12,597	12,597	12,597	12,597	12,597
Panel B: Generality and Originality						
Dep Var = BHAR	**Innovation Measures**					
	GEN	**GEN$_{TN}$**	**GEN$_{TC}$**	**ORG**	**ORG$_{TN}$**	**ORG$_{TC}$**
Innovation	2.067	0.766	0.636	0.244 ***	0.117 ***	0.117 ***
	(0.99)	(0.96)	(0.90)	(3.72)	(4.72)	(3.54)
Dual	0.765 *	0.803 *	0.764 *	0.758 *	0.813 *	0.788 *
	(1.78)	(1.88)	(1.78)	(1.67)	(1.85)	(1.73)
Pct	−0.914 ***	−0.914 ***	−0.914 ***	−0.849 ***	−0.853 ***	−0.850 ***
	(−6.58)	(−6.58)	(−6.58)	(−6.02)	(−6.09)	(−6.03)
Dual * Innovation	**72.898 *** **	**23.570 ** **	**25.096 *** **	**2.077 ***	**0.847 ***	**0.977 ***
	(2.73)	**(2.44)**	**(2.74)**	**(1.78)**	**(1.87)**	**(1.65)**
Pct * Innovation	10.862	3.911	3.553	−0.869 ***	−0.365 ***	−0.438 ***
	(1.12)	(1.04)	(1.08)	(−2.69)	(−3.02)	(−2.70)
LN_MV	−0.588 ***	−0.588 ***	−0.588 ***	−0.589 ***	−0.590 ***	−0.589 ***
	(−32.94)	(−32.90)	(−32.92)	(−32.89)	(−32.98)	(−32.86)
RD_Sale	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004
	(−1.12)	(−1.12)	(−1.12)	(−1.14)	(−1.14)	(−1.12)
CAPX_AT	0.262	0.259	0.261	0.259	0.227	0.258
	(1.12)	(1.10)	(1.11)	(1.10)	(0.97)	(1.10)
PPE_AT	0.219	0.217	0.219	0.182	0.179	0.185
	(1.42)	(1.41)	(1.42)	(1.18)	(1.16)	(1.20)
ROA	−0.047 ***	−0.047 ***	−0.047 ***	−0.046 ***	−0.045 ***	−0.046 ***
	(−5.36)	(−5.37)	(−5.37)	(−5.22)	(−5.13)	(−5.23)
LEV	−0.204 ***	−0.205 ***	−0.204 ***	−0.206 ***	−0.201 ***	−0.207 ***
	(−2.85)	(−2.87)	(−2.86)	(−2.88)	(−2.81)	(−2.89)
CASH_AT	−0.286 ***	−0.284 ***	−0.285 ***	−0.281 ***	−0.279 ***	−0.281 ***
	(−3.50)	(−3.47)	(−3.49)	(−3.43)	(−3.41)	(−3.44)

