The Lifecycle Effects of Corporate Takeover Defenses

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William C. Johnson
Suffolk University

Jonathan M. Karpoff
University of Washington and ECGI

Sangho Yi
Sogang Univesity

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Abstract

We document that the relation between firm value and the use of takeover defenses is positive for young firms but becomes negative as firms age. This value reversal pattern reflects specific changes in the costs and benefits of takeover defenses as firms age and arises because defenses are sticky and rarely removed. Firms can attenuate the value reversal by removing defenses, but do so only when the defenses become very costly and adjustment costs are low. The value reversal explains previous mixed evidence about takeover defenses and implies that firm age proxies for takeover defenses' heterogeneous impacts on firm value.

Keywords: Takeover defenses, antitakeover provisions, value reversal, lifecycle

JEL Classifications: G34, K22, L14

William C. Johnson*
Associate Professor, Finance
Suffolk University, Sawyer Business School
73 Tremont Street
Boston, MA 02108, USA
e-mail: wcjohnson@suffolk.edu

Jonathan M. Karpoff
Professor of Finance
Foster School of Business, University of Washington
PACCAR Hall, 4277 NE Stevens Way
Seattle, WA 98195, USA
phone: + 1 206 685 4954
e-mail: karpoff@uw.edu

Sangho Yi
Professor of Finance
Sogang University, Business School
35 Baekbeom-ro, Daeheung-dong, Mapo-gu,
Seoul, South Korea
e-mail: yisangho@sogang.ac.kr

*Corresponding Author

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William C. Johnson
Sawyer Business School
Suffolk University
Boston, MA 02108
wcjohnson@suffolk.edu

Jonathan M. Karpoff
Foster School of Business
University of Washington
Seattle, WA 98195
karpoff@uw.edu

Sangho Yi
Sogang Business School
Sogang University
Seoul, South Korea
yisangho@sogang.ac.kr

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Corresponding author: Jonathan M. Karpoff, Foster School of Business, Box 353226, University of Washington, Seattle, WA 98195; 206-685-4954; karpoff@uw.edu.

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Introduction

Most managers and researchers would probably agree that "one size does not fit all firms" when it comes to takeover defenses. But the existing literature provides little guidance to understand how firms use or shed takeover defenses or how defenses affect firms differently, in the cross-section or over time. The impact of takeover defenses on firm value is particularly unsettled, as Burkart and Panunzi (2006) conclude "…there is still little consensus about the effects of takeover defenses on shareholder wealth, despite the large number of papers on this topic."[1]

This paper proposes a framework to better understand firms' uses of takeover defenses and their effects on firm value. We build upon previous research suggesting that takeover defenses convey benefits and costs that are specific to each firm.[2] We hypothesize that, in addition: (i) the benefits typically decline and the costs increase as a firm ages; and (ii) takeover defenses are sticky, so firms tend not to shed them even when they become costly. As a result, defenses that add value when a firm is young impair value as the firm ages. We call this the value reversal hypothesis of corporate takeover defenses.

Consistent with the value reversal hypothesis, we find that the relation between Tobin's q and a firm's use of defenses decreases as the firm ages. The value reversal pattern is extremely robust, as it holds using different measures of a firm's takeover defenses, including the E-index, the presence or absence of a classified board, the E-index minus golden parachutes, and several other measures discussed below. The value reversal pattern does not reflect selection effects, but rather, occurs within individual firms as they age. It persists in fixed samples of surviving firms and is robust to various empirical specifications. In multivariate tests that examine the determinants of q, the coefficient on the E-index is 0.283 at the time of the firm's IPO and is -0.173 ten years after the IPO (both coefficients significant at the 1% level, and significantly different from each other). These point estimates imply that an incremental takeover defense

[1] In another survey, Straska and Waller (2014, p. 941) concur: "… [E]vent studies have been largely inconclusive in determining how antitakeover provisions impact shareholder wealth."
[2] See, for examples, Johnson, Karpoff, and Yi (2015), Cen, Dasgupta, and Sen (2016), Cremers, Litov, and Sepe (2017), and Field and Lowry (2020).

is associated with an average increase in firm value of $23.0 million at the IPO stage, but a decrease in value of $41.5 million among firms that survive to be ten years old.

We hypothesize that two forces drive the value reversal pattern. First, takeover defenses convey fewer benefits and impose higher costs as a firm ages. Consistent with this hypothesis, proxies for the bonding benefits of takeover defenses – including the values of sales to large customers, durable product sales, and CEO-founders – decrease with firm age. Likewise, proxies for the entrenching costs of takeover defenses – including the values of cash holdings, diversifying acquisitions, and a combined CEO and board chair – increase with firm age.[3] Furthermore, the value reversal – that is, the decrease in the relation between q and takeover defenses as a firm ages – is related to these specific changing benefits and costs. These results imply that the value reversal is not due to firm age *per se*. Rather, it arises because firm age serves as a proxy for firm-specific changes in the benefits and costs of takeover defenses.

The second force that drives the value reversal is that takeover defenses are extremely sticky, i.e., firms do not frequently remove them. If takeover defenses were not sticky, firms would adjust their defenses as the benefits decrease and costs increase, and there would be no value reversal. Consistent with this hypothesis, we find that takeover defenses are extremely sticky and are rarely removed. The unconditional probability that a firm with preexisting defenses will keep all of its defenses the following year is 98.7%, and 93.3% of the firms in our sample never remove even a single E-index takeover defense after their IPOs. Also, the value reversal occurs primarily among firms that deploy the most sticky defenses. These results help to complete the picture of the value reversal, which arises because the benefits and costs of takeover defenses change over time and firms do not adjust their defenses accordingly.

This raises the question of why most firms do not remove their defenses even when they become costly. To explore this question we examine the characteristics of the relatively few firms that do remove a defense. We hypothesize that firms have incentive to remove a defense when its net benefit is negative. As Kahan and Klausner (1996) and Hannes (2005, 2006) argue, however, removing a defense requires

[3] We discuss these proxy variables and the rationale for each in Section 4, building upon similar proxies in Johnson et al. (2015), Cen et al. (2016), Cremers et al. (2017), and Intintoli, Serfling, and Shaikh (2017).

shareholders to overcome a collective action problem in the face of organizational inertia and managerial opposition. The evidence supports this hypothesis, as we find that the probability that a firm removes a takeover defense is positively related to the cost of having defenses and negatively related to measures of shareholders' cost of collective action to remove a defense. Furthermore, the value reversal is mitigated for firms that do remove takeover defenses. These results are consistent with a costly adjustment equilibrium in which firms are constrained from continuously adjusting to their optimal takeover defenses by the cost of adjustment.

Together, these results show that the benefits and costs of having takeover defenses, and the benefits and costs of removing defenses, vary across firms and for each firm as it ages. Defenses are sticky and tend not to change, but their effect on firm value changes significantly as the firm ages. This creates a life cycle-based value reversal pattern in the relation between the uses of defenses and firm value. Firms sometimes remove a defense – but only rarely and when the benefits of removal exceed the costs – and thus attenuate the value reversal pattern.

A possible concern with our analysis is that firm value and the use of takeover defenses are endogenous to the firm's competitive environment. If the value reversal reflects selection and endogeneity, it still explains how the relation between firm value and takeover defenses can be positive in some samples (e.g., Johnson et al., 2015) and negative in others (e.g., Bebchuk, Cohen, and Ferrell, 2009). The differences reflect selection effects, typically involving younger vs. older firms.

For several reasons, however, we interpret the evidence as indicating that the value reversal reflects a causal relation between a firm's (sticky) takeover defenses and value. The first reason is that the value reversal occurs within firms over time and is not due to selection effects or a change in sample composition over time. The value reversal occurs primarily in fixed samples of surviving firms, especially the subset of surviving firms that do not remove any defenses. Previous research finds that firms' q values decline with firm age (Loderer, Stulz, and Waelchli, 2017). We find, however, that the decline in q occurs primarily among firms that have large numbers of defenses and do not remove any defenses as they age. The value reversal also is robust in tests that control for survivorship bias using Heckman 2-stage models.

The second reason the value reversal appears not to reflect endogeneity, selection, or reverse causality is the observation that takeover defenses are very sticky and rarely adjusted. It is firms' inability or unwillingness to adjust their defenses after their IPO that identifies tests of the value reversal hypothesis. Stated differently, an IPO firm's takeover defenses are most likely endogenous to its current characteristics and environment, but because defenses are so sticky and rarely adjusted, they are largely predetermined for the firm's future 10-year old self.

Endogeneity might nonetheless remain prevalent in tests using data from young firms because a firm's choice of takeover defenses at its IPO could reflect its expected takeover likelihood over the next few years. To examine the remaining influence of endogeneity when firms are young, we conduct tests using two distinct sets of instruments for a firm's use of defenses. The first set of instruments is based on the characteristics of the firm's law firm and the firm's location at the time of its IPO, as used by Johnson et al. (2015). The second set is based on a firm's geographic and IPO cohort peers, as used by Karpoff, Schonlau, and Wehrly (2017). In Section 3.3 we argue that these instruments plausibly satisfy the exclusion requirement and that conjectures linking the instruments to a direct effect on firm value are unlikely. The results from the 2SLS models are consistent with our overall inferences.

Another potential concern with our analysis is that the E-index may be a poor measure of takeover defense and that, a priori, it should have no relation to firm value in the first place. For example, Klausner (2013) and Catan and Kahan (2016) argue that, because all firms have shadow poison pills, most takeover defenses other than classified boards are inconsequential. Other research suggests that golden parachutes are not strongly associated with takeover deterrence, implying that they should be excluded from the E-index.[4] To address concerns about E-index provisions, we conduct all of our tests using just the presence or absence of a classified board, excluding golden parachutes from the E-index, and various other subsets of takeover defenses, and find similar results as when using the full E-index.

[4] See Eckbo (1990), Sokolyk (2011), Goktan and Kieschnick (2012), Bebchuk, Cohen, and Wang (2014).

We also probe the robustness of the results to other measurement concerns. The results are similar using the Bartlett and Partnoy (2020) measure of total firm value, Dybvig and Warachka's (2015) measure of firm value based on cost efficiency, and alternate measures of takeover defense stickiness. The results are robust to alternate measures of the firm's lifecycle, including the firm's sales growth rate, its industry sales growth rate, and measuring firm age from its founding rather than from its IPO date. Further tests indicate that the value reversal pattern is not driven by differences in expected takeover premiums as firms age or by differences in firms' acquisition patterns over time.

These findings make several contributions to the literature. First, they document a new empirical fact – the value reversal – that the relation between a firm's value and its use of takeover defenses declines as the firm ages. Previous researchers have conjectured that takeover defenses could have different values for young and old firms.[5] To our knowledge, however, our evidence is the first to show specifically that the average relation between a firm's q and its use of takeover defenses is positive at the time of the IPO, declines steadily as the firm matures, and becomes negative about four or five years after the IPO. We also show that this change does not reflect selection effects, but rather, the decreasing within-firm relation between firm value and the firm's use of takeover defenses as the firm ages.

Second, we show that specific benefits of takeover defenses decline with firm age, while specific costs of takeover defenses increase with firm age. In Section 4, for example, we show that the Faulkender and Wang (2006) measure of the value of cash declines monotonically and significantly across firm age cohorts. These findings imply that the value reversal occurs not because of age per se, but rather, because of specific changes in firm characteristics that correlate with firm age. Firm age simply serves as a proxy for the net effect of the complex and heterogeneous changes in the benefits and costs of a firm's takeover defenses.

[5] See Bebchuk (2003), Johnson et al. (2015), and Bebchuk and Kastiel (2017). Researchers have also begun to examine lifecycle effects in firms' uses of individual takeover defenses, including classified boards (Field and Lowry, 2020; Karakaş and Mohseni, 2020) and dual-class shares (Cremers, Lauterbach, and Pajuste, 2020; Kim and Michaely, 2019).

Third, we provide novel evidence on firms' uses of takeover defenses as they age. Takeover defenses are extremely sticky, as the unconditional likelihood that a firm will keep all of its preexisting defenses from one year to the next is 98.7%. As a result, most surviving 10 or 15-year old firms have the same defenses as when they went public. Not all defenses are equally sticky, however, and we find that the value reversal occurs primarily among firms with the most sticky defenses.

Fourth, we provide new evidence on the dynamics of firms' decisions to remove takeover defenses. Although defenses are sticky, firms do occasionally remove them – but primarily when the benefits from removing defenses are high and shareholders' costs of collective action to remove them are low. Such adjustments mitigate the value reversal effect. But the value reversal persists because, for many firms, the adjustment costs keep them from shedding defenses even when the defenses become costly.

The value reversal hypothesis has significant implications for corporate governance research. It provides a relatively comprehensive narrative of firms' decisions to deploy takeover defenses, the costs and benefits over time of maintaining them, and the costs and benefits of adjusting them. The value reversal provides a potential resolution to the takeover defense puzzle, i.e., the long-standing debate whether takeover defenses work to increase or decrease firm value.[6] Evidence of the value reversal also provides a tool to control for cross-sectional variation in a takeover defense's impact. Many empirical studies use takeover defenses to measure a firm's managerial entrenchment or governance quality. Our results show that firm age can be used as a proxy for the heterogeneous effects that defenses have on firm value, as the effects are more likely to be positive for young firms and negative for older firms.

[6] On one side, the traditional view holds that takeover defenses entrench managers and decrease firm value, e.g., Cary (1969), DeAngelo and Rice (1983), Gompers, Ishii and Metrick (2003), Masulis, Wang, and Xie (2007), and Bebchuk, Cohen and Ferrell (2009). The opposing side holds that takeover defenses help firms to improve value and performance, e.g., Caton and Goh (2008), Cen, Dasgupta, and Sen (2016), Cremers, Litov, and Sepe (2017), and Cremers, Guernsey, Litov, and Sepe (2020).

1. Hypotheses

Previous research implies that takeover defenses impose costs by insulating managers from the threat of outside takeover and increasing the cost of agency (e.g., DeAngelo and Rice 1983; Gompers et al. 2003).[7] Takeover defenses also offer benefits by encouraging long-term investment (Stein 1988; Cremers and Ferrell 2014) and by bonding relationships with important counterparties (Shleifer and Summers 1988; Laffont and Tirole 1988; Cremers et al. 2017). Johnson et al. (2015) show that the bonding benefits are important for IPO firms because these firms rely heavily on business relationships with important stakeholders that are vulnerable to hold up problems. Also, the costs tend to be low for young firms because their managers have large ownership stakes and, as Jensen and Meckling (1976) show, agency costs decrease with the size of the manager's ownership stake. For these reasons, the marginal benefit and marginal cost equate at a high level of takeover protection for young firms.

In Section 4 below we show that the marginal benefit of takeover protection declines and the marginal cost increases as firms age. Such changes are suggested by prior findings. For example, Helwege, Pirinsky, and Stulz (2007) report that managerial ownership tends to decline with firm age, implying that the agency cost of equity increases with firm age. Similarly, the evidence in Johnson, Kang, and Yi (2010) and Cen, Dasgupta, and Sen (2015) indicates that mature firms are less likely to rely on a small number of key customers than young firms, implying a smaller bonding benefit from takeover protection.