Table 6. *Cont.*

Panel B: Generality and Originality						
Dep Var = BHAR	**Innovation Measures**					
	GEN	**GEN_{TN}**	**GEN_{TC}**	**ORG**	**ORG_{TN}**	**ORG_{TC}**
Q	0.065	0.065	0.065	0.054	0.052	0.055
	(0.83)	(0.83)	(0.83)	(0.69)	(0.66)	(0.70)
HI	−0.047	−0.041	−0.042	−0.008	−0.025	−0.006
	(−0.15)	(−0.14)	(−0.14)	(−0.03)	(−0.08)	(−0.02)
HI2	0.008	0.003	0.003	−0.022	−0.008	−0.024
	(0.03)	(0.01)	(0.01)	(−0.07)	(−0.03)	(−0.08)
LN_AGE	−0.211 ***	−0.209 ***	−0.211 ***	−0.191 ***	−0.200 ***	−0.190 ***
	(−3.31)	(−3.28)	(−3.30)	(−2.98)	(−3.13)	(−2.97)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.259	0.258	0.258	0.257	0.258	0.256
Obs	12,597	12,597	12,597	12,597	12,597	12,597
Panel C: Innovation Efficiency						
Dep Var = BHAR	**Innovation Measures**					
	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$
Innovation	0.069 ***	0.059 ***	0.031	0.081 ***	0.048 ***	0.046 ***
	(3.77)	(2.69)	(1.24)	(4.02)	(2.92)	(2.75)
Dual	0.922 *	0.780	0.660	0.823	0.890 *	0.927 *
	(1.87)	(1.49)	(1.23)	(1.58)	(1.78)	(1.86)
Pct	−0.953 ***	−0.881 ***	−0.794 ***	−0.856 ***	−0.882 ***	−0.878 ***
	(−5.74)	(−5.04)	(−4.43)	(−4.91)	(−5.30)	(−5.27)
Dual * Innov	**−0.038**	**−0.146**	**−0.224**	**−0.083**	**−0.058**	**−0.029**
	(−0.19)	**(−0.71)**	**(−1.12)**	**(−0.43)**	**(−0.32)**	**(−0.16)**
Pct * Innov	−0.061	0.002	0.072	0.010	−0.000	0.002
	(−0.89)	(0.02)	(0.97)	(0.14)	(−0.01)	(0.02)
LN_MV	−0.586 ***	−0.583 ***	−0.583 ***	−0.583 ***	−0.585 ***	−0.586 ***
	(−32.77)	(−32.57)	(−32.42)	(−32.59)	(−32.71)	(−32.71)
RD_Sale	−0.003	−0.003	−0.004	−0.003	−0.004	−0.004
	(−1.04)	(−1.03)	(−1.06)	(−1.00)	(−1.06)	(−1.07)
CAPX_AT	0.264	0.260	0.250	0.280	0.273	0.273
	(1.12)	(1.10)	(1.06)	(1.19)	(1.16)	(1.16)
PPE_AT	0.202	0.210	0.216	0.214	0.212	0.211
	(1.31)	(1.36)	(1.40)	(1.39)	(1.37)	(1.37)
ROA	−0.049 ***	−0.050 ***	−0.049 ***	−0.051 ***	−0.049 ***	−0.049 ***
	(−5.58)	(−5.63)	(−5.54)	(−5.72)	(−5.57)	(−5.56)
LEV	−0.219 ***	−0.225 ***	−0.222 ***	−0.223 ***	−0.217 ***	−0.216 ***
	(−3.06)	(−3.13)	(−3.09)	(−3.12)	(−3.02)	(−3.01)
CASH_AT	−0.275 ***	−0.279 ***	−0.279 ***	−0.271 ***	−0.274 ***	−0.274 ***
	(−3.36)	(−3.41)	(−3.41)	(−3.31)	(−3.35)	(−3.35)
Q	0.046	0.046	0.049	0.045	0.051	0.051
	(0.59)	(0.58)	(0.62)	(0.58)	(0.65)	(0.65)
HI	−0.029	−0.014	0.002	−0.043	−0.012	−0.019
	(−0.10)	(−0.04)	(0.01)	(−0.14)	(−0.04)	(−0.06)
HI2	0.001	−0.014	−0.030	0.007	−0.017	−0.011
	(0.00)	(−0.05)	(−0.10)	(0.02)	(−0.06)	(−0.04)
LN_AGE	−0.216 ***	−0.215 ***	−0.205 ***	−0.226 ***	−0.219 ***	−0.219 ***
	(−3.37)	(−3.35)	(−3.20)	(−3.53)	(−3.41)	(−3.42)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.257	0.256	0.256	0.258	0.257	0.257
Obs	12,597	12,597	12,597	12,597	12,597	12,597

5.2. Returns to Bondholders

In this section, we study the impact of dual ownership on bondholder returns. We follow prior studies and employ one-year buy-and-hold abnormal bond returns *BDRET*, defined as the value-weighted average of the one-year buy-and-hold returns of different bond issues within a firm relative to their respective benchmark portfolios matched by credit rating and maturity (Bessembinder et al. (2009)). We now estimate the regression Equation (4), in a similar manner as Equation (3) except that our dependent variable now is bond abnormal returns (*BDRET*). All other variables are defined as in Equation (3).

$$\begin{aligned} BDRET_{i,t+1} = \alpha_t + \gamma_i + \beta_1 Dual_{i,t} + \beta_2 Innovation_{i,t+1} \\ + \beta_3 Innovation_{i,t+1} * Dual_{i,t} + \delta X_{i,t} + \varepsilon_{i,t+1}, \end{aligned} \quad (4)$$

Table 7 provides regression results. It appears that neither dual ownership nor innovation measures are significantly associated with bond returns. However, the interaction terms between dual ownership and various innovation measures are overall significantly and positively related to bond abnormal returns. This evidence is consistent with the notion that dual ownership increases bondholder returns by promoting innovative activities, in particular, patent quantity, citations, generality, originality, and patent count efficiency.

Taken together, our analyses show that dual ownership enhances both shareholder and bondholder value via enhancing corporate innovative activities, in particular those inventions with broader impacts on future innovation, and those that are radical and breakthrough rather than marginal. These results are consistent with the hypothesis that dual owners garner superior information advantages due to their participation in both the equity and bond markets and thereby make more effective monitors and advisers to the management regarding innovation. We do not find evidence consistent with the notion that dual ownership exacerbates the shareholder-bondholder conflict of interest, thereby aggravating risk aversion, compromising the effectiveness of shareholder monitoring, and hindering corporate innovation. It is worth noting that Low et al. (2007) suggest that stronger shareholder power, through superior monitoring of managers, improves collateral values, in particular bondholder excess returns. We provide evidence consistent with Low et al. (2007).

Table 7. Dual Ownership, Innovation, and Bond Returns. This table presents regression results of one-year buy-and-hold abnormal bond returns on the interaction term of dual ownership and various innovation measures. Panel A analyzes the number of patents and total citations received in life, Panel B analyzes patent generality and originality, and Panel C analyzes innovation efficiency. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants and control variables are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations

Dep Var = BDRET	**Innovation Measures**					
	Ln(1+Pats)	**Ln(1+Pats$_{TN}$)**	**Ln(1+Pats$_{TC}$)**	**Ln(1+Cites)**	**Ln(1+Cites$_{TN}$)**	**Ln(1+Cites$_{TC}$)**
Innovation	−0.018	−0.027	−0.048	−0.006	−0.013	−0.015
	(−1.23)	(−1.30)	(−1.39)	(−0.28)	(−1.08)	(−1.20)
Dual	−0.124	−0.074	−0.049	−0.031	0.024	0.040
	(−0.59)	(−0.35)	(−0.23)	(−0.15)	(0.12)	(0.20)
Pct	0.107	0.097	0.088	0.117	0.087	0.080
	(0.76)	(0.69)	(0.63)	(0.85)	(0.63)	(0.58)
Dual * Innovation	**0.305 *** **	**0.335 ** **	**0.483 ** **	**0.399 ** **	**0.113**	**0.082**
	(2.92)	**(2.26)**	**(2.02)**	**(2.35)**	**(1.16)**	**(0.85)**
Pct * Innovation	0.021	0.045	0.078	−0.090	0.013	0.019
	(0.31)	(0.46)	(0.48)	(−0.76)	(0.20)	(0.30)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.602	0.600	0.600	0.600	0.599	0.599
Obs	1676	1676	1676	1676	1676	1676

Table 7. *Cont.*

Panel B: Generality and Originality						
Dep Var = BDRET	**Innovation Measures**					
	GEN	**GEN$_{TN}$**	**GEN$_{TC}$**	**ORG**	**ORG$_{TN}$**	**ORG$_{TC}$**
Innovation	−2.354	−0.947	−0.820	−0.054	−0.011	−0.026
	(−1.20)	(−1.21)	(−1.22)	(−0.76)	(−0.38)	(−0.73)
Dual	−0.045	−0.040	−0.048	−0.163	−0.033	−0.150
	(−0.22)	(−0.20)	(−0.24)	(−0.77)	(−0.16)	(−0.71)
Pct	0.131	0.140	0.132	0.161	0.132	0.159
	(0.97)	(1.05)	(0.98)	(1.15)	(0.97)	(1.13)
Dual * Innovation	**55.189 *** **	**20.447 *** **	**18.834 *** **	**1.608 *** **	**0.475 ** **	**0.768 *** **
	(3.13)	**(2.95)**	**(3.17)**	**(3.21)**	**(2.37)**	**(3.05)**
Pct * Innovation	8.873	4.185	2.972	−0.112	−0.055	−0.054
	(0.75)	(0.84)	(0.75)	(−0.36)	(−0.42)	(−0.35)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.604	0.604	0.604	0.602	0.600	0.602
Obs	1676	1676	1676	1676	1676	1676
Panel C: Innovation Efficiency						
Dep Var = BDRET	**Innovation Measures**					
	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Pats_{TC}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TN}}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites_{TC}}{1+R\&D}\right)$
Innovation	0.010	0.019	0.023	0.020	0.009	0.008
	(0.76)	(1.20)	(1.27)	(1.41)	(0.82)	(0.73)
Dual	0.317	0.251	0.192	0.258	0.211	0.192
	(1.40)	(1.06)	(0.79)	(1.08)	(0.92)	(0.84)
Pct	−0.015	−0.054	−0.089	−0.101	−0.024	−0.023
	(−0.10)	(−0.33)	(−0.53)	(−0.61)	(−0.15)	(−0.15)
Dual * Innov	**0.184 ** **	**0.107**	**0.054**	**0.094**	**0.079**	**0.064**
	(2.28)	**(1.27)**	**(0.65)**	**(1.20)**	**(1.08)**	**(0.86)**
Pct * Innov	−0.079	−0.103 *	−0.117 **	−0.118 **	−0.078	−0.076
	(−1.49)	(−1.82)	(−2.06)	(−2.21)	(−1.62)	(−1.57)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj Rsq	0.600	0.599	0.599	0.599	0.599	0.599
Obs	1676	1676	1676	1676	1676	1676

6. Financial Crisis Analyses

So far, we have shown that dual ownership promotes corporate innovation, including patent count, citations, generality, originality, and innovative efficiency. Furthermore, dual ownership enhances both shareholder and bondholder returns via its positive impact on innovation. Overall, our evidence is consistent with dual ownership benefiting corporate innovation, possibly due to dual owners' advantages at internalizing (at least partially) the costs of debts leading to reduced conflict of interest between shareholders and creditors. This advantage enables dual owners to make better, more effective monitors and advisers when it comes to corporate decisions such as innovation. Our evidence is inconsistent with the hypothesis that dual ownership may serve to hinder risky corporate investments such as innovation, as dual owners may suffer from exaggerated risk aversion and conflict of interest arising from their bond holdings. We recognize, however, that these two competing hypotheses are not mutually exclusive, and one may dominate the other for certain types of firms or during certain time periods.

In this section, we examine the impact of an economy-wide shock on the effect of dual ownership on innovation. More specifically, we aim to test whether firms with greater dual ownership fare better during the financial crisis period when the investors and economy at large suffer extraordinary uncertainty and risk, and a severe loss of trust and confidence

in the capital markets. Alternatively, dual ownership may impede corporate innovation and, in turn, reduce firm value, due to aggravated risk aversion and intensified conflict of interest between shareholders and bondholders, during the financial crisis period.