[Insert Figure 1]

Figure 1 illustrates the effects of such changes as a firm ages: the marginal benefit curve shifts down and the marginal cost curve shifts up, implying a decrease in the optimal level of takeover protection from TD^*_{young} to TD^*_{old}. If firms could adjust their takeover defenses optimally at low cost, they would deploy fewer defenses as they age. The evidence, however, indicates that takeover defenses are extremely sticky and rarely removed. Figure 2 reports on the number of firm-years in our sample in which firms added,

[7] Takeover defenses also can convey benefits by increasing managers' ability to negotiate a higher premium in the event of a takeover (DeAngelo and Rice 1983; Comment and Schwert 1995). Cuñat, Gine, and Guadalupe (2020), however, do not find support for this channel. Section 7.5 and Online Appendix Table A.19 report evidence that the value reversal does not reflect changes in firms' expected takeover premiums.

removed, or maintained their prior years' defenses. In 94.0% of firm-years, the firm makes no changes, in 4.7% of firm-years a firm adds takeover defenses, and only in 1.3% of firm-years does a firm remove any defenses.

[Insert Figure 2]

In Section 6 below we examine why takeover defenses are sticky and the circumstances that prompt firms to remove defenses. For the moment, however, we focus on the consequences of sticky defenses. In Figure 1, a firm that retains the takeover defenses it had in place at its IPO (TD^*_{young}) will experience a loss in value associated with having too many defenses compared to its (now) optimal level of TD^*_{old}. This loss consists of a decrease in surplus (area *adg* minus area *bce*) as the optimum shifts from TD_{young} to TD_{old}, plus the loss (area *efh*) from suboptimally remaining at the TD_{young} number of defenses. These losses only increase as the benefits decline and the costs increase further as the firm ages. Stated differently, the very same takeover defenses that create value when the firm is young impose increasing costs as the firm ages. A takeover defense's contribution to firm value declines and can even become negative.

These lifecycle dynamics can be expressed in a simple model in which firm value q depends on its takeover defenses E, age since IPO t, and control variables X:

$$q = \mathrm{f}(E, t, X)$$

Previous research implies that firm value, as measured by q, tends to decrease with firm age, i.e., $\partial q/\partial t < 0$.[8] The takeover defense puzzle, which is the subject of much debate in the literature, reflects debate over whether $\partial q/\partial E$ is positive or negative. The lifecycle view illustrated by Figure 1 proposes that $\partial q/\partial E$ is not monotonic and that $\partial^2 q/\partial E\partial t < 0$. The proposition that $\partial^2 q/\partial E\partial t < 0$ is the value reversal hypothesis.

Hypothesis 1 (Value reversal): When takeover defenses are costly to remove and are sticky, the relation between firm value and the firm's use of takeover defenses declines as the firm ages.

[8] E.g., see Holmstrom (1989), Fama and French (2001), Pástor, Taylor, and Veronesi (2009), Manso (2011), Ferreira, Manso, and Silva (2014), Loderer and Waelchli (2015), and Loderer, Stulz, and Waelchli (2017).

The empirical implication of the value reversal hypothesis is illustrated in Figure 3. As a firm ages, its takeover defenses contribute less to firm value, and the contribution can even switch from positive to negative.

[Insert Figure 3]

The value reversal hypothesis does not imply that the value reversal is driven mechanically by a firm's age. Rather, the value reversal reflects firm-specific changes in the costs and benefits of takeover defenses that tend to occur as a firm ages. This is the basis for Hypothesis 2.

> **Hypothesis 2 (Channels):** With sticky takeover defenses, the value reversal (i.e., the decline in $\partial q/\partial E$ as the firm ages) occurs because of firm-specific changes that decrease the benefits of takeover defense and/or increase the cost of takeover defense.

Hypothesis 2 implies that (i) the benefits of takeover defenses decrease and the costs increase as a firm ages, and (ii) the value reversal reflects these specific changes in benefits and costs. We test this hypothesis in Section 4 by identifying proxies for the benefits and costs of having a takeover defense.

Hypotheses 1 and 2 hold to the extent that takeover defenses are sticky. This implies that the value reversal occurs primarily among firms with the most sticky defenses.

> **Hypothesis 3 (Takeover defense stickiness):** The value reversal (i.e., the decline in $\partial q/\partial E$ as the firm ages) is most pronounced among firms with the most sticky takeover defenses, i.e., where the cost of takeover defense adjustment is high.

Although Figure 2 shows that takeover defenses are extremely sticky, it also shows that a small number of firms do remove takeover defenses in any given year. We hypothesize that firms remove their takeover defenses when the benefits of removal exceed the costs of removal:

> **Hypothesis 4 (Adjustment dynamics):** Firms are most likely to remove takeover defenses when the net benefits of takeover defense are low and the net costs of adjustment are low.

Hypothesis 4 is a limits to arbitrage argument. Adjusting a firm's takeover defenses – in particular, removing a defense – can be costly. In the presence of adjustment costs, firms do not adjust continuously to the decrease in net benefits of takeover defenses as the firms age. Rather, firms make discrete adjustments when it is cost efficient to do so. We test Hypothesis 4 by developing measures of the net benefits of takeover defenses and the cost of adjustment.

2. Data and sample

2.1 Takeover defenses as firms age

To test our hypotheses, we compile a comprehensive sample of firms going public in U.S. markets from 1997 through 2011 and track these firms forward in time. Our sample selection criteria are similar to those of Arikan and Stulz (2016), who study firms' acquisition patterns as they age. We begin the sample in 1997 to ensure access to annual reports, proxy statements, and prospectus filings through the SEC's EDGAR database. We eliminate all REITS, ADRs, funds, firms without CRSP and COMPUSTAT coverage, firms incorporated outside the US, and firms with a dual share class structure, and merge in data from Jay Ritter's web site on firm founding dates.[9] This yields a sample of 2,283 IPO firms with sufficient data on stock prices from CRSP, accounting data from COMPUSTAT, and takeover defense data in the firms' SEC filings. We track each firm through 2014 or through the last year it is included on COMPUSTAT, whichever is earlier. If the firm has two or more consecutive years of missing data in COMPUSTAT, we eliminate subsequent observations. We hand collect the CEO's shareholdings disclosed in the firm's SEC filings (predominantly proxy statements), and use the Thompson Reuters 13f filing database to collect data on institutional shareholdings after the IPO.

To measure each firm's use of takeover defenses over time, we track the six defenses in the E-index, which Bebchuk et al. (2009) argue are particularly important to shareholders and firm valuation. These defenses include classified boards, poison pills, limits on shareholder amendments of firm bylaws,

[9] We thank Jay Ritter for generously providing these data at https://site.warrington.ufl.edu/ritter/ipo-data/.

supermajority requirements to change the firm charter, supermajority requirements to approve mergers, and golden parachutes. For each firm, we collect data on the firm's takeover defenses at its IPO by examining the IPO firm prospectus with its attached bylaws and charter. We then track changes in the firm's defenses by examining proxy statements, annual reports, and related press releases for all years the firm remains in COMPUSTAT through 2014. We rely on this manual process because many firms in our sample are not covered by the Institutional Shareholders Services (ISS, formerly RiskMetrics) governance database. Our data also avoid problems in the ISS data, including coding errors and a structural break in 2006 (see Larcker, Reiss, and Xiao 2015). For further details of our collection process, please see the Online Data Appendix at https://ssrn.com/abstract=2813265. This process results in a panel of 16,230 firm-year observations from 1997 through 2014, which forms the sample in most of our tests.

[Insert Table 1]

Table 1 reports on the sample by IPO year. Consistent with Gao, Ritter, and Zhu (2013), the sample contains more IPO firms per year before 2001 than afterward. The year with the largest number of IPOs is 1999 with 409 and the year with the fewest is 2008 with 16.

Panel B of Table 1 reports on the changing composition of the sample over IPO age cohorts. As described in Table 1, we begin with 2,283 IPO firms. Of these, 130 are acquired within one year of the IPO and 54 are delisted and also leave the sample, leaving 2,099 surviving firms in Year 1.[10] Of these surviving firms, three do not have sufficient Compustat data in Year 1 (although these three firms reappear in later years), leaving 2,096 observations in the Year 1 cohort. The table reports on analogous attrition counts for each age cohort. Through 2014, a total of 1,038 (45%) of the sample firms are acquired and 591 (26%) are delisted for other reasons. An additional reason the sample declines with older age cohorts is that many firms are truncated out of Year *t* cohorts because they are younger than *t* in 2014, which is the last year of our sample data. Because our IPO sample begins in 1997, the oldest firms in our sample are 17 years old.

[10] Most of the delistings in our sample occur from firms not meeting exchange listing requirements due to low price, insufficient capital, or delinquency in paying listing fees. Based on the CRSP delisting codes, only 72 of the delistings are due to bankruptcy.

A total of 54 firms survive through age 17, although as noted in the table, three of these firms subsequently are acquired and seven delist for other reasons before the end of 2014.

2.2 Changes in takeover defenses

Table 2 reports on the use of the six E-index takeover defenses in the years following a firm's IPO. Firms have an average of 2.40 takeover defenses when they go public. After their IPOs, firms rarely adopt new defenses, and they remove existing defenses even more rarely. These patterns are evident in Table 2 and Figure 2. The average E-index does not decline with firm maturity, but rather, increases slightly. The average E-index increases to a maximum of 3.01 at the end of year 10, decreasing to 2.63 at the end of year 17.

[Insert Table 2]

In Section 5, we examine the circumstances in which firms (rarely) remove or add defenses. Until then, however, we focus on a main implication of the data in Table 2 and Figure 2, which is that takeover defenses are extremely sticky. Also, the Online Appendix reports on firms' adoption and removal of each of the six provisions that constitute the E-index (Table A.1). As shown there, the slight increase in the average E-index after the IPO reflects primarily an increase in the fraction of firms adopting poison pills and golden parachutes. The most frequently removed provision is a classified board, at least partly reflecting pressure by groups such as the Harvard Shareholder Rights Project.[11]

3. Tests of Hypothesis 1: The value reversal

3.1 Univariate tests of the value reversal hypothesis

Table 3 reports on univariate tests of Hypothesis 1. We compute the median E-index value for each age cohort and compare the average industry-adjusted Tobin's *q* for firms with above and below the median

[11] See http://www.srp.law.harvard.edu/companies-entering-into-agreements.shtml; Bebchuk, Hirst, and Rhee (2014)

E-index.[12] At the time of the IPO, firms with low E-index values have a mean q of 2.09, compared to 2.52 for firms with high E-index values. The difference of 0.43 is significant at the five percent level. Measured one year after the year of their IPOs, the difference in mean q is smaller but still significantly positive. Measured two years after the IPO, the difference is smaller still, and in the 3-4 year old cohort, the average difference is negative but insignificant. For older cohorts, the gap between low- and high- E-index firms widens and is statistically significant. This result is consistent with Hypothesis 1, which implies that takeover defenses add more value for young firms than old firms.

[Insert Table 3]

Some researchers argue that classified boards are the most important takeover defenses that a firm can adopt (e.g., see Klausner 2003; Bates, Becher, and Lemmon 2008). Others argue that explicit poison pills or golden parachutes do not offer incremental takeover defense (e.g., Eckbo 1990; Sokolyk 2011; Goktan and Kieschnick 2012; and Bebchuk, Cohen, and Wang 2014). We therefore repeat the tests in Table 3 using only the presence or absence of a classified board as a measure of takeover defense, or adjusting the E-index to exclude poison pills or golden parachutes. The results of these tests, which are reported in Tables A.3-A.5 of the Online Appendix, are similar to those reported here. In all cases, firms with high measures of takeover defense have significantly higher values when they are young and significantly lower values when they are older.

3.2 Multivariate tests of the value reversal hypothesis

The results in Table 3 are mainly descriptive and could reflect selection effects, omitted variables, and survivorship bias. Table 4, Panel A reports on multivariate tests of Hypothesis 1 in which (non-industry adjusted) q is the dependent variable and the E-index is the key explanatory variable. We include the same

[12] We present industry-adjusted Tobin's q measures in the univariate tests to demonstrate that the results are not driven by industry effects. Following Gormley and Matsa (2014), we use industry dummies to pick up industry effects in the multivariate tests. Also, we define the median in each year cohort in the univariate comparisons, allowing a firm to change from one group to the other in different years. A total of 239 firms (out of 2,283 in the total sample) change from below the median E-index to above the median E-index, or vice versa. Fixing groups by the median E-index at the time of the IPO and maintaining this definition for the life of the cohort does not appreciably change the results.

control variables as in Gompers, Ishii, and Metrick (2003), which include an indicator variable for firms incorporated in Delaware, the firm age in years, the natural log of firm assets, and an indicator for firms in the S&P 500 Index. We also include the percent of shares held by the CEO as reported in the firm's SEC filings, and the total percent of shares held by institutional shareholders as reported in the firm's 13f filings.[13] The controls include industry and year fixed effects, and when we group two or more age cohorts together (e.g., the Year 3-4 cohort), we cluster standard errors by firm. Online Appendix Table A.28 reports similar results using industry x year fixed effects.

For firms at the time of their IPOs (Year 0), the coefficient on the E-index is 0.283 and is significant at the 1% level (Table 4, Panel A Model 1). Evaluated at the mean E-index value of 2.40 for these firms, this estimate implies that a one standard deviation increase in the number of takeover defenses is associated with a 11.3% increase in Tobin's *q*. The coefficient is smaller but still positive and statistically significant for firms in Year 1. For firms in year cohorts 2 through 6, the coefficient is insignificant, but gradually moves from positive to negative for older age cohorts. For firms in the ≥ 10 years cohort, the coefficient is negative and statistically significant. For firms at least 10 years from their IPO, the coefficient is -0.173 and significant at the 1% level. Our finding for the Year ≥10 cohort is similar to the negative relation between *q* and the E-index reported by Bebchuk, Cohen, and Ferrell (2009). This is not surprising, as the Bebchuk et al. (2009) result is based on firms in the ISS database, which is comprised mostly of older firms.

The coefficients for the control variables raise the possibility of multicollinearity issues. We find, however, that the coefficients for the E-index are not sensitive to the inclusion or exclusion of any of the control variables. The control variables also have a mean variance inflation factor of 1.14, indicating very little standard error inflation caused by multicollinearity.

[13] When we cannot obtain the CEO's holdings for a given year, we replace missing values with a zero and add an indicator variable taking a value of one if the CEO's shareholdings are not available. The coefficient for the missing CEO holdings is statistically insignificant in every test except for some specifications involving the year 7-9 cohort. There are missing data for CEO holdings in 3,061 (18.9%) of our firm-year observations. The results are similar if we replace these missing observations with lagged observations or if we eliminate these 3,061 observations. Also, the results are not sensitive to alternate groupings of firm age cohorts, for example, having 16 separate cohorts for each year 0 – 15 relative to the IPO, or using the Young, Middle, and Late stage groupings used by Arikan and Stulz (2016), instead of the groupings reported in Table 4.

Where Panel A of Table 4 reports cross-sectional tests by age cohort, Panel B, Model 1 reports results from a panel data test that includes data from all firm-years. To capture the lifecycle effect, we include a dummy variable that equals one for firms older than four years. We use a breakpoint of four years because the coefficients on the E-index in Panel A turn negative after four years, and this separates the sample roughly in half. (As reported in the Online Appendix Table A.6, the results are similar using a count variable for firm age from the IPO rather than the dummy variable for *Firm age > 4 years*. The results also are similar using dummies for *Firm age > 3 years* or *Firm age > 5 years*.) The interaction between the E-index and the indicator for *Firm age > 4 years* is -0.196 and is significant at the 1% level – again indicating a strong value reversal effect. The point estimates indicate that the E-index is positively related to *q* for young firms, especially firms at the IPO stage, but is negatively related to *q* for older firms.