In Table 8, we re-run our baseline regressions (Table 3) and the tests on stock- and bondholder returns (Tables 5 and 6), separating our sample into non-crisis versus financial crisis periods. The non-crisis period is defined as the years 2003–2006, and the financial crisis period as 2007–2010, in which public trust in corporations, capital markets, and institutions unexpectedly declined. We cannot conduct this test for the NBER patent dataset because of limitations in data availability, as the NBER patent database ends in 2006. Instead, we use the KPSS database for 2003–2010 and construct innovation measures without technology classifications (even for the years 2003–2006). This enables a consistent comparison and avoids any bias due to a change of sample after 2007. However, results using the KPSS database from 2003 to 2006 are similar to those using the NBER database.

Table 8. Financial Crisis Analyses. This table presents regression results during non-crisis versus financial crisis periods. The non-crisis period is defined as 2003–2006 and the financial crisis period as 2007–2010. Panel A analyzes patent output variables including the number of patents and total citations received in life, and the innovation efficiency measures defined as patent number and citations divided by R&D. Panel B regresses one-year buy-and-hold abnormal stock returns on the interaction term of dual ownership and various innovation measures, while Panel C focuses on one-year buy-and-hold abnormal bond returns. *t*-statistics based upon robust standard errors are shown in brackets. All regressions include firm and year fixed effects. Constants and control variables are included in all regressions but omitted from the tables for brevity. All except binary variables are winsorized at the upper and lower 1% level. Variables are defined in Appendix A. ***, **, and * denotes significance at the 1%, 5%, and 10% level.

Panel A: Patents and Citations				
Dep Var =	**Ln(1+Pats)**	**Ln(1+Cites)**	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$
		Non-Crisis Period		
Dual	**0.397 ***	**1.294 *****	**0.431**	**1.304 *****
	(1.69)	**(3.26)**	**(1.53)**	**(3.03)**
Pct	−0.083	−0.555 ***	−0.427 ***	−0.926 ***
	(−1.07)	(−4.19)	(−4.55)	(−6.45)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.916	0.841	0.893	0.792
Obs	14,956	14,956	14,956	14,956
		Financial Crisis Period		
Dual	**−1.464 *****	**−1.076 *****	**−1.301 *****	**−0.900 *****
	(−5.22)	**(−4.14)**	**(−4.05)**	**(−2.96)**
Pct	0.282 ***	0.301 ***	0.092	0.095
	(2.66)	(3.07)	(0.76)	(0.83)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.523	0.406	0.894	0.913
Obs	13,543	13,543	13,543	13,543

Panel B: Dual Ownership, Innovation, and Stock Returns				
Dep Var = BHAR	**Innovation Measures**			
	Ln(1+Pats)	**Ln(1+Cites)**	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$
		Non-Crisis Period		
Innovation	0.040 *	0.064 ***	0.009	0.049 ***
	(1.75)	(4.36)	(0.44)	(3.37)
Dual	0.513	0.450	1.071 **	1.160 ***
	(1.01)	(0.92)	(2.29)	(2.63)

Table 8. *Cont.*

Panel B: Dual Ownership, Innovation, and Stock Returns				
Dep Var = BHAR	**Innovation Measures**			
	Ln(1+Pats)	**Ln(1+Cites)**	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$
Pct	−0.819 ***	−0.771 ***	−0.907 ***	−0.969 ***
	(−5.35)	(−5.20)	(−5.71)	(−6.50)
Dual * Innov	**0.482 ** **	**0.434 ** **	**0.031**	**0.244**
	(1.96)	**(2.30)**	**(0.11)**	**(1.07)**
Pct * Innov	−0.149	−0.166 **	0.016	−0.090
	(−1.55)	(−2.44)	(0.20)	(−1.38)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.256	0.257	0.255	0.257
Obs	12,605	12,605	12,605	12,605
		Financial Crisis Period		
Innovation	−0.065 **	−0.058	−0.018	−0.020
	(−1.97)	(−1.51)	(−0.87)	(−0.92)
Dual	0.613	0.622	0.653	0.660
	(1.53)	(1.57)	(1.38)	(1.38)
Pct	−0.466 ***	−0.452 ***	−0.581 ***	−0.606 ***
	(−3.18)	(−3.10)	(−3.33)	(−3.42)
Dual * Innov	**−0.128**	**−0.278**	**0.017**	**0.013**
	(−0.36)	**(−0.67)**	**(0.11)**	**(0.09)**
Pct * Innov	0.055	−0.003	−0.080	−0.093
	(0.45)	(−0.02)	(−1.21)	(−1.40)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.122	0.122	0.122	0.122
Obs	11,533	11,533	11,533	11,533
Panel C: Dual Ownership, Innovation, and Bond Returns				
Dep Var = BDRET	**Innovation Measures**			
	Ln(1+Pats)	**Ln(1+Cites)**	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$
		Non-Crisis Period		
Innovation	−0.036 **	−0.028 **	−0.001	−0.007
	(−2.00)	(−2.13)	(−0.04)	(−0.44)
Dual	−0.114	−0.195	0.220	0.222
	(−0.47)	(−0.85)	(1.04)	(1.09)
Pct	−0.087	0.028	0.063	0.049
	(−0.52)	(0.17)	(0.45)	(0.36)
Dual * Innov	**0.146**	**0.189 ** **	**0.269 ** **	**0.315 *** **
	(1.58)	**(2.47)**	**(2.03)**	**(2.96)**
Pct * Innov	0.141 **	0.055	−0.068	−0.076
	(2.21)	(1.04)	(−0.89)	(−1.21)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.607	0.607	0.604	0.606
Obs	1677	1677	1677	1677
		Financial Crisis Period		
Innovation	−0.020	−0.026	−0.010	−0.008
	(−0.95)	(−1.02)	(−0.65)	(−0.52)
Dual	−0.096	−0.093	−0.140	−0.140
	(−0.52)	(−0.51)	(−0.66)	(−0.64)
Pct	−0.217 *	−0.217 *	−0.161	−0.162
	(−1.76)	(−1.78)	(−1.18)	(−1.16)

Table 8. *Cont.*

Panel C: Dual Ownership, Innovation, and Bond Returns				
Dep Var = BDRET	**Innovation Measures**			
	Ln(1+Pats)	**Ln(1+Cites)**	$Ln\left(\frac{1+Pats}{1+R\&D}\right)$	$Ln\left(\frac{1+Cites}{1+R\&D}\right)$
Dual * Innov	**−0.076**	**−0.100**	**−0.012**	**−0.013**
	(−0.54)	**(−0.61)**	**(−0.18)**	**(−0.19)**
Pct * Innov	0.055	0.078	0.026	0.023
	(0.67)	(0.77)	(0.51)	(0.46)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj Rsq	0.027	0.027	0.026	0.026
Obs	2395	2395	2395	2395

Panel A of Table 8 analyzes the effect of dual ownership on patent count, citations, and innovation efficiency as proxied by patent count and citations, respectively, per R&D dollar spent. Panel A shows a positive and significant coefficient on dual ownership in three out of four models during the non-crisis period of 2003–2006. In contrast, dual ownership is significantly and negatively related to all four innovation measures during the financial crisis period. These results indicate that dual ownership had a negative impact on the firm's ability to innovate during the crisis, thereby exaggerating the already dire situation associated with firms during the financial crisis. While our tests do not fully uncover the specific mechanism at force here, a possible explanation is that dual owners suffer extraordinary risk aversion due to their holdings of the same firm's bonds during the extremely uncertain, risky crisis period when the trust in corporations, institutions, and the whole economy deteriorated. As a result, dual owners may serve to discourage risk-taking, even those risky, positive NPV projects like patenting innovation.

One question that can arise is how is this fear and uncertainty effect connected to the conflict of interest between shareholders and debtholders? This effect is similar to what debt overhang would do to firms, especially financially distressed firms: exaggerated risk aversion and worsened underinvestment. Financial crisis can exaggerate financial distress for many firms, increase risk aversion of firm managers and reduce investment in risky but valuable projects such as innovations. Particularly for dual holders, this peril of underinvestment in innovation will outweigh the benefits of internalizing the costs of debtholders during financial crisis thus leading to a reduction in innovation output.

Put differently, the magnitude of the conflict of interest between shareholders and debtholders varies from time to time, and so do the benefits and costs associated with dual holdings. Generally speaking, during normal times, dual holdings may alleviate the conflict of interest by decreasing risk aversion and encouraging valuable risk-taking (mitigation of the underinvestment problem as shown in the main test). During financial crisis, under extreme uncertainty, however, both stockholders and debtholders are subject to exaggerated risk and certainty and, in turn, experience extreme risk aversion (not only debtholders as during the normal time). Therefore, rather than mitigating risk aversion, dual holdings have little impact or even worsen the impact on risk aversion.[9]

Consistent with our conjecture, Panels B and C show that while the coefficients on the interaction terms between dual ownership and our four innovation measures are significant and positive during the non-crisis period, these coefficients become insignificant during the financial crisis period. And these findings hold for both stock and bond abnormal returns.

In sum, our financial crisis analyses suggest that the conflict of interest between stock- and bond-holders culminates during the financial crisis period, thereby exaggerating dual owners' risk aversion, deterring corporate innovation, and failing to increase value for shareholders or bondholders.

7. Robustness, Discussion, and Limitation

In previous sections, we have examined how mutual fund dual ownership affects shareholder-bondholder conflicts and in turn corporate innovation quantity and quality, shareholder and bondholder value creation, and firm innovative outcomes during normal vs. financial crisis periods. In this section, we further our study to investigate a range of additional tests in an effort to ensure that our findings are robust to alternative factors, issues, and explanations.[10] In addition, we discuss the potential limitations of our study.