The Online Appendix Tables A.4 and A.5 report on multivariate tests that use the presence or absence of a classified board to depict strong or weak takeover defenses and that use several other variations of the E-index. The results are similar to those reported in Table 4. The Online Appendix also reports on tests using alternative measures of firm maturity, including firm age from founding (Table A.7.A), average industry age (Table A.7.B), firm sales growth rates (Table A.7.C), and average industry growth rates (Table A.7.D).

3.3 Identification

The evidence of a value reversal hypothesis, which is consistent with Hypothesis 1, is extremely robust. In this section we explore whether the value reversal is causal and occurs within individual firms, or whether it reflects selection issues and endogeneity.

3.3.1 Selection bias

First, we examine whether the value reversal reflects a kind of age selection in which firms that survive tend to have high-*q*/low-*E* and low-*q*/high-*E* combinations. This could result if firms with low-

q/low-*E* and high-*q*/high-*E* combinations are more likely to be acquired or otherwise leave the sample. We replicate our tests using fixed subsamples of surviving firms, thus keeping the sample firms constant.

[Insert Figure 4]

Figure 4 illustrates the results for the 544 firms in the sample that survive 10 or more years after their IPOs. Table A.8 in the Online Appendix reports descriptive information for this cohort of surviving firms. Figure 4.A plots industry-adjusted *q* as a function of the E-index at the time of the IPO for each of the 544 firms. A simple linear regression yields a significantly positive coefficient of 0.430 (t-statistic = 2.75). Panel B plots the same relation for the same set of 544 firms four years after their IPOs. For this four-year old cohort, the relation between *q* and *E* is near zero and is statistically insignificant. Panel C shows the same plot for these 544 firms at age 10. Here, the relation between *q* and *E* is significantly negative (coefficient = -0.380, t-statistic = 4.19). Again, these firms' E-index values are sticky over time. But their *q* values are not sticky. The largest effects are among firms with many defenses: these firms have relatively high *q*'s at the time of their IPOs, but relatively low *q*'s ten years later.

To further examine whether the changes in *q* occur within individual firms, we constrain the sample of 10-year surviving firms to those firms that never change their takeover defenses. The results, which are tabulated in Online Appendix Tables A.12–A.14, show that these firms experience the most severe value reversal. In another test, we examine firm-level changes in Tobin's q over time. Previous researchers have shown that q values tend to decline with firm age, on average. Our results indicate that the decline is largely attributable to firms' (fixed) number of takeover defenses; firms with higher E-index values at their IPOs have the largest decline in q over the next ten years (see the Online Appendix, Sections 6 and 26 and Tables A.15 and A.39.) Furthermore, the value reversal is significantly smaller among firms that remove one or more takeover defenses. Together, these results strongly indicate that the value reversal occurs within individual firms, and particularly within firms that have the stickiest defenses.

To further investigate whether the value reversal reflects selection bias, we estimated a Heckman two-stage sample survivorship test. To instrument for acquisition likelihood, we use the distance from the firm's headquarters to a large city, as Cai, Tian, and Xia (2015) find that firms located close to large cities are more likely to be acquired. The results from this test is similar to our main tests and are reported in the Online Appendix Table A.13. Overall, these results indicate that the value reversal occurs within each firm, on average, and does not arise from survivorship bias or a changing composition of firms over time.

3.3.2 Reverse causality

Cremers, Litov, and Sepe (2017) and Eldar and Wittry (2021) argue that takeover defenses might be added after a decline in firm value. If so, a finding that, among mature firms, firm value is negatively related to a firm's use of takeover defenses could reflect reverse causality. The results in Tables 3 and 4, however, are inconsistent with reverse causality because most firms' takeover defenses are acquired at their IPOs, whereas the relation between firm value and takeover defenses becomes negative only years later. In Table 7 below, we also investigate whether the value reversal is driven by the (relatively few) defenses that are added after firms' IPOs. These results strongly show that the value reversal is driven by takeover defenses that are adopted at the time of the IPO and not by any defenses that are adopted after the IPO.

3.3.3 2SLS tests with instrumental variables

To further investigate whether our results reflect the endogenous determination of firm value and takeover defenses, we estimate 2SLS models using instrumental variables for a firm's use of takeover defenses. As argued above, many of our tests are identified by the fact that takeover defenses are sticky and firms do not adjust their defenses as they age. This argument, however, does not apply at the time of the IPO when most of the firms' defenses are chosen. If firm managers choose defenses at the IPO based on expected firm performance and takeover likelihood, this identification strategy may fail in, say the Year 0, Year 1, and Year 2 samples. So our 2SLS tests are particularly relevant for cohorts of younger firms.

We conduct separate IV tests using two distinct sets of instruments. The set of first instruments is similar to those used by Johnson, Karpoff, and Yi (2015) and Lowry and Field (2020), and are based on the firm's law firm at the time of its IPO, plus an indicator variable for California-based firms. The second set of instruments is similar to those used by Karpoff, Schonlau, and Wehrly (2017), and are based on the E-index values of each firm's non-industry geographic peers and non-industry IPO-cohort peers. For details on the construction and rationale of these instruments, we refer to Johnson et al. (2015) and Karpoff et al. (2017), respectively. To summarize, the instruments are based on findings that there are strong law firm, geographic, and IPO peer-based influences on firms' uses of takeover defenses that are not related to the firm's fundamentals at the IPO stage (e.g., see Coates 2001; Daines and Klausner 2001). These peer-based instruments explicitly exclude firms from the same industry, removing any industry-driven commonalities in firms' values and takeover defenses.

Model 2 in Panel B of Table 4 reports the second-stage panel data regressions using the first set of instruments. Our first-stage regressions for Models 2 and 3 are reported in Online Appendix Table A.16. Data requirements to compute the instrumental variable values reduce the sample size from 16,230 to 10,983 firm-year observations. In a test for weak instruments, the Cragg-Donald Wald F-statistic is 6.20, which is larger than the Stock and Yogo (2005) critical value for a model with two endogenous regressors with a 0.15 size distortion (4.58), although it is lower than the critical value with a 0.10 size distortion (7.03).

For the total sample, the coefficient on the interaction of *E-index x Firm age > 4 years* is -0.360 and is significant at the 5% level. Model 3 of Panel B in Table 4 reports the second stage regressions using the second set of instruments based on geographic cohort firms and IPO cohort firms. Consistent with 2SLS models used by Cliff and Denis (2004) and Johnson, Karpoff, and Yi (2015), we do not include industry or year fixed effects. Our results are largely unaffected if we include industry fixed effects. As in Cliff and Denis (2004), however, the inclusion of year indicator variables reduces the statistical significance of some results. We find that the *Instrumented (E-index x Firm age > 4 yrs)* coefficient is -11.98 and is significant at the 5% level.

To summarize, we cannot completely rule out endogeneity as a potential explanation for the value reversal documented by our empirical tests. But the channel by which such endogeneity would have to work seems unlikely. We would need to assume that there exists some unspecified firm characteristic that is not related to the firm's industry but that causes firms to simultaneously: (i) deploy strong takeover defenses when they go public, (ii) have high q's at their IPOs, and (iii) have a systematic decline in their q values such that their q's are relatively low several years after their IPOs. Furthermore, our results in Section 5 would require that (iv) these effects would have to be at work only among firms with the most sticky defenses. Such a sequence of coincidences makes endogeneity an unlikely explanation. A simpler interpretation that is consistent with our full battery of tests is that the value reversal reflects the changing impact of a firm's (sticky) takeover defenses on firm value as the firm ages.

4. Tests of Hypothesis 2: Takeover defenses' changing benefits and costs

4.1 Empirical estimates of costs and benefits of defenses

Hypothesis 2 states that the value reversal reflects a decrease in the benefits and an increase in the costs of takeover defenses as firms age. To test this hypothesis, we develop three measures of the costs and three measures of the benefits of takeover defenses. Our approach is based on the procedure used by Faulkender and Wang (2006) to study the value of cash and Dittmar and Mahrt-Smith (2007) to study the impact of takeover defenses on the value of cash. This literature calculates the value of cash as the estimate of γ_1 from the following model:

$$r_{i,t} - R_{i,t}^{B} = \gamma_0 + \gamma_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma_2 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \gamma_3 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \gamma_4 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \gamma_5 \frac{\Delta I_{i,t}}{M_{i,t-1}} + \gamma_6 \frac{\Delta D_{i,t}}{M_{i,t-1}} + \gamma_7 \frac{C_{i,t-1}}{M_{i,t-1}} + \gamma_8 L_{i,t} + \gamma_9 \frac{NF_{i,t}}{M_{i,t-1}} + e_{i,t} \qquad (2)$$

In equation (2), the left-hand term is firm i's share return in year t minus a benchmark return (the return on the size- and book-to-market matched Fama-French portfolio). The right-hand terms include changes in: cash holdings ($C_{i,t}$), earnings before interest and extraordinary items ($E_{i,t}$), total assets net of cash ($NA_{i,t}$), R&D expenditures ($RD_{i,t}$), interest expense ($I_{i,t}$), and total dividends ($D_{i,t}$); plus the lagged value of cash ($C_{i,t-1}$), market leverage at the end of fiscal year t ($L_{i,t}$), and the firm's net financing during fiscal year t ($NF_{i,t}$). All regressors are divided by the market value of equity at the end of year $t-1$, ($M_{i,t-1}$).

In the value of cash literature, $\hat{\gamma}_1$ is interpreted as the marginal value to firm i of a dollar of cash, and deviations of $\hat{\gamma}_1$ below 1.0 are interpreted as evidence of managerial agency costs. Thus, $\hat{\gamma}_1$ is an inverse measure of the cost of managerial entrenchment. We therefore use $\hat{\gamma}_1$ as an inverse measure of the entrenchment-related cost of a firm's takeover defenses, and Hypothesis 2 implies that $\hat{\gamma}_1$ decreases with firm age.

Building upon the Faulkender and Wang (2006) model, we expand equation (2) to simultaneously estimate five additional costs and benefits of a firm's takeover defenses:

$$r_{i,t} - R_{i,t}^{B} = \gamma_0 + \gamma_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma_2 \frac{\Delta divers_{acquisitions_{i,t}}}{M_{i,t-1}} + \gamma_3 CEOchair_{i,t} + \gamma_4 \frac{\Delta cust_{sale_{i,t}}}{M_{i,t-1}} + \gamma_5 \frac{\Delta Dur_{sale_{i,t}}}{M_{i,t-1}} + \gamma_6 CEOfounder_{i,t} + \gamma_7 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \gamma_8 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \gamma_9 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \gamma_{10} \frac{\Delta I_{i,t}}{M_{i,t-1}} + \gamma_{11} \frac{\Delta D_{i,t}}{M_{i,t-1}} + \gamma_{12} \frac{C_{i,t-1}}{M_{i,t-1}} + \gamma_{13} L_{i,t} + \gamma_{14} \frac{NF_{i,t}}{M_{i,t-1}} + e_{i,t} \quad (3)$$

In equation (3), $\hat{\gamma}_2$ measures the marginal value of the firm's expenditures on diversifying acquisitions. Previous research (Harford 1999; Masulis, Wang, and Xie 2007) indicates that value-destroying acquisitions reflect managerial entrenchment and agency costs. Hypothesis 2 implies that such entrenchment costs increase with firm age, and that the estimate $\hat{\gamma}_2$ declines with firm age. Similarly, $\hat{\gamma}_3$ measures the incremental value of having the CEO and board chair positions occupied by the same person. Such a combination of power in a single individual conveys both operational benefits and entrenchment costs (e.g., Larcker and Tayan 2016). Hypothesis 2 implies that the entrenchment costs increase with firm age, implying that $\hat{\gamma}_3$ declines with firm age.

Previous research also shows that takeover defenses offer benefits by providing a guarantee, or bond, against changes in corporate strategy that could harm important stakeholders such as large customers and customers of durable products.[14] CEOs who are also founders are especially likely to have important stakeholder relationships that are bonded by guarantees against takeovers (e.g., Shleifer and Summers 1988; Adams, Almeida, and Ferreira 2009). Hence, we use sales to large customers, durable product sales, and the presence of a CEO-founder as proxies for the potential benefits of takeover defenses. Equation (3)

[14] See Titman (1984), Knoeber (1986), Fee, Hadlock, and Thomas (2006), Cremers, Nair and Peyer (2008), Johnson et al. (2015), Cremers, Masconale, and Sepe (2016). The Appendix reports variable definitions. Briefly, sales to large customers and durable product sales use Compustat segment level data.

estimates the marginal value of each of these characteristics to the firm, and Hypothesis 2 implies that the coefficient estimates $\hat{\gamma}_4$, $\hat{\gamma}_5$, and $\hat{\gamma}_6$ all decrease with firm age.

We follow Faulkender and Wang's (2006) procedure and variable definitions (see the Appendix) to estimate equation (3). The excess firm return is measured on a fiscal year basis, adjusted by the size and book-to-market matched portfolio return as provided on Ken French's website, and each variable is winsorized at the 1% and 99% levels. All dollar values are expressed in 2015 constant dollars using the Consumer Price Index. Section 21 of the Online Appendix provides detailed information about the Faulkender and Wang (2006) variables that are in Equation (3).

Our focus is on the coefficients for the six measures of the entrenchment-related costs and bonding-related benefits of a firm's takeover defenses in Equation (3). Each of the continuous proxy variables is normalized by the lagged firm market capitalization ($M_{i,t-1}$), allowing us to interpret the coefficients as the marginal value of one dollar change in the variable of interest.[15] *CEOchair* (γ_3) and *CEOfounder* (γ_6) are indicator variables that have a value of 1 for firms that have a CEO-board chair and a CEO-founder, respectively.

Column 1 of Table 5 reports the results from a pooled regression estimate of equation (3) using the universe of COMPUSTAT firms from 1972-2018. Consistent with the value of cash literature (e.g., Faulkender and Wang 2006), the estimate $\hat{\gamma}_1$, 0.872, is significantly lower than 1.0 (F-statistic = 20.2). This implies that, for our total sample, the marginal value of $1 of cash is, on average, 87 cents.

Columns 2-4 of Table 5 report the results when firms are grouped by age ranges from the years of their IPOs. The estimate $\hat{\gamma}_1$ decreases from 1.033 for young firms (1–5 years old) to 0.962 for firms that are 6–9 years old, and 0.752 for firms that are at least 10 years old. The coefficient $\hat{\gamma}_1$ is not significantly different from 1.0 in columns 2 and 3, but it is significantly lower than 1.0 in column 4 (F-statistic = 46.3)

[15] In years where there are no diversifying acquisitions or no sales to a large customer, we replace these values with a zero. The results are qualitatively similar when omitting these observations but the sample size is significantly smaller.

for firms at least ten years old. Furthermore, the coefficients in columns 2 and 4 are significantly different from each other (t = 5.10).

These results are consistent with Hypothesis 2. The marginal value of cash is relatively high for young firms and low for older firms. Again, the deviation of $\hat{\gamma}_1$ from 1.0 is interpreted in the literature as a result of managerial entrenchment and agency costs. Our results imply that such costs of entrenchment increase with firm age, implying that the costs of having takeover defenses that facilitate such entrenchment also increase with firm age.