7.1. Managerial Attributes and Corporate Governance

Recent studies show that some managers may be more exploratory while others may be more risk-averse. Thus, manager attributes matter a great deal in corporate innovation. For example, He and Hirshleifer (2022) find that CEOs with Ph.D. degrees tend to promote more exploratory patents with greater novelty, generality, and originality, invest more in R&D and alliances, and deliver superior long-run operating performance. Further, corporate governance, particularly the board of directors, affects corporate innovation (e.g., Griffin et al. 2021; Bolton and Zhao 2022; Benetyte et al. 2021). We thus perform robustness tests by running the baseline regressions while controlling for additional managerial attributes and board-of-director governance variables that are likely associated with innovation. These variables include Insider Ownership (fraction of firm's shares owned by the top five executives); Equity_Total Pay (the sum of the top five executives' equity pay divided by the sum of their total pay); G-Index (Governance-Index as constructed in Gompers et al. (2003)); Board Size (the number of directors on board); Board Independence (fraction of independent directors); Board Interlock (fraction of directors who are interlocked); Board Busyness (fraction of directors who sit on three or more outside boards); and Average Director Age (the average age of directors).

Untabulated analyses show that after controlling for these additional managerial attributes and board governance variables, Dual Ownership remains positive and significant, lending further support to our baseline findings.[11] Consistent with prior literature, e.g., Chemmanur and Tian (2018) and Bolton and Zhao (2022), we find some evidence that insider ownership is negatively associated with innovation; managerial entrenchment as proxied by G-index helps promote innovation by protecting managers against adverse circumstances out of their control; executive equity pay enhances innovation by providing the appropriate risk-taking incentives; board size is negatively related to innovation due to ineffective monitoring and advising as the number of directors increases; director professional ties (interlock) improves innovation while director busyness deters innovation by attenuating director attention.

7.2. Dynamic Panel GMM Estimation

While we have provided evidence of a significant and positive association between dual ownership and corporate innovation, it is possible that innovation may drive dual ownership, or an unobservable factor can determine both simultaneously. Thus, it's important to address or at least consider such endogeneity issues in our analyses.

As the first attempt to mitigate concerns of endogeneity/simultaneity to some degree, we regress future innovation (in $t + 1$) on current mutual fund dual ownership (at the end of year t) in all of our regression analyses. Untabulated results show that longer time distances between mutual fund dual ownership and innovation (Year $t + 2$, Year $t + 3$, and Year $t + 5$) produce qualitatively similar results. We use Year $t + 1$ to maximize the size of our sample. We also include an extensive set of firm characteristics, and firm and year fixed effects to control any time-invariant, firm-specific unobservables that might potentially drive both mutual fund dual holdings and innovation measures.

To more completely address the potential endogeneity issue, we follow prior literature, such as Wintoki et al. (2012) and Wang and Zhao (2015), and conduct dynamic panel

GMM estimations. More specifically, we estimate the following dynamic GMM model by employing the method of Blundell and Bond (1998):

$$Innovation_{i,t+1} = \alpha_t + \gamma_i + \rho Innovation_{i,t} + \beta Dual_{i,t} + \delta X_{i,t} + \varepsilon_{i,t+1} \quad (5)$$

where *Innovation* denotes a measure of patent quantity, citations, generality, and originality, *Dual* is mutual fund dual ownership, X contains all of the control variables, and αt and γi are year and firm fixed effects, respectively. Untabulated results show that dual ownership remains positive and significant for patent citations per patent, generality, and originality scores but loses statistical significance for patent quantity.[12] Overall, we find qualitatively similar results after controlling for endogeneity using dynamic panel GMM estimators, in particular for patent quality measures.[13]

7.3. Data Limitation

We note that our innovation variables are constructed with the NBER (ends in 2006) and KPSS data (ends in 2010) through 2010. Most of the prior studies we have cited have their sample periods end in 2010. The KPSS data have been recently updated through 2020 since we started this study, however, we still choose to keep the original sample period through 2010 for several reasons.

First, ending our sample period in 2010 enables us to provide the most reliable comparison to other studies, including both mutual fund/institutional dual ownership studies and innovation studies. It is possible that some of the dynamics between innovation and mutual fund dual holdings might have changed during the 2011–2020 period, which would not be captured by our study. Nevertheless, we feel it would be best to use the sample through 2010 particularly because if we employ an innovation dataset beyond 2011 and uncover new results relative to prior studies, we are not able to distinguish whether the new findings are driven by the dynamics between dual ownership and innovation per se or by the new sample period.

Second, in the updated KPSS data from 2011–2020, technology classification data is not available. Therefore, we won't be able to construct the technology class/category adjusted patent quantify or citation measures used in this study, nor are we able to construct patent generality or originality measures. The only variables we can construct from the new dataset are raw patent quantity and raw patent citations.

Taken together, to obtain the best use of both our mutual fund dual holdings and innovation data and to provide the most relevant comparisons to prior work, we feel it would be best to use the KPSS data through 2010.

8. Conclusions

Using the NBER and KPSS patent and citation databases, we examine the impact of mutual fund dual ownership (i.e., the percentage of shares outstanding held by mutual fund families who hold both stocks and bonds of the same firms) on corporate innovation during 2003–2010. Our findings indicate that dual ownership has a positive effect on a firm's future patent quantity and quality, as measured by patent count, citations, generality, and originality. This effect is primarily driven by non-index mutual fund dual holders, which are more likely to actively monitor corporate management. Our results are consistent with the hypothesis that dual ownership promotes both the quantity and quality of corporate innovation. These benefits may arise from the advantages dual owners gain by holding both the equity and debt of the same firm, which allows them to align incentives and make superior corporate decisions. Furthermore, our study shows that dual ownership increases returns for both stockholders and bondholders especially for higher-quality, more radical, and breakthrough innovations that have a more significant and broader impact on future innovation.

Further analysis reveals that the positive effects of mutual fund dual ownership on corporate innovation and shareholder and bondholder value only hold during the non-crisis period. In contrast, during the 2007–2010 financial crisis, dual ownership has a negative impact

on a firm's ability to innovate. These results align with the idea that during the uncertain and risky crisis period, dual owners are subject to extraordinary risk aversion due to their bond holdings. As a result, they may have discouraged risk-taking, including investments in potentially profitable projects such as patenting innovation. Our evidence suggests that the conflicts of interest between stockholders and bondholders are exacerbated during financial crisis periods, leading to increased risk aversion among dual owners, hindering corporate innovation, and failing to enhance shareholder or bondholder returns.

This paper adds to the existing research on the impact of dual ownership on corporate decisions by uncovering a new mechanism through which dual ownership may influence a firm's value. Our findings provide new insight into the ongoing debate surrounding the role of mutual fund families that hold both stocks and bonds in shaping corporate investment decisions and generating value for firms.

More specifically, we show that, indeed, there appears to be coordination between individual mutual funds within a fund family. This collaboration between individual funds despite the unique attributes of mutual funds helps internalize the costs of shareholder-debtholder conflicts of interest—essentially mutual fund families become both the shareholder and debtholder of their investee firms. As a result, mutual fund dual ownership mitigates this shareholder-debtholder conflicts of interest in the portfolio firms and leads to greater patent quantity, quality, originality, and impact, as well as greater firm value.

Our findings have important policy implications regarding mutual fund regulations. For one, we have documented that cross-fund collaboration and information-sharing can play a beneficial role in the corporate governance of portfolio companies by alleviating conflicts of interest between shareholders and debtholders. Our findings also shed new light for practitioners and researchers alike in that one should take into consideration the impact of dual ownership, beyond mutual fund ownership alone, on firm stock and bond returns when making investment decisions or performing analytical studies.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Variable Definitions

Variable	Definition
Panel A: Patent Innovation	
Pats	The total number of patents filed by (and ultimately granted to) a firm in a year (sample period: application year over 1995–2010).
$Pats_{TN}$	Equals Pats divided by the average number of patents filed across all firms in the same application year and the same U.S. Patent and Trademark Office (USPTO) technological class.
$Pats_{TC}$	Equals Pats divided by the average number of patents filed across all firms in the same application year and the same Hall et al. (2002) (henceforth HJT) technological category.
Cites	Total future citations received in life on all patents filed by (and ultimately granted to) a firm in a year (sample period: application year over 1995–2010).
$Cites_{TN}$	Equals Cites divided by the total number of citations received on all patents filed in the same USPTO class (HJT technological category) for the same application year.
$Cites_{TC}$	Equals Cites divided by the total number of citations received on all patents filed in the same HJT techno-logical category for the same application year.

Variable	Definition
Panel A: Patent Innovation	
GEN	The average generality score across all patents filed by a firm in a calendar year, where the generality score for each patent is constructed using USPTO technological classes as follows and bias-corrected as in Hall (2005): $$Generality_i = 1 - \sum_j^{n_i} S_{ij}^2,$$ where S_{ij} denotes the percentage of citations received by patent i that belongs to patent class j, out of n_i pa-tent classes.
GEN_{TN}	Constructed analogously except that the generality score for each patent is scaled by the average generality of all patents filed in the same USPTO (HJT) class for the same application year to correct for truncation bias in citation data.
GEN_{TC}	Constructed analogously except that the generality score for each patent is scaled by the average generality of all patents filed in the same HJT class for the same application year to correct for truncation bias in cita-tion data.
ORG	The average originality scores across all patents filed by a firm in a calendar year, where the originality score for each patent is constructed using USPTO class and bias-adjusted as in Hall (2005), which is con-structed in the same manner as the generality score, except that originality score refers to citations *made* rather than *received*.
ORG_{TN}	Constructed similarly to ORG, except that the originality score for each patent is scaled by the average originality of all patents filed in the same USPTO (HJT) class and application year.
ORG_{TC}	Constructed similarly to ORG, except that the originality score for each patent is scaled by the average originality of all patents filed in the same HJT class and application year.
Panel B: Mutual Fund Ownership	
Dual	The fraction of the total number of shares outstanding held by dual owners for a firm at the year-end.
Pct	The fraction of the total number of shares outstanding held by all mutual funds for a firm at the year-end.
Adj Dual	The sum of shares held by dual owners divided by the sum of shares held by all mutual funds for a firm at the year-end.
Panel C: Stock and Bond Performance	
BHAR	Daily buy-and-hold stock returns minus the value-weighted average returns on a matched size, book-to-market, and momentum portfolio over the next 365 calendar days, following the current fiscal year-end.
BDRET	Value-weighted average of the one-year buy-and-hold returns of different bond issues within a firm relative to their respective benchmark portfolios matched by credit rating and maturity (Bessembinder et al. 2009)
Panel D: Control Variables	
LN_MV	Natural logarithm of MV, where MV is Market value of equity = share price times the number of shares outstanding [#25*#199].
RD_Sale	Research and development expenditures over total sales [#46/#12].
CAPX_AT	Capital expenditures over total assets [#128/#6].
PPE_AT	Net property, plant, and equipment over total assets [#8/#6].
ROA	Return on assets, defined as operating income before depreciation over total assets [#13/#6].
LEV	Book value of debts over book value of total assets [(#34+#9)/#6].
CASH_AT	Cash over total assets [#1/#6].
Q	Tobin's q, defined as market value of assets over book value of total assets [(#6-#60+abs(#25*#199))/#6].
H.I.	Herfindahl index based on sales of 4-digit SIC industry to which the firm belongs.
HI^2	The square of H.I.
LN_AGE	Natural logarithm of one plus firm age, measured as the number of years listed in CRSP.
Panel E: Additional Control Variables for Robustness Tests—Managerial Attributes & Board of Directors	
Insider Ownership	Fraction of firm's shares owned by the top five executives.
Equity _Total Pay	The sum of the top five executives' equity pay divided by the sum of their total pay.
G-Index	Governance-Index as constructed in Gompers et al. (2003)
Board Size	The number of directors on the board.
Board Independence	Fraction of independent directors on the board.
Board Interlock	Fraction of directors who are interlocked.
Board Busyness	Fraction of directors who sit on three or more outside boards.
Avg. Director Age	The average age of directors on the board.