We find similar lifecycle effects for our other proxies for the entrenchment costs of takeover defenses. The estimate $\hat{\gamma}_2$ in column 1 is -0.202, implying that, on average, the marginal dollar spent on diversifying acquisitions results in a $0.202 decline in firm value. The previous literature interprets the negative value of diversifying acquisitions as resulting from entrenchment and agency costs. Like the cost of holding cash, however, this cost of entrenchment increases with firm age. As shown in column 2, the marginal value of a dollar spent on diversifying acquisitions is positive, albeit not statistically significant, for young firms. It is only for older firms (in column 4) that the estimate $\hat{\gamma}_2$ is negative and statistically significant. The difference in coefficients between columns 2 and 4 is statistically significant as well (t = 2.16). The coefficient for *CEOchair*, $\hat{\gamma}_3$, represents the cost of maintaining a combined CEO and board chair position. This coefficient is negative and statistically significant only for the oldest cohort of firms. Together, these measures indicate that entrenchment-related agency costs increase with firm age, implying that the costs of takeover protections also increase with firm age.

Just as the proxies for the costs of takeover defenses show an increase as firms age, the proxies for the benefits of having takeover protection decline with firm age. The estimate $\hat{\gamma}_4$ in column 1 is 0.092 and is statistically significant. This indicates that, measured over all firms, the marginal value of a dollar of sales to large customers is positive. As indicated in columns 2-4, however, the benefits from sales to large customers is largest in the youngest cohort and smallest in the oldest cohort of firms. Again, previous research interprets sales to large customers as a measure of the potential benefits of takeover defenses, because such defenses help to bond the quasi-rents that accrue from important stakeholder relationships, such as those with large customers (e.g., Johnson et al. 2015; Cremers et al. 2017). The results in Table 5 indicate that such benefits tend to decline with firm age. The difference between the youngest firm coefficient and the oldest firm coefficient is significant at the 10% level (t-stat = 1.71).

The results for durable product sales and CEO-founders are similar. Over all firms, the marginal value of durable product sales is not statistically significant. Among young firms, however, the estimate $\hat{\gamma}_5$ is 0.016 and is statistically significant. As previously noted, takeover defenses can help to guarantee a firm's warranty commitments to customers of durable products. This benefit of takeover protection, however, accrues primarily to young firms. Further, the difference between the coefficient for the youngest firms and the oldest firms is significant at the 5% level (t-stat=2.33). Likewise, the value to a CEO-founder is significantly positive for young firms, as the estimate $\hat{\gamma}_6$ in column 2 is 0.145 and statistically significant. Again, CEO-founders frequently have valuable stakeholder relationships that takeover defenses can help to protect (Shleifer and Summers 1988). This benefit of takeover defense, however, is most important for young firms and is least important for older firms.

The results in Panel A of Table 5 indicate that the entrenchment-related costs of takeover protection tend to increase and the bonding-related benefits of takeover protection tend to decrease as a firm ages. These results are consistent with Hypothesis 2. In Panel B of Table 5 we use the point estimates from these tests to calculate estimates of the costs and benefits of takeover defenses for the firms in our sample. For each sample firm-year, we multiply the coefficients from the appropriate age cohort in Panel A by the firm's sales to large customers, durable product sales, cost of holding cash, and diversifying acquisitions, each divided by the firm's market capitalization. For the CEO-founder and dual CEO-board chair measures, we multiply the age cohort coefficient by an indicator variable taking a value of one if the firm has a CEO-founder or a dual CEO-board chair. The means reported in Panel B represent the value of each firm characteristic as a percentage of firm value. For the overall sample, the average firm's cash holdings contribute -1.14% to firm value. For young firms (column 2), the average firm's cash holdings contribute

1.10% to firm value, whereas for old firms (column 4) the average firm's cash holdings contribute -10.43%.[16]

We combine the estimates of the value of each cost and benefit to construct an aggregate measure of the net benefits of takeover protection for each firm-year in our sample. Panel B of Table 5 reports the mean of this aggregate net benefit measure (*Aggregate value of defenses/market cap)* by age cohort. For all firms in the sample, the combination of cash holdings, diversifying acquisitions, CEO-board chair combination, sales to large customers, sales of durable products, and CEO-founder presence contributes an average 6.65% to firm value. The mean value of this combination of firm characteristics, however, is 10.82% of firm value for young firms (column 2) and -8.83% of firm value for older firms (column 4). This finding illustrates a key driver of the value reversal, as posited in Hypothesis 2: for young firms, the net benefits of takeover protection are positive, whereas for older firms, the net benefits are negative.

4.2 The effect of changing costs and benefits on the value reversal

Hypothesis 2 implies not only that the net benefits of takeover protection decline with firm age, but also that the value reversal reflects this decline in net benefits. That is, firms with larger declines in the net benefits of takeover defenses will experience the largest value reversal. To test this prediction, we examine whether the value reversal is influenced by each of the six cost and benefit measures from Table 5. Table 6 reports the results of panel regressions of Tobin's q that are similar to those reported in Table 4 Panel B, but adding controls for each of these six cost and benefit measures. For each cost measure, we construct an indicator variable that equals 1 for firm-year observations for which the measure is below the median value across all firm-years, e.g., *Low value of cash holdings*. For each benefit measure, the indicator is set equal to one if the measure is above the median value across all firm-years, e.g., *High value of sales to large customers*.

[16] Panel A reports the marginal value of cash in a similar way to the prior literature. In Panel B, we consider the cost of holding excess cash to be the coefficient for the marginal value of cash minus 1 ($\gamma_1 - 1$).

Columns (1) – (3) report the results using measures of the costs of having defenses. In Column (1), the interaction of *Low value of cash holdings x E-index* is negative, indicating that the use of takeover defenses is associated with lower firm value especially among firms with high costs of entrenchment (as measured by the value of cash). Column (2) reports that the interaction term *Low value of diversifying acquisitions x E-index* has a negative and statistically significant value as well. The interaction term for CEO-board chair combination also is negative but is not statistically significant.

Columns 4-6 examine the benefits of takeover defenses and their impact on value reversal. Column (4) reports the results using sales to large customers as a measure of the bonding benefits of takeover protection. The term of interest is the interaction of *High value of sales to large customers x E-index*, which captures the incremental value of having takeover protections for firms that have valuable relationships with large customers. The coefficient on the interaction term is positive, 0.065, and significant at the 10% level. Similarly, in column (5), the coefficient on the interaction term *High value of durable product sales x E-index* is positive and significant at the 1% level. These results indicate that having takeover defenses are valuable particularly for firms that have valuable customer relationships, and for which the bonding benefits of takeover defenses are relatively large.[17] The interaction *High value of CEOfounder x E-index* also is positive, but is statistically insignificant.

Column (7) uses the *Aggregate value of takeover defenses* measure, which as shown in Panel B of Table 5, combines all six of the proxies for costs and benefits into a single measure. Here, the interaction *High aggregate value of defenses x E-index* is positive and significant at the 1% level. This result shows how the value reversal reflects the decrease in net benefits of takeover protection as firms age.

In the models in Table 6 the coefficients on the *E-index x Firm age > 4 years* term remain negative and statistically significant. We interpret this pattern as evidence that our proxies for the benefits and costs of takeover defenses do not capture all of the benefits and costs of takeover defenses. Rather, each is a

[17] The results in Table 6 indicate that, ignoring the effects of takeover defenses, firms with a high value of sales to large customers and firms with high durable product sales have relatively low q values. The value reversal hypothesis maintains that firms with these characteristics derive relatively large benefits from takeover defenses, as indicated by the coefficients on the interaction terms.

proxy variable that picks up a part of the overall net benefits, thus reducing the magnitude of the effect that is attributed to firm age. Since each proxy does not capture all of the net benefits, firm age continues to serve as an overall stand-in for various other firm characteristics that drive the net benefits of takeover protection.

5. Tests of Hypothesis 3: Takeover defense stickiness

Hypothesis 3 states that the value reversal arises because takeover defenses are sticky and firms rarely remove them. If takeover defenses were not sticky, firms could remove them when the defenses' benefits decrease and costs increase – thus eliminating the value reversal pattern. Thus, the value reversal should be most apparent among firms with the most sticky defenses.

Figure 2 illustrates that, consistent with Hypothesis 3, takeover defenses are rarely removed and are therefore very sticky. To further test this hypothesis, we consider two measures of cross-sectional differences in takeover defense stickiness. The first is an ex post measure based on defenses that have actually been removed. We infer that the defenses that are not removed are relatively sticky. Hypothesis 3 implies that the value reversal pattern is driven by these defenses and not by any defenses that were removed.

To test this prediction, we repeat the age cohort cross-sectional regressions for Tobin's q from Table 4, but partition each firm-year's E-index into three categories: *E-index provisions at the IPO*, *Provisions removed after the IPO*, and *Provisions added after the IPO*. Panel A of Table 7 reports the results. The coefficient on *E-index provisions at the IPO* is positive and statistically significant for the youngest cohort of firms (Year=0), and declines almost monotonically until it is negative and statistically significant for the oldest cohort of firms (Year $\geq$ 10). There is no such pattern in the coefficients for either *Provisions removed after the IPO* or *Provisions added after the IPO*. Thus, the value reversal pattern is evident for E-index provisions maintained since the IPO – i.e., the stickiest defenses – and is not driven by defenses that were subsequently removed (or added). This pattern is consistent with Hypothesis 3. It also shows that the value reversal pattern is not a reflection of firms' (endogenous) adjustments to their E-indexes after their IPOs.

Panel B of Table 7 reports on a replication of the panel data test in Model 1 of Panel B in Table 4 using only the *E-index provisions at the IPO* measure. The coefficient on *E-index provisions at the IPO x Firm age > 4 yrs* is negative and statistically significant at the 1% level, similar to the OLS results in Table 4 Panel B. These results also are consistent with Hypothesis 3, as they show that the value reversal is driven by the stickiest takeover defenses.

A potential problem with our ex post measure of stickiness is that it reflects both the cost of removing a defense and the cost of having the defense in place. Firms could remove a provision that is very costly to remove if the provision is also very costly to the firm. To address this concern, we consider an alternate measure of takeover defense stickiness that reflects the expected cost of removing a defense. In particular, we use Cremers et al.'s (2016) c-index as a measure of expected stickiness. The c-index is a subset of the E-index and consists of classified boards, supermajority requirements to amend the corporate charter, and supermajority requirements to approve a merger. Cremers et al. (2016) note that the provisions in the c-index require the consent of both the board and shareholders, whereas the other E-index provisions can be adopted or changed unilaterally by the board. Choi and Min (2018) argue that provisions that require both shareholder and director consent are relatively difficult to remove, implying that the c-index consists of provisions that are difficult to remove.[18] The median c-index in our sample is 1, and we classify firms with c-index values above 1 as having particularly sticky defenses.[19]

Table 8 reports tests of Hypothesis 3 using the c-index as a measure of defense stickiness. Panel A uses data only from firm-years with high c-index values, and Panel B uses only firm-years with low c-index values. The value reversal is apparent in Panel A, as the coefficient on the E-index is positive and statistically significant for firms at their IPOs, and decreases monotonically across age cohorts until it is

[18] Section 22 of the Online Appendix provides evidence on the rates at which the individual E-index provisions are removed and discusses prior research that shows that c-index provisions provide more effective defenses against takeovers than the other E-index provisions.

[19] As robustness checks, we also classify firms as having particularly sticky defenses if their c-index is greater than 0, or greater than 2. The results are similar to those reported in Table 8. Our base definition of sticky defenses (c-index > 1) comes the closest to splitting the sample in half, with 7,107 firm-years that are classified as having particularly sticky defenses and 9,123 firm-years classified as having less sticky defenses.

negative and statistically significant for firms in the oldest age cohort. There is no value reversal pattern in Panel B. These results also are consistent with Hypothesis 3, as they indicate that the value reversal pattern arises among firms with the most sticky defenses.

Panel C of Table 8 reports on replication of the panel data test in Model 1 of Panel B in Table 4, but after partitioning firm-years into high and low c-index values. The coefficient on *High c-index x Firm age > 4 yrs* is negative and statistically significant at the 1% level, while the coefficient on *Low c-index x Firm age > 4 yrs* is not statistically significant. Finally, in Model 3 we interact the E-index measure with the *High c-index x Firm age > 4 yrs* variable in a pooled regression and find that value reversal is statistically significant only for high c-index firms. Again, these results are consistent with Hypothesis 3, as they show that the value reversal is driven by the stickiest takeover defenses.

6. Tests of Hypothesis 4: Dynamic adjustment of takeover defenses

Although takeover defenses are sticky and it is uncommon for firms to remove them, Figure 2 shows that removal does sometimes occur. Hypothesis 4 states that firms remove defenses when the benefits of doing so are high and the costs of adjustment are low. We test this hypothesis by using measures of the benefits and costs of takeover defense removal.

6.1 Benefits of removing takeover defenses

To measure the benefits of removing takeover defenses, we use the measures introduced in Table 5, Panel B. These are firm-year specific measures of the values to each firm of its (i) cash holdings, (ii) diversifying acquisitions, (iii) a combined CEO-board chair position, (iv) sales to large customers, (v) durable product sales, and (vi) a CEO-founder. We hypothesize that firms are more likely to remove defenses when the entrenchment costs of having a defense are high or the bonding benefits are low. This implies that the likelihood a firm will remove a defense is negatively related to all six of these measures.

Table 9, Panel A reports on tests of these predictions using a linear probability model using the full sample panel data. In each model, the dependent variable is an indicator taking a value of one if the firm removes one or more takeover defense in that particular year. All regressions include controls for firm age, firm size, CEO ownership, institutional ownership, and year and industry fixed effects. In Model 1, the coefficient on *Value of cash holdings* is -0.032 and is statistically significant at the 1% level. Since lower values of cash indicate higher costs of entrenchment, this result indicates that a firm is more likely to remove a takeover defense when defenses are costly. The results in Models 2 and 3 for the value of diversifying acquisitions and the value having a CEO-board chair are similar. Models 4–6 report results for our measures of the benefits of takeover defenses. In Model 4, the coefficient for *Value of sales to large customer* is -0.015 and is statistically significant at the 1% level. This indicates that the likelihood that a firm will remove a takeover defense is negatively related to this measure of the benefit of having a defense. Similarly, the coefficients for *Value of durable product sales* and *Value of CEOfounder* are negative and statistically significant. Model 7 uses our aggregate measure of the value of a firm's takeover defense, as introduced in Panel B of Table 5. The coefficient for *Aggregate value of defenses* is also negative and statistically significant. These results indicate that firms are more likely to remove takeover defenses when the defenses' net benefits are small.

6.2 Costs of removing takeover defenses

As a further test of Hypothesis 4, we consider the cost of removing a firm's takeover defenses. The results are reported in Table 9, Panel B. In each model in Panel B, we include the *Aggregate value of defenses* measure, which as reported in Panel A, is negatively related to the removal of a takeover defense. Each model also includes a measure of the cost of adjusting the firm's defenses. The first cost-of-adjustment measure is the indicator for a higher-than-median value of the c-index, *High c-index*. As noted above, the c-index includes defenses that require action from both the board and shareholders to remove, in contrast to the other provisions that require only unilateral action by the board. In Model 1, the coefficient on *High c-index* is negative and statistically significant. This indicates that firms with defenses that require more shareholder coordination to remove a defense tend to remove defenses relatively infrequently.

Prior research suggests additional measures for the cost of removing a takeover defense. Coates (2001) argues that managers typically want more takeover protections while shareholders want fewer protections. But Shleifer and Vishny (1986), Hannes (2005, 2006), and Choi and Min (2018) note that shareholders face a collective action and free-riding problem in making value-improving adjustments to a firm's governance, including removing takeover defenses. Free-riding and coordination among shareholders can be particularly costly when shareholders have heterogeneous views about the benefits of a takeover, perhaps because they have different information or cost bases (e.g., see Bagwell 1991; Rice 2006; Dimmock, Gerken, Ivkovich, and Weisbenner 2018; Levit, Malenko, and Maug 2021). These arguments imply that shareholders will overcome the free-riding problem and remove a takeover defenses when the cost of collective action is low and shareholders have relatively homogeneous information about firm value.

To implement these ideas, we use three measures of shareholder information heterogeneity and three measures of shareholders' cost of acting collectively. The measures of shareholder information heterogeneity are the stock's bid-ask spread, an indicator for firms located in a large city, and the number of analysts following the firm. The bid-ask spread reflects, in part, adverse selection and information heterogeneity among investors (e.g., Amihud 2002). Hypothesis 4 therefore implies that the likelihood of a defense removal is negatively related to the firm's bid-ask spread. Loughran (2007) argues that firms located in large cities are subject to low cost information and have high share liquidity, both of which facilitate greater homogeneity among shareholders' information and expectations. Hypothesis 4 therefore implies that large city firms have lower-cost communication among shareholders, which increases the likelihood of removing a takeover defense. Similarly, analyst following is positively related to stock price informativeness and negatively related to analyst forecast errors, implying that analysts reduce information heterogeneity among shareholders (e.g., Change, Dasgupta and Hilary 2006; Bowen, Chen, and Cheng 2010). Hypothesis 4 implies that the number of analysts following the firm should be positively related to the likelihood of a defense removal.

The three measures of collective action costs are (i) the percent of the firm's shares owned by passive shareholders, (ii) an indicator for whether the firm is targeted by the Harvard Shareholder Rights Project, and (iii) an indicator for whether a hedge fund has taken an ownership position in the firm. Previous research shows that passive institutional shareholders frequently engage with management teams to advocate for governance improvements. Such pressure can help to overcome shareholders' collective action problem.[20] The Harvard Shareholder Rights Project was an explicit attempt to facilitate collective action by shareholders, and its web page claims that it encouraged 121 firms to drop classified boards during the 2011-2014 proxy seasons.[21] Likewise, hedge fund investors overcome the collective action problem by taking equity stakes and coordinating efforts, frequently pressuring firm managers to make governance changes such as the removal of a takeover defense (e.g., see Brav, Jiang, Partnoy, and Thomas 2008; Boyson, Gantchev, and Shivdasani 2017; Kedia, Starks, and Wang 2021). Hypothesis 4 implies that all three of these measures will be positively related to the likelihood of a defense removal, as all three indicate conditions in which the costs of adjustment are reduced and collective action by shareholders becomes more likely.[22]

Models 2–7 in Panel B of Table 9 report the results from these measures of information heterogeneity and collection action costs. In Model 2, for example, the coefficient on the *Big city* indicator is .007, while in Model 5 the coefficient on the Harvard Shareholder Rights Project indicator is 0.333. In each of the six models, the coefficient for the adjustment cost measure has the predicted sign and is statistically significant. To investigate whether these results are influenced by outliers or measurement units, we replicated these tests using the percentile ranking of each firm-year's value for each adjustment cost variable. The results,

[20] E.g., Iliev and Lowry (2015), Appel, Gormley, and Keim (2016), McCahery, J., Z. Sautner and L. Starks (2016), and Dasgupta, Fos, and Sautner (2020). Online Appendix Section 25 and Table A.38 report results of additional tests in light of findings that certain subgroups of passive institutional shareholders are most likely to engage with managers over governance matters (e.g., Harford, Kecskes, and Mansi 2018; Bebchuk and Hirst 2019; Bebchuk et al. 2020; Kedia, Starks, and Wang 2021). The *Passive shareholdings* results in Table 9 are mostly attributable to shareholdings of mutual funds other that the largest three funds (Black Rock, State Street Global Advisors, and Vanguard), to mutual funds that are managed by firms that have relatively small employee retirement fund management subsidiaries, and to long-term passive shareholdings.

[21] See http://www.srp.law.harvard.edu/companies-entering-into-agreements.shtml, accessed November 23, 2020. See also Cremers and Sepe (2017) and Bebchuk and Cohen (2017) for analyses of the Harvard Shareholder Rights Project.

[22] In Section 23 and Table A.34 of the Online Appendix, we report on tests showing that the Harvard SRP tends to target large firms and that hedge fund activists tend to target low-q firms. It is possible that the Harvard SRP and activist hedge funds target particularly costly takeover defenses for removal, in which case these measures reflect a high cost of the removed defense rather than a low adjustment cost. Both effects imply that involvement by the Harvard SRP and activist hedge funds will be positively related to the likelihood of a defense removal.

reported in Online Appendix Table A.24, are similar to those reported in Table 9. These results are strongly consistent with Hypothesis 4. Although takeover defenses are extremely sticky, firms do occasionally remove them, and removals occur when the benefits of removal are high and the costs of removal are low.

While our focus is on the forces that encourage firms to remove defenses, Online Appendix Table A.22 reports on tests of the characteristics of firms that add takeover defenses. Firms that add defenses are more likely to acquire new large customers and to increase sales to large customers, suggesting that firms add defenses when there is a bonding benefit of doing so. The likelihood of adding a new defense is not related to any of our measures of the cost of collective action by shareholders. This result is consistent with observations that additions typically are proposed by managers and are not impeded by shareholders' cost of collective action (e.g., Hannes 2006).

6.3 Relative magnitudes of the benefits and costs of removing takeover defenses

The results in Panels A and B of Table 9 indicate that the likelihood of removing a defense is positively related to the benefits and negatively related to the costs of removal. In Panel C, we report on the magnitudes of the effects on removal likelihood implied by the estimated coefficients. The coefficients on the aggregate measure of benefits in Panel B range from -0.014 to -0.018. Using a point estimate of -0.017 and setting other covariates at their median values, a one standard deviation increase in the aggregate net benefit implies a change in the probability of removal of 0.252%. The unconditional likelihood or removing a defense is approximately 1%, so this is an economically meaningful impact.

It turns out, however, that the costs of removing a defense also are economically important. Being targeted by the Harvard Shareholder Rights Project, for example, implies an increase in the probability of defense removal by 1.139 percentage points, an impact that is 4.52 times the impact of a one standard deviation increase in the aggregate net benefits measure. Having a hedge fund investor increases the probability by 0.438 percentage points, and a one standard deviation increase in a firm's ownership by passive investors increases the probability of a defense removal by 0.246 percentage points. Overall, the results in Panel C indicate that the costs associated with free riding and information heterogeneity are substantial. This helps to explain why firms why firms rarely remove takeover defenses.

7. Additional tests

In this section we summarize a number of additional tests that examine the sensitivity of our inferences to alternate measures and model specifications. We also test alternative conjectures that could explain different subsets of our results.

7.1. Alternative measures of takeover defenses and firm maturity

Our main tests use the E-index as the primary measures of a firm's takeover defenses and years from IPO to measure firm maturity. The value reversal pattern, however, does not depend on these specific measures. As reported in Online Appendix Tables A.2-5, the value reversal pattern is evident using the existence of a classified board as the measure of a firm's takeover defenses, or using adjusted E-index measures that exclude golden parachutes or explicit poison pills.

Online Appendix Table A.7.A tabulates our main results using total age from the date of the firm's founding to measure firm maturity (see Loughran and Ritter 2002). The results indicate that during the early life of the firm the relation between the E-index and firm value is positive and statistically significant. But starting at a total firm age of eight years and older, the relation between firm value and the E-index becomes negative. For firm ages above 12 years the relation is negative and statistically significant. These results are consistent with our main tests, which document the value reversal pattern using years since IPO to measure firm age.

An alternate measure of firm maturity is the age of other firms in its industry. An industry in which the average firm is young is likely to be an immature industry, whereas an industry with older firms is more likely to be more mature. If the bonding-related benefits of takeover defenses are larger for firms in less mature industries, we should expect to observe a positive relation between q and the E-index especially among firms in young industries. To explore this hypothesis, we first calculate the average age of firms in each of the 48 Fama and French (1997) industries, defining age as the first time the firm has a non-zero assets value on COMPUSTAT. (Firm age and industry mean age have a correlation of 0.36.) The results, which are tabulated in Online Appendix Table A.7.B show that the value reversal pattern appears using this industry measure of firm maturity. Among firms in industries for which the mean firm age is 0-7 years, the relation between firm value and the E-index is positive and statistically significant. The coefficient on the E-index becomes negative among firms in industries with higher average firm ages until the relation is negative and statistically significant for firms from industries with average firm ages above 15 years.

An alternate (inverse) measure of firm maturity is the firm's sales growth rate. We partition our sample into subgroups based on the firm's sales growth rate, and again using the industry sales growth rate. The results, which are reported in Online Appendix Tables A.7.C and A.7.D, also show the value reversal pattern. In particular, the relation between firm value and the E-index is positive when firm (or industry) sales are high, and negative when the sales growth rate is low.

7.2 Alternative measures of firm performance

Most papers that examine firm value and governance use Tobin's q to measure firm value (e.g., Gompers, Ishii, and Metrick 2003; Bebchuk, Cohen, and Ferrell 2009). As a measure of firm value, however, Tobin's q suffers from measurement error (Erickson and Whited 2000) and problems of interpretation (Dybvig and Warachka 2015). As an alternative to q, Bartlett and Partnoy (2020) propose using equity plus debt as a measure of firm value. As reported in Online Appendix Table A.21, using this measure yields results that are similar to our main results.

As another alternative to q, Dybvig and Warachka (2015) propose an inverse measure of cost discipline, R_c, which is measured as (selling, general, and administrative expense – R&D expense – advertising expense)/total capital.[23] We repeat our tests using R_c as the dependent variable instead of q and

[23] Following Dybvig and Warachka (2015) we use net property, plant, and equipment as our proxy for firm capital. We also replace missing values of selling, general, and administrative, R&D and advertising with zeroes. Dybvig and Warachka (2015) subtract R&D and advertising expenses from selling, general, and administrative expenses because

report the results in Online Appendix Table A.17. The interaction term *E-index* x *Firm age > 4 yrs* is positive and significant at the 10% level, indicating that the relation between cost efficiency and a firm's takeover defenses declines with firm age. As in our main tests, this result is most prominent among firms with relatively sticky takeover defenses and high costs of adjusting defenses.

Online Appendix Table A.29 reports similar tests using return on assets (ROA) as the dependent variable. ROA is positively related to the use of takeover defenses for young firms, but not for the older cohorts of firms, although the differences between the young and old firms are not statistically significant. Together, these results suggest that the value reversal in firm value, as reflected in *q*, is partly driven by changes in cost efficiency and operating performance. But we infer that the Dybvig and Warachka (2015) cost efficiency measure and operating performance as measured by ROA do not capture all of the drivers of firm value or the value reversal.

7.3 Is the value reversal industry or time-specific?

We repeated our main analyses within each of the Fama and French (1997) 10 industry groups. The value reversal pattern – i.e., a positive relation between firm value and the *E-index* at Year = 0 that gradually decreases and becomes negative by about Year 5 – is apparent in nine of the ten industries. We also repeat our analyses on subsamples of IPO firms from before and after the dot.com boom period of 2000. The value reversal pattern appears in both the early and late subperiods. These results indicate that our main results apply across most industries and in different time periods.

7.4 Substitutes for corporate takeover defenses

Previous research shows that firm-level takeover defenses have smaller value effects among firms that are covered by state antitakeover laws, firms in competitive industries, and firms for which managers have voting control (Giroud and Mueller 2010; Karpoff and Wittry 2018; Gutherie and Hobbs 2021). If

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these expenses may create intangible assets that do not appear on the firm's balance sheet. Our results are similar if we do not remove these expenses from the cost discipline measure.

takeover defenses have small effects at such firms, we would expect (i) the relation between firm value and the E-index to be attenuated in such firms and (ii) the value reversal – that is, the decline in the relation between firm value and the E-index as firms age – to be attenuated in such firms. As reported in Online Appendix Tables A.30-A.32 and A.24, the data are roughly consistent with this conjecture. We find that either the value reversal pattern, or the overall relation between firm value and the E-index, or both, are attenuated among firms that are covered by directors duties, poison pill, fair price, and control share acquisition laws, firms in more competitive industries, firms for which insiders have voting control, and firms with Employee Stock Ownership Plans (ESOPs) – all provisions that can substitute for the E-index provisions in providing a defense against takeovers. The value reversal is not attenuated among firms covered by business combination state antitakeover laws, but this probably reflects the fact that nearly all of the firm-years in our sample (95%) include coverage by a business combination law.

7.5 Prior acquisition activity and takeover premiums

It is also possible that our sample firms' q values are affected by their acquisitions, and their acquisition activity could be correlated with their takeover defenses (e.g., see Masulis, Wang, and Xie 2007). For example, a firm that grows via acquisition could have higher book assets than an otherwise identical firm that grows via internal (expensed) investment, resulting in lower q's for the acquisitive firm. To examine this effect, we identify acquisitions by our sample firms using the SDC Platinum database. If the value reversal is more prominent among firms that have acquired other firms, the lower q values for older firms could reflect a greater tendency for such firms to book their assets. As reported in Table A.18 of the Online Appendix, however, the value reversal pattern is evident in subsamples of firms with and without prior acquisitions, indicating that the value reversal is not driven by a firm's prior acquisition activity.

An alternative story that explains some of our results is that firms with the highest expected takeover premiums load up with many defenses. As these firms age and are not acquired, their q's decline because of a decrease in their expected takeover premiums, not an increase in costs and decrease in benefits of takeover defenses. Our controls for the endogenous use of takeover defenses are designed to address this possibility. As an additional test, however, we repeat all of our main tests with an additional control for the firm's expected takeover likelihood based on acquisitions in the firm's industry in the prior 6-12 months. The results are similar to those reported in our main tests in the paper and are reported in Table A.19 in the Online Appendix.

Relatedly, Cuñat et al. (2020) find that firms that drop takeover defenses experience an increase in their unconditional expected takeover premiums. It is possible that the value reversal reflects a relative increase in value among firms that remove defenses because they end up with relatively few defenses. However, the evidence in Table 7 rejects such a conjecture, as it shows that the value reversal does not appear among firms that remove defenses. Rather, the value reversal occurs in firms that do not change their defenses.

7.6 Additional controls

We also consider the possibility that the known decline in firm profitability after an IPO could be related to our results (Pastor, Taylor, and Veronesi 2009). Including a measure for firm ROA in the tests, however, does not change any of our inferences. Since Tobin's q is related to investment or growth opportunities, we control for the firm's capital expenditures as measured by capex/assets. Capital expenditures are positively related to Tobin's q in our sample, but this additional control has no material effect on any of our inferences.

To examine whether there is a systematic influence of the firm's state of incorporation, we conducted our main tests on the subset of 1,808 firms (79%) in our sample that are incorporated in Delaware, as well as the subset of firms that are incorporated elsewhere. The results from both subsamples reveal a strong lifecycle effect of the relation between q and E. Also, Morck, Shleifer, and Vishny (1988) show that the relation between firm value and managerial ownership is non-linear. As reported in Online Appendix Table A.20, our results are not substantially affected when we include controls that allow for such a non-linear relation.