Notes

[1] See, e.g., Parrino et al. (2003), Hartzell and Starks (2003), Chen et al. (2007), Cornett et al. (2008), Kim and Lu (2011), Aghion et al. (2013), and Luo et al. (2021), among others.

[2] For example, previous studies examine the relation between innovation and various other factors, including state anti-takeover laws (Atanassov (2013) and Chemmanur and Tian (2018)), analyst coverage (He and Tian (2013)), institutional ownership (Aghion et al. (2013)), CEO overconfidence (Hirshleifer et al. (2012)), non-executive employee stock options (Chang et al. (2015)), labor unions (Bradley et al. (2018)), hedge fund activists (Brav et al. (2018)), hedge fund ownership (Wang and Zhao (2015)), corporate diversity and inclusion policies (Mayer et al. (2018)), pay-for-performance (Ederer and Manso (2013)), family control (Sakawa and Watanabel (2021)), and corporate ditigal transformation in China (Li and Shen (2021)), among others.

[3] We thank an anonymous referee for suggesting this important alternative hypothesis. It aids in obtaining a more complete view of the multitude of aspects of shareholder-debtholder conflict of interest.

[4] We thank Noah Stoffman for making this data available at iu.box.com/patents.

[5] Only the NBER data contains detailed information on USPTO technological classes and HJT categories; thus for all bias-adjusted measures we are able to use only the NBER data through 2006.

[6] Zhou (2001) suggests that firm fixed effects may significantly reduce the power of statistical tests, especially in the absence of large within-variations in ownership. Thus, the inclusion of firm fixed effects should, if anything, bias against us finding significant results.

[7] Several other studies, such as Lanjouw and Schankerman (2004), Matolcsy and Wyatt (2008), and Pandit et al. (2011), find a positive association between patent counts or patent citations and firms' returns, operating performance, and valuation.

[8] To form the size/book-to-market (BM)/momentum benchmark, all NYSE-listed firms are divided into five quintiles based on size, five quintiles based on BM, and five quintiles based on momentum, where size, BM, and momentum are defined as in Fama and French (1992, 1993), Lyon et al. (1999), and Daniel et al. (1997). The intersection of these groupings yields 125 size/BM/momentum portfolios. Each sample firm is placed into its appropriate portfolio, and its return is adjusted for the value-weighted average returns across all other firms in that portfolio, i.e., all firms on CRSP with size, BM, and momentum data after excluding firms that have gone public, had an SEO or acquisition within the past three years. Results using an equal-weighting scheme are qualitatively similar.

[9] We thank an anonymous referee for raising these points.

[10] We thank two anonymous referees for their suggestions on these robustness checks, which have significantly enhanced our paper and lent further credence to our findings.

[11] Tables are available upon request.

[12] Tables are available upon request.

[13] We choose not to perform some other econometric methods that have been used in previous work to address endogeneity (e.g., two-stage least squares (2SLS) regressions or propensity score matching) because it is extremely challenging, if not impossible, to identify appropriate instrumental variables that are correlated with mutual fund dual holdings but not with firm innovation or to design structure models, which might lead to results that are econometrically powerful but not economically meaningful. We do not employ the identification strategy by using mergers between mutual fund families as exogenous shocks to mutual fund dual holdings out of the concern that such mergers might be scarce over the sample period, rendering it difficult to interpret the results. Indeed, Wang et al. (2021) report only 34 cross-family mutual fund mergers between 2010 and 2016, where fund families become dual holders post-mergers.

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