8. Conclusions

This paper documents a new empirical finding – that the relation between q and a firm's E-index declines steadily as a firm ages – and explores the reasons for, and implications of, this value reversal. We find that the bonding-related benefits of takeover defenses tend to decline and the agency-related costs of defenses tend to increase as a firm ages. If takeover defenses were easily removed, firms could adjust to these changes by decreasing their takeover defenses over time. We find, however, that takeover defenses are extremely sticky and rarely removed. Fully 93.3% of the firms in our sample never remove any of the defenses they had in place at the time of their IPOs, and the unconditional probability that a firm with defenses will keep all of its existing defenses in any given year is 98.7%. One way of stating our main result is that takeover defenses are sticky, but q values are not. Takeover defenses that help to create value when firms are young become increasingly costly as the firms age.

We also explore why takeover defenses are sticky and the conditions under which firms remove them. Even though takeover defenses are rarely removed, removals do occur when the cost of having a defense is high and the cost of making an adjustment is low. These results indicate that firms adjust their uses of takeover defenses as economic theory would suggest, but that frictions impede continuous adjustments and that, as a result, older firms frequently have more defenses in place than they would have in a world without frictions.

The value reversal hypothesis offers a possible resolution of the takeover defense puzzle, which is the disparity in previous test results on the question of whether takeover defenses work primarily to increase or decrease firm value (see Burkart and Panunzi 2006; Straska and Waller 2014). The value reversal hypothesis is more detailed than a general admonition that "one size does not fit all." Instead, the relation between firm value and takeover defenses depends specifically on identifiable benefits and costs of having takeover defenses and the costs of removing defenses.

The value reversal hypothesis also provides a tool for empirical researchers to control for the heterogeneous effects of takeover defenses on firm values. As our results show, the benefits and costs of takeover defense depend on firm-specific characteristics. The effects of these characteristics on firm value, however, are related to firm age. As a result, researchers can use firm age to control for the heterogeneous impact of defenses on firm value.

Although these results shed light on the takeover defense puzzle, they raise another: Is a firm's use of takeover defenses at its IPO time-consistent? That is, when a firm adopts takeover defenses at the time of its IPO, do managers and investors consider the defenses' long-term costs? Time consistency in equilibrium requires that takeover defenses have positive net present value at the time of the IPO, suggesting that, despite the long-term costs, defenses convey sufficient benefits that increase the firm's probability of survival and/or buyout value. That is, adopting takeover defenses at the time of a firm's IPO is like investing in a project with back-end costs. In this case, the back-end costs are higher agency costs in the future if the firm survives and grows. For many firms, the short-term benefits of having takeover defenses exceed these long-term – and conditional upon survival – costs.

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Appendix A: Variable definitions

This table reports the definitions for the major variables used in the tests.

Variable	Definition
c-index / high c-index	The sum of indicator variables for the three takeover defenses that require both the board and shareholders to approve their removal: classified board, supermajority to approve a merger, and restrictions on charter revisions. High c-index is an indicator variable taking a value of one if the firm is above the sample-wide median c-index value of one.
CEO ownership	The percent of shares outstanding held by the CEO of the firm as reported in the firm prospectus filing (at the time of the IPO) and the proxy statements (in later years).
Missing CEO ownership (indicator)	An indicator variable taking a value of one if the firm does not have sufficient SEC filings to obtain CEO ownership. (Missing values for CEO ownership are set to zero.)
Delaware (indicator)	An indicator variable taking a value of one if the firm is incorporated in Delaware.
E-index	An index created by adding together the six indicator variables for the following takeover defenses: classified board; limits on shareholder amendments of the firm bylaws; supermajority to amend the firm charter; supermajority to approve a merger; poison pill; golden parachute.
Firm age (years)	The current year minus the year of IPO founding, as provided by Jay Ritter, https://site.warrington.ufl.edu/ritter/files/2015/08/Founding-dates-for-10266-firms-going-public-in-the-US-during-1975-2015-2015-07.pdf.
Institutional ownership	Institutions' fractional share ownership as reported in the 13D filings data.
Log (assets)	The logarithm of total assets (at) as reported by COMPUSTAT.
S&P 500 firm (indicator)	An indicator variable taking a value of one if the firm is included in the S&P 500 index and zero otherwise.
Tobin's q	The market value of assets divided by the book value of assets (at). The market value of assets is defined as the book value of assets plus the market value of common stock less the book value of common stock and balance sheet deferred taxes. All values are taken from COMPUSTAT in all years except at the IPO, when the market value utilized is the first CRSP stock market price.
Variables used in replication and extension of Faulkender and Wang (2006) (Table 5)	
$\Delta E_{i,t}$	Firm *i*'s year *t* change in earnings before interest and extraordinary items.
$\Delta NA_{i,t}$	Firm *i*'s year *t* change in net assets.
$\Delta RD_{i,t}$	Firm *i*'s year *t* change in R&D expenditures.
$\Delta I_{i,t}$	Firm *i*'s year *t* change in interest expense.
$\Delta D_{i,t}$	Firm *i*'s year *t* change in total dividends plus share repurchases.
$L_{i,t}$	Firm i's market leverage at the end of fiscal year t, defined as total debt divided by the sum of total debt and market capitalization.
$NF_{i,t}$	Net financing, defined as sales of common and preferred stock minus purchases of common and preferred stock, plus long-term debt issues minus long-term debt reductions.
Costs of takeover defenses (Tables 5, 6, 9)	
Value of cash holdings	Firm cash holdings multiplied by the appropriate coefficient from Table 5 minus one, divided by market capitalization.
Value of diversifying acquisitions	The sum of the value of all acquisitions of firms with two-digit sic codes that differ from the acquiring firm, based on SDC Platinum, multiplied by the appropriate coefficient from Table 5 based on firm age, divided by market capitalization.
Value of CEO-chair	An indicator for the presence of a dual role CEO-board chair multiplied by the appropriate coefficient from Table 5 based on firm age divided by market capitalization

Benefits of Takeover defenses (Tables 5, 6, 9)	
Value of sales to large customers	The firm's sales to a large customer obtained from the COMPUSTAT segment level data multiplied by the appropriate coefficient from Table 5 based on firm age, divided by market capitalization.
Value of durable product sales	The firm's sales of durable products multiplied by the appropriate coefficient from Table 5 based on firm age divided by market capitalization. Using Compustat segment level data, durable product sales are defined as sales from any division with an SIC code from 3400-3999 (Titman, 1984). In unreported tests, we also use the total sales for firms in durable product industries and find nearly identical results.
Value of CEO-founder	An indicator for the presence of a CEO-founder multiplied by the appropriate coefficient from Table 5 based on firm age, divided by market capitalization.
Costs of collective action measures (Table 9)	
Harvard SRP	An indicator variable taking a value of one if the firm is targeted by the Harvard Shareholder Rights Project at the Harvard Law School.
Hedge Fund (indicator)	An indicator variable taking a value of one if the firm is targeted by a hedge fund and zero otherwise. We thank Alon Brav for graciously sharing his extended data from Brav, Jiang, and Kim, 2009.
Passive shareholdings	The percent of shares held by passive institutional owners, calculated from 13D filings. Passive owners are defined through a text search for any fund that is an index fund.
Shareholder information heterogeneity measures (Table 9)	
Bid-ask spread	The average bid-ask spread calculated from CRSP using daily data. Firms with fewer than 90 days of data are assigned a missing value.
Big city (indicator)	An indicator variable taking a value of one if the firm headquarters is located in one of the top ten metropolitan zip codes as defined by the US Census Bureau.
Num analysts	The number of analysts covering a firm in a particular year based on the IBES analyst coverage data. Firms not covered in the IBES database are assigned a value of zero.

Figure 1. Age related changes in the costs and benefits of takeover defenses

This figure illustrates the marginal costs and marginal benefits of the use of takeover defenses for a firm at two stages in its lifecycle. The value reversal hypothesis (Hypothesis 1) is based on the prediction that, as firms age, the costs of having takeover defenses increase and the benefits of having takeover defenses decrease.

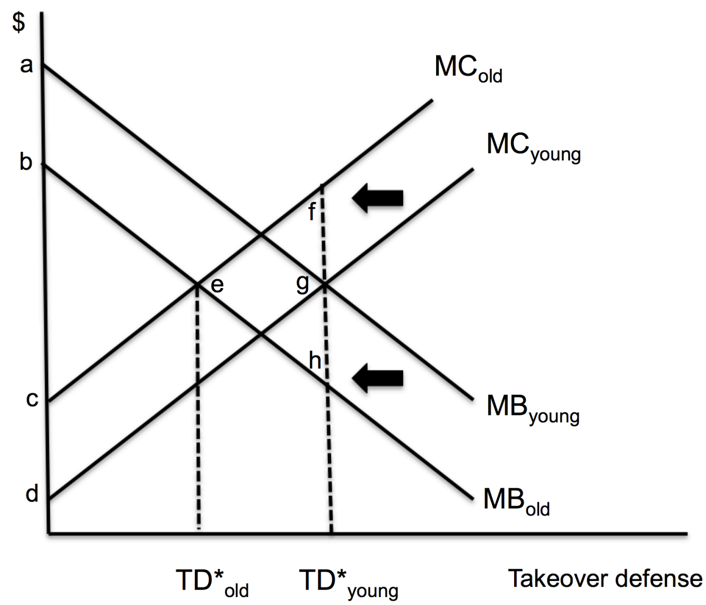


Figure 2. Frequencies of changes in firms' takeover defenses

This figure reports the firm-years in the sample in which firms add, remove, or make no changes to their takeover defenses. The sample consists of 13,947 firm-year observations from 2,283 firms that had IPOs between 1997-2011. Firms are tracked from the first year after their IPO until the firms are either delisted or the sample period ends in 2015.

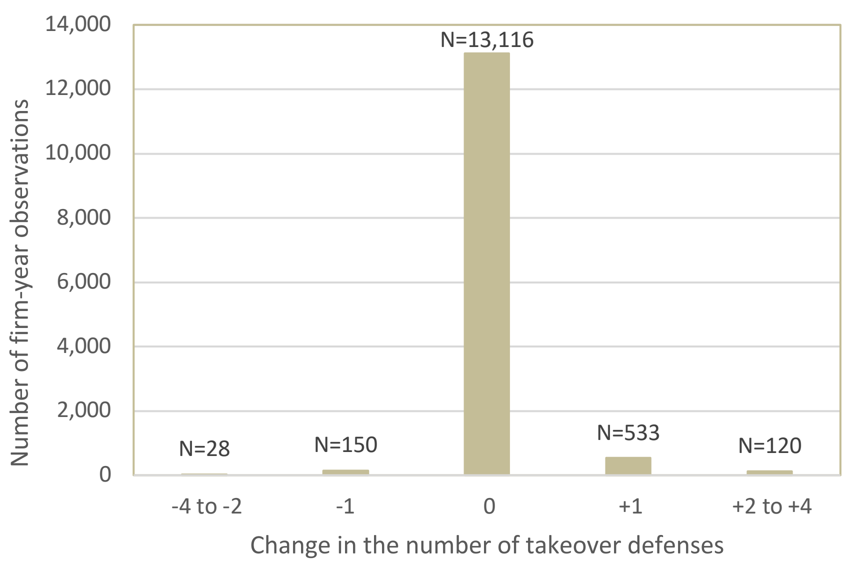


Figure 3. Illustration of the value reversal effect of takeover defenses

This figure illustrates the value reversal effect of a fixed level of takeover defense (labeled here as TD^*_{young}) as a firm matures. As the firm matures, the net benefits of takeover defenses decrease, and a level of defense that created value at early stages of the firm's life becomes more costly as the firm matures. This relation illustrates the prediction of the value reversal hypothesis (Hypothesis 1), and characterizes the empirical results reported in Section 3.

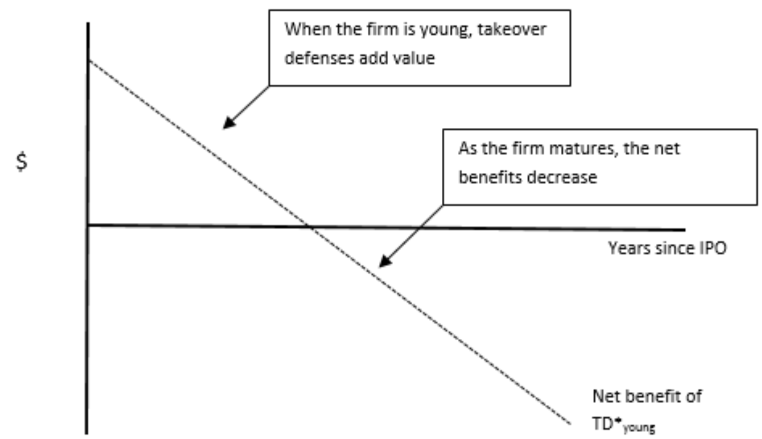
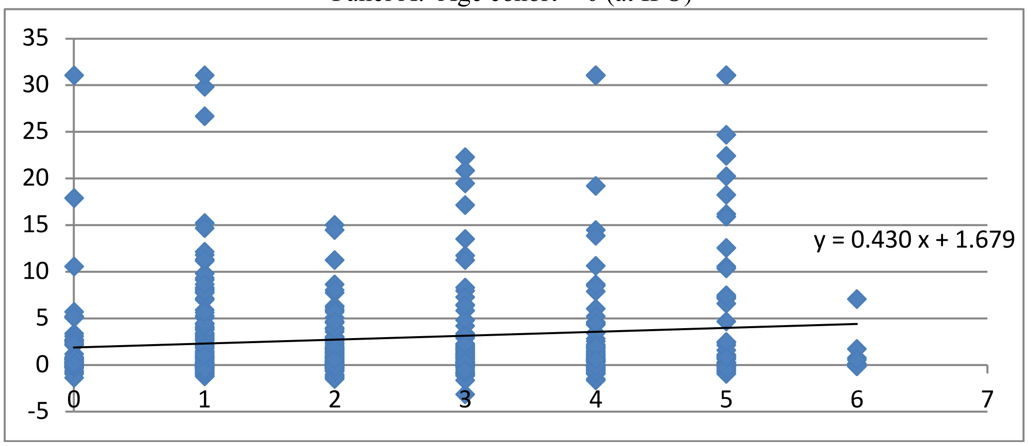


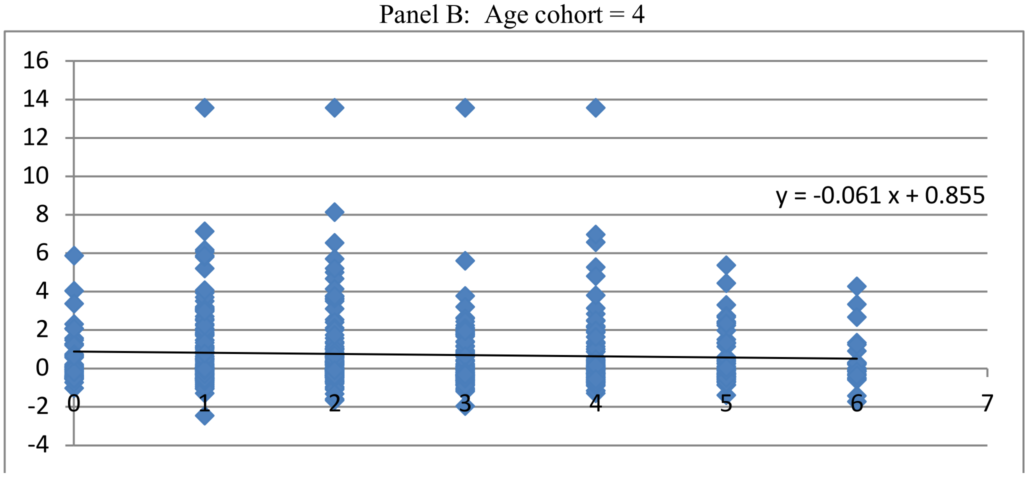
Figure 4. Scatterplots of the q-E index relation for different age cohorts

This figure plots industry-adjusted *q* as a function of the firm's E-index at three different ages for a constant sample of 544 firms that survive at least 10 years after their IPOs. Extreme values are Winsorized at the 99% level, although results are similar with no Winsorization or with truncation at the 99% level. The slope coefficient in Panel A is positive and statistically significant at the 1% level; the slope coefficient in Panel B is not statistically significant; and the slope coefficient in Panel C is negative and statistically significant at the 1% level.

Panel A: Age cohort = 0 (at IPO)



Panel B: Age cohort = 4



Panel C: Age cohort = 10

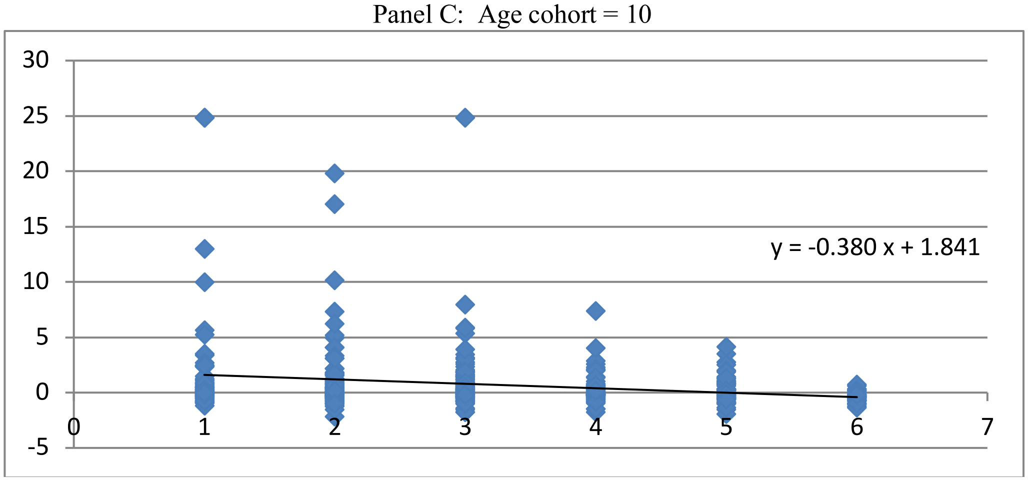


Table 1. IPO years of the sample firms and sample attrition as firms age

Panel A reports the number of distribution of the 2,283 sample firms by the years of their IPOs. The sample excludes REITS, ADRs, funds, firms without CRSP and COMPUSTAT coverage, firms incorporated outside the United States, firms with a dual class share structure, and firms not in Jay Ritter's database of firms with a founding date. We also exclude IPO firms that do not have prospectus filings, annual reports, and proxy statement filings available in the SEC's EDGAR database. Panel B describes the attrition in sample firms in the years after their IPOs. The number of surviving firms in any subsequent year *t* equals the number of surviving firms in year *t-1* minus the firms that leave by merger, delisting, and truncation in year *t-1*. Firms leaving by merger and delisting are identified by the CRSP delisting code. Truncation occurs because our data continue only through 2014, when many firms in the sample continue to survive.

Panel A. IPO years of the sample firms	
IPO Year	N
1997	384
1998	248
1999	409
2000	310
2001	64
2002	49
2003	59
2004	153
2005	129
2006	138
2007	153
2008	16
2009	36
2010	76
2011	59
Total	2,283

Panel B. Sample attrition as firms age

Years from IPO	Number of surviving firms	Firms with missing data	Number of firms with data for year *t*	Attrition: Firms leaving by merger	Firms leaving by delisting	Firms leaving by truncation	Total attrition
0	2,283	0	2,283	130	54	0	184
1	2,099	3	2,096	175	83	8	266
2	1,833	6	1,827	133	83	7	223
3	1,610	4	1,606	105	61	48	214
4	1,396	1	1,395	92	58	48	198
5	1,198	4	1,194	81	35	20	136
6	1,062	0	1,062	61	33	20	114
7	948	1	947	53	32	59	144
8	804	0	804	51	29	64	144
9	660	0	660	35	26	55	116
10	544	0	544	28	17	49	94
11	450	2	448	19	20	19	58
12	392	0	392	17	13	17	47
13	345	0	345	22	9	32	63
14	282	0	282	17	14	62	93
15	189	0	189	14	13	60	87
16	102	0	102	2	4	42	48
17	54	0	54	3	7	44	54
Total	16,251	21	16,230	1,038	591	654	2,283

Table 2. Firms' uses of E-index provisions by firm age

This table reports the average E-index values and the numbers of firms adopting and removing takeover defenses each age cohort relative to the IPO year. The sample consists of 2,283 IPO firms from 1997-2011, and excludes REITS, ADRs, funds, firms without CRSP and COMPUSTAT coverage, firms incorporated outside the United States, firms with a dual class share structure, and firms not in Jay Ritter's database of firms with a founding date. We also exclude IPO firms that do not have prospectus filings, annual reports, and proxy statement filings available in the SEC's EDGAR database.

Years from IPO	N	Average E-index at beginning of year	Firms adding new provisions	Firms removing provisions	Average E-index at end of year
0	2,283	2.40	22	0	2.41
1	2,096	2.41	93	6	2.49
2	1,827	2.48	105	7	2.60
3	1,606	2.60	104	13	2.69
4	1,395	2.69	47	6	2.73
5	1,194	2.73	53	2	2.78
6	1,062	2.77	33	10	2.79
7	947	2.79	44	10	2.84
8	804	2.83	56	12	2.90
9	660	2.90	48	13	2.94
10	544	2.94	52	25	3.01
11	448	3.01	6	18	2.98
12	392	2.98	3	18	2.95
13	345	2.95	5	16	2.90
14	282	2.90	2	13	2.85
15	189	2.85	2	5	2.85
16	102	2.85	0	3	2.76
17	54	2.76	0	1	2.63
Total	16,230	2.69	653	178	2.69

Table 3. Univariate tests of the value reversal hypothesis

This table compares Tobin's *q* for firms with high and low E-index values by age cohort. Age cohort is measured as years from the IPO. The sample consists of 2,283 firms that went public from 1997-2011. Industry median-adjusted Tobin's *q* is winsorized at the 99th percentile. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Industry adjusted Tobin's q by E-index and years from IPO

Years from IPO	N	Mean industry adjusted *q*		Difference	t-stat	Mann-Whitney test (z-stat)
		Below-median E-index firms	Above-median E-index firms			
0	2,283	2.09	2.52	0.43	2.01**	1.95*
1	2,096	0.59	0.92	0.33	3.21***	3.06***
2	1,827	0.52	0.63	0.11	1.09	1.70*
3-4	3,001	0.62	0.58	-0.05	-0.60	0.44
5-6	2,256	0.91	0.48	-0.42	-3.73***	-2.95***
7-9	2,411	0.68	0.40	-0.28	-3.24***	-3.21***
≥10	2,356	1.25	0.36	-0.89	-5.07***	-2.83***
Total	16,230	0.97	0.78	-0.19	-3.90***	-2.31***

Table 4. Multivariate tests of the value reversal hypothesis

Panel A reports estimates from cross-sectional OLS regressions in which the dependent variable is Tobin's *q* winsorized at the 99th percentile. Each cross-section consists of firms in the same age cohort, defined as years from the IPO. Panel A includes data from all 2,283 IPO firms from 1997-2011. Panel B reports estimates from panel data consisting of all 16,230 firm-years in the sample. Columns 2 and 3 of Panel B reports second-stage 2SLS results using the instrumental variables from Johnson, Karpoff, and Yi (2015) and Karpoff, Schonlau, and Wehrly (2017), respectively. All regressions include industry and year fixed effects. Standard errors for models with only one observation per firm are reported below the coefficients. Panel A-C Models 4-7 report standard errors clustered by firm. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Panel A. Cross-sectional regressions by firm age relative to the year of the IPO (Year = 0), dependent variable = Tobin's q

	(1) Year = 0	(2) Year = 1	(3) Year=2	(4) Year=3, 4	(5) Year = 5-6	(6) Year = 7-9	(7) Year≥10
E-index	0.283***	0.079**	0.014	0.008	-0.028	-0.018	-0.173***
	(0.053)	(0.039)	(0.036)	(0.030)	(0.040)	(0.043)	(0.052)
Delaware (indicator)	0.517***	0.248	0.426**	0.202	0.318	0.391***	0.184
	(0.196)	(0.154)	(0.166)	(0.162)	(0.200)	(0.139)	(0.222)
Firm age (years)	6.542***	0.627	1.696***	2.017***	2.623***	2.086***	2.880***
	(0.498)	(0.404)	(0.452)	(0.336)	(0.520)	(0.335)	(0.499)
Log(assets)	-0.123***	-0.069***	-0.020	-0.009	-0.001	0.008	0.054
	(0.029)	(0.022)	(0.020)	(0.020)	(0.024)	(0.025)	(0.044)
S&P 500 firm (indicator)	-0.274***	-0.127**	-0.372***	-0.586***	-0.816***	-0.637***	-0.778***
	(0.071)	(0.057)	(0.085)	(0.084)	(0.109)	(0.094)	(0.164)
CEO ownership	1.342***	0.488*	-0.259	-0.535**	-0.914**	-0.154	0.230
	(0.330)	(0.280)	(0.310)	(0.250)	(0.378)	(0.411)	(0.616)
Institutional ownership	-1.080***	1.011***	1.327***	1.183***	1.261***	1.146***	1.590***
	(0.411)	(0.242)	(0.218)	(0.178)	(0.205)	(0.195)	(0.388)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,283	2,096	1,827	3,001	2,256	2,411	2,356
R^2	32.44	18.44	23.33	29.77	26.38	31.16	20.43

Panel B. Panel data regressions, dependent variable = Tobin's q

	(1) OLS	(2) 2SLS JKY (2015) instruments	(3) 2SLS KSW (2017) instruments
Firm age > 4 yrs (indicator)	0.108***	0.641*	31.991**
	(0.028)	(0.341)	(15.319)
E-index	0.272**		
	(0.130)		
E-index x Firm age > 4 yrs	-0.196***		
	(0.035)		
Instrumented E-index		0.228***	0.557
		(0.067)	(0.766)
Instrumented E-index x Firm age > 4 yrs		-0.360**	-11.978**
		(0.127)	(5.696)
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	No
Year fixed effects	Yes	Yes	No
N	16,230	16,230	10,983
R^2	20.04	14.67	11.89

Table 5. Lifecycle measures of the benefits and costs of takeover defenses

This table reports on the variables we use to examine the channels by which the value reversal operates. We examine firm characteristics that serve as proxies for the costs or benefits of takeover protection. The measures of costs are the values of cash holdings, diversifying acquisitions, and having a combined CEO-board chair. The measures of benefits are the values of sales to large customers, durable product sales, and having a CEO-founder. Coefficients reflecting the value of each firm characteristic are estimated from an extension of the model in Faulkender and Wang (2006):

$$r_{i,t} - R^B_{i,t} = \gamma_0 + \gamma_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma_2 \frac{\Delta divers_{acquisitions_{i,t}}}{M_{i,t-1}} + \gamma_3 CEOchair_{i,t} + \gamma_4 \frac{\Delta cust_{sale_{i,t}}}{M_{i,t-1}} + \gamma_5 \frac{\Delta Dur_{sale_{i,t}}}{M_{i,t-1}} + \gamma_6 CEOfounder_{i,t} + \gamma_7 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \gamma_8 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \gamma_9 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \gamma_{10} \frac{\Delta I_{i,t}}{M_{i,t-1}} + \gamma_{11} \frac{\Delta D_{i,t}}{M_{i,t-1}} + \gamma_{12} \frac{C_{i,t-1}}{M_{i,t-1}} + \gamma_{13} L_{i,t} + \gamma_{14} \frac{NF_{i,t}}{M_{i,t-1}} + e_{i,t}$$

Column 1 reports estimates for all Compustat firms, while columns 2-4 reports results for three age cohorts. Robust standard errors are reported below each coefficient. $\Delta C_{i,t}$ is the change in cash and cash equivalents; $\Delta divers_{acquisitions_{i,t}}$ is the change in diversifying acquisitions; $CEOchair_{i,t}$ is an indicator variable taking a value of one if the board chair is held by the CEO; $\Delta cust_{sale_{i,t}}$ is the change in sales to a large customer over the past year; $\Delta Dur_{sale_{i,t}}$ is the change in durable product sales over the past year; $CEOfounder_{i,t}$ is an indicator variable taking a value of one if the CEo is also the founder of the firm; $\Delta E_{i,t}$ is the change in earnings before interest and extrodinary items; $\Delta NA_{i,t}$ is the change in total assets, net of cash; $\Delta RD_{i,t}$ is the change in R&D expenditures; $\Delta I_{i,t}$ is the change in interest expense; $\Delta D_{i,t}$ is the change in total dividends plus share repurchases; $C_{i,t-1}$ is the cash and cash equivalents holdings from the prior fiscal year; $L_{i,t}$ is the market leverage from the current fiscal year; and $NF_{i,t}$ is the net financing defined as the sale of common and preferred stock minus the purchase of common and preferred stock plus long-term debt issuance minus long-term debt reduction. All changes are calculated from the last fiscal year to the current fiscal year and many of the variables are normalized by the firm's market capitalization at the end of the prior year, $M_{i,t-1}$. All measures are winsorized at the 1% and 99% level. In Panel B we use the coefficients from Panel A to calculate the value of each benefit and cost, divided by firm market capitalization, for the firms in our sample. Panel B also reports on an aggregate measure of the net benefits of a firm's takeover protection in a given year *t* as:

$$Aggregate\ value\ of\ defenses_{i,t} = [(\gamma_1 - 1)C_{i,t} + \gamma_2\ diversify\_acquisitions_{i,t} + \gamma_3\ CEOchair_{i,t} * M_{i,t-1} + \gamma_4\ cust_{sale_{i,t}} + \gamma_5\ durable\_sales_{i,t} + \gamma_6\ CEOfounder_{i,t} * M_{i,t-1}] \div Market\ capitalization_{i,t}$$

All variables are winsorized at the 99th percentile. *, **, and *** indicate that the measure is statistically different from zero using a two-tailed test at the 10%, 5%, and 1% significance levels.

(continued on the next page)

Table 5, continued

Panel A. Estimates for the costs and benefits of takeover protection

	(1) Total sample	(2) Age 1-5 (a)	(3) Age 6-9	(4) Age ≥10 (b)	Test of coefficients (a–b) t-stat (p-value)
Proxies for the cost of takeover defenses					
Cash holdings	0.872***	1.033***	0.962***	0.752***	5.10***
	(0.028)	(0.066)	(0.059)	(0.036)	(0.00)
Diversifying acquisitions	-0.202**	0.204	-0.054	-0.278***	2.16**
	(0.095)	(0.254)	(0.189)	(0.082)	(0.03)
CEO-board chair	-0.018	0.037	0.010	-0.035***	0.55
	(0.015)	(0.061)	(0.094)	(0.013)	(0.58)
Proxies for the benefits of takeover defenses					
Sales to large customers	0.092***	0.194**	0.082**	0.081***	1.71*
	(0.015)	(0.080)	(0.036)	(0.016)	(0.09)
Durable product sales	0.001	0.016**	0.021	0.001	2.33**
	(0.000)	(0.007)	(0.017)	(0.000)	(0.02)
CEO-founder	0.090**	0.145**	0.067	-0.017	1.30
	(0.042)	(0.074)	(0.060)	(0.087)	(0.19)
Control variables					
ΔE_t	0.774***	0.912***	0.775***	0.714***	
	(0.022)	(0.063)	(0.039)	(0.027)	
ΔNA_t	0.197***	0.175***	0.204***	0.201***	
	(0.010)	(0.020)	(0.020)	(0.013)	
ΔRD_t	2.894***	3.347***	3.397***	2.241***	
	(0.226)	(0.496)	(0.448)	(0.291)	
ΔI_t	-2.699***	-3.063***	-2.706***	-2.405***	
	(0.130)	(0.311)	(0.254)	(0.167)	
ΔD_t	2.288***	1.010**	2.600***	2.700***	
	(0.173)	(0.425)	(0.442)	(0.207)	
C_{t-1}	0.145***	0.279***	0.147***	0.095***	
	(0.012)	(0.040)	(0.026)	(0.011)	
L_t	-0.118***	-0.187***	-0.119***	-0.092***	
	(0.010)	(0.027)	(0.024)	(0.011)	
NF_t	0.072***	0.256***	0.089**	-0.035	
	(0.020)	(0.043)	(0.039)	(0.025)	
Intercept	-0.033***	-0.068***	-0.039***	-0.023***	
	(0.003)	(0.010)	(0.008)	(0.004)	
N	123,803	24,929	22,802	76,072	
R^2	12.51	12.65	14.34	12.34	

Panel B. Average (mean) costs and benefits of takeover defenses as a percent of the firm's market capitalization

	Total sample	Age 1-5	Age 6-9	Age ≥10
Costs of defenses (%)				
Value of cash holdings	-1.14%	1.10%	-1.54%	-10.43%
Value of diversifying acquisitions	-0.09%	0.31%	-0.19%	-1.71%
Value of CEO-board chair	0.25%	0.40%	0.09%	-0.22%
Benefits of defenses (%)				
Value of sales to large customer	2.91%	3.37%	1.99%	2.27%
Value of durable product sales	2.61%	2.61%	3.42%	1.43%
Value of CEO-founder	2.11%	3.03%	0.90%	-0.18%
Costs plus benefits				
Aggregate value of defenses	6.65%	10.82%	4.67%	-8.83%

Table 6. Value reversal and the costs and benefits of takeover defenses

This table reports estimates from panel data regressions in which the dependent variable is Tobin's q winsorized at the 99th percentile. Each regression examines the impact of high versus low values of takeover defenses as measured by the value of cash, the value of diversifying acquisitions, the value of a combined CEO-chair position, the value of a large customer, the value of durable product sales, and the value of a CEO-founder. The values are calculated using the coefficients generated in Table 5. The aggregate value of defenses is calculated as:

$$Aggregate\ value\ of\ defenses_{i,t} = (\gamma_1 - 1)C_{i,t} + \gamma_2\ diversify\_acquisitions_{i,t} + \gamma_3\ CEOchair_{i,t} * M_{i,t-1}$$
$$+\gamma_4\ cust_{sale_{i,t}} + \gamma_5\ durable\_sales_{i,t} + \gamma_6\ CEOfounder_{i,t} * M_{i,t-1}$$

All regressions include the controls used in Table 4 Panel A, plus industry and year fixed effects. Standard errors are clustered by firm and reported below the regression coefficients. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Panel data regressions of Tobin's q in all years after IPO by costs and benefits of takeover defenses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
E-index	0.149***	0.146*	0.108***	0.073**	0.051	0.094***	0.054
	(0.026)	(0.015)	(0.028)	(0.036)	(0.038)	(0.030)	(0.040)
Firm age > 4 yrs (indicator)	-0.516***	0.264*	0.269**	0.273**	0.237*	0.267**	-0.028
	(0.138)	(0.031)	(0.131)	(0.130)	(0.121)	(0.130)	(0.127)
E-index x Firm age > 4 yrs (indicator	-0.166***	-0.196**	-0.193***	-0.197***	-0.172***	-0.189***	-0.178***
	(0.043)	(0.006)	(0.035)	(0.035)	(0.033)	(0.035)	(0.035)
Cost of defenses							
Low value of cash holdings	1.334***						
	(0.136)						
Low value of cash holdings x E-index	-0.092**						
	(0.046)						
Low value of diversifying acquisitions		0.456**					
		(0.030)					
Low value of diversifying acquisitions x E-index		-0.038*					
		(0.018)					
Low value of CEOchair			0.162				
			(0.426)				
Low value of CEOchair x E-index			-0.164				
			(0.102)				
Benefits of defenses							
High value of sales to large customer				-0.334**			
				(0.132)			
High value of sales to large customer x E-index				0.065*			
				(0.039)			
High value of durable product sales					-2.063***		
					(0.119)		
High value of durable product sales x E-index					0.108***		
					(0.035)		
High value of CEOfounder						-0.005	
						(0.196)	
High value of CEOfounder x E-index						0.054	
						(0.059)	
Cost plus benefits							
High aggregate value of defenses							-1.404***
							(0.126)
High aggregate value of defenses x E-index							0.110***
							(0.039)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	16,230	16,230	16,230	16,230	16,230	16,230	16,230
R^2	22.53	20.09	20.08	20.15	27.45	20.11	23.09

Table 7. Value reversal for E-index provisions at the IPO compared to added or removed provisions

Panel A reports on tests that are similar to those in Panel A of Table 4, but in which each firm-year E-index is partitioned into three components: the E-index at the time of the firm's IPO, provisions that were added after the IPO, and provisions that were deleted after the IPO. Each cross-section consists of firms in the same age cohort, defined as years from the IPO. Panel B reports on tests that are similar to those in Panel B of Table 4, but using the firm's E-index at the time of its IPO instead of its contemporaneous E-index. (The variables *Provisions added after IPO* and *Provisions deleted after the IPO* are statistically insignificant and do not affect the other coefficients in these tests.) The dependent variable in all models is the firm's Tobin's q winsorized at the 99th percentile. The sample consists of 2,283 firms that went public from 1997-2011, as described in the text and in Table 4. All regressions include industry and year fixed effects. Standard errors for models with only one observation per firm are reported below the coefficients. Panel A, Models 4-7, report standard errors clustered by firm. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Panel A: Cohort-specific cross-sectional regressions of Tobin's q on the partitioned E-index

	(1) Year = 0	(2) Year = 1	(3) Year=2	(4) Year=3, 4	(5) Year = 5-6	(6) Year = 7-9	(7) Year≥10
E-index provisions at the IPO	0.283***	0.086**	0.012	0.006	-0.041	-0.041	-0.187***
	(0.053)	(0.040)	(0.035)	(0.030)	(0.039)	(0.039)	(0.051)
Provisions added after IPO		-0.296	0.295	-0.244*	0.120	-0.114	-0.048
		(0.220)	(0.287)	(0.130)	(0.228)	(0.123)	(0.328)
Provisions removed after IPO		-1.248**	1.433	-0.488	0.543	0.229	0.194
		(0.527)	(1.316)	(0.358)	(0.463)	(0.374)	(0.240)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,283	2,096	1,827	3,001	2,256	2,411	2,356
R^2	32.44	13.01	18.62	23.39	29.82	26.45	31.42

Panel B: Panel data regressions of Tobin's q on the firm's E-index provisions at the IPO

	(1) Total sample
IPO stage E-index	0.116***
	(0.028)
Firm age > 4 yrs (indicator)	0.262**
	(0.122)
E-index provisions at the IPO x Firm age > 4 yrs	-0.211***
	(0.035)
Control variables	Yes
Industry fixed effects	Yes
Year fixed effects	Yes
N	16,230
R^2	20.48

Table 8. Value reversal and takeover defense stickiness

This table compares Tobin's *q* for firms with relatively sticky vs. non-sticky defenses. Firms are classified as having sticky defenses if the value of their c-index, as defined by Cremers et al. (2017) is greater than or equal to two. Age cohort is measured as years from the IPO. The sample consists of 2,283 firms that went public from 1997-2011. Panel A reports estimates from cross-sectional OLS regressions in which the dependent variable is Tobin's *q* winsorized at the 99th percentile, using data from firm-years in which the c-index is greater than or equal to two. Panel B includes observations in which the c-index is less than two. Panel C reports estimates from panel data consisting of all age-cohorts in the sample for firms with low (Model 1) or high (Model 2) c-index values. Singleton observations are dropped from each age-industry-year cohort. All regressions include industry and year fixed effects. Standard errors are clustered by firm and reported below the regression coefficients. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Panel A. High c-index firm-years by age cohort, dependent variable = Tobin's q

	(1) Year = 0	(2) Year = 1	(3) Year=2	(4) Year=3, 4	(5) Year = 5-6	(6) Year = 7-9	(7) Year≥10
E-index	0.354**	0.028	0.016	-0.129	-0.064	-0.135*	-0.446***
	(0.142)	(0.102)	(0.085)	(0.081)	(0.079)	(0.078)	(0.112)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	909	866	795	1,344	1,022	1,114	1,057
R^2	38.44	16.52	22.75	23.70	26.88	27.48	34.36

Panel B. Low c-index firm-years by age cohort, dependent variable = Tobin's q

	(1) Year = 0	(2) Year = 1	(3) Year=2	(4) Year=3, 4	(5) Year = 5-6	(6) Year = 7-9	(7) Year≥10
E-index	-0.015	-0.109	-0.148*	0.027	0.040	-0.014	0.182
	(0.124)	(0.091)	(0.089)	(0.079)	(0.107)	(0.126)	(0.157)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,374	1,230	1,032	1,657	1,234	1,297	1,299
R^2	31.68	13.40	19.02	27.08	35.57	29.43	38.85

Panel C. Panel data regressions of Tobin's q using all firm-years after IPO partitioned by c-index

	(1) Low c-index	(2) High c-index	(3) Total sample
E-index	0.001	0.077	0.016
	(0.065)	(0.066)	(0.064)
Firm age > 4 yrs (indicator)	-0.157	0.932**	-0.045
	(0.190)	(0.365)	(0.185)
E-index x Firm age > 4 yrs	0.034	-0.338***	0.012
	(0.099)	(0.077)	(0.100)
High c-index			0.101
			(0.293)
E-index x High c-index			0.054
			(0.089)
Firm age > 4 yrs x High c-index			0.691*
			(0.386)
E-index x Firm age > 4 yrs x High c-index			-0.303**
			(0.127)
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	9,123	7,107	16,230
R^2	22.51	20.64	20.53

Table 9. Determinants of takeover defense removals

This table reports results from linear probability models in which the dependent variable equals one for firm-years in which the firm removes one or more takeover defenses, using panel data from the sample of 2,283 firms that went public from 1997-2011. The general regression model is:

$$\mathrm{I}(eindex\_change)_{i,t} = \delta_0 + \delta_1 Age_{i,t} + \delta_2 Log(assets)_{i,t} + \delta_3 CEO_{shares_{i,t}} + \delta_4 institutional_{shares_{i,t}} + \delta_5 benefits\_defenses_{i,t} + \delta_6 costs\_defenses_{i,t} + \delta_7 Free\_riding_1 + \delta_8 Info\_heterogeneity_2 + e_{i,t}$$

Models 1- 6 of Panel A each includes one measure of the agency-related cost or bonding-related benefit of having takeover defenses. Each regression examines the impact of high versus low values of having takeover defenses as measured by the value of cash, the value of diversifying acquisitions, the value of a CEO-chair, the value of a large customer, the value of durable product sales, and the value of a CEO founder. The values are calculated using the coefficients generated in Table 5. The aggregate value of defenses is calculated as:

$$Aggregate\ value\ of\ defenses_{i,t} = (\gamma_1 - 1)C_{i,t} + \gamma_2\ diversify\_acquisitions_{i,t} + \gamma_3\ CEOchair_{i,t} * M_{i,t-1} + \gamma_4\ cust_{sale_{i,t}} + \gamma_5\ durable\_sales_{i,t} + \gamma_6\ CEOfounder_{i,t} * M_{i,t-1}$$

Model 1 of Panel B includes *High c-index,* which is an indicator that takes the value of one if the firm has two or more c-index provisions (which Cremers et al., 2016, argue are costly to remove). Models 2-4 include measures of shareholders' cost of acting collectively to remove a takeover defense, including the firm being targeted by the Harvard Shareholder Rights Project (*Harvard SRP*), being targeted by a hedge fund (*Hedge fund*), and the percent of passive shareholdings in the firm (*Passive shareholdings*). Models 5-7 include measures of information heterogeneity among shareholders (as such heterogeneity also impedes collective action), including being located in a top ten city in the US by population (*Big city*), the number of analysts covering the firm in the IBES data (*Num analysts*), and the average daily bid-ask spread over the past year (*Bid-ask spread*). Panel C reports on the effect of one-standard deviation changes from the mean for each of these measures on the probability of removing a defense, relative to a one-standard deviation change in the *Aggregate value of defenses*. Standard errors are clustered by firm and reported below the regression coefficients. *, **, and *** indicate statistical significance using a two-tailed test at the 10%, 5%, and 1% significance levels.

Panel A. The effects of the costs and benefits of takeover defenses on takeover defense removals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm age (years)	0.001**	0.001**	0.001**	0.001**	0.001**	0.001*	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log(assets)	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO ownership	-0.019***	-0.019***	-0.019***	-0.019***	-0.019***	-0.017***	-0.018***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Institutional ownership	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Costs of defenses ($ millions)							
Value of cash holdings	-0.032**						
	(0.013)						
Value of diversifying acquisitions		-0.019*					
		(0.012)					
Value of combined CEO-Chair			-0.194***				
			(0.063)				
Benefits of defenses ($ millions)							
Value of sales to large customer				-0.015***			
				(0.005)			
Value of durable product sales					-0.007*		
					(0.004)		
Value of CEO-founder						-0.052***	
						(0.012)	
Costs plus benefits							
Aggregate value of defenses							-0.017***
							(0.005)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	13,946	13,946	13,946	13,946	13,946	13,946	13,946
R^2	0.95	1.78	1.81	1.76	2.88	1.96	1.76

(continued on the next page)

Table 9, continued

Panel B. The effects of shareholder information heterogeneity and the cost of collective action on takeover defense removals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm age (years)	0.001**	0.001**	0.002**	0.001*	0.001	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log(assets)	0.003***	0.003***	0.002**	0.003***	0.004***	0.002**	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CEO ownership	-0.019***	-0.017***	-0.018***	-0.019***	-0.013**	-0.018***	-0.017***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)
Institutional ownership	0.001	0.001	-0.005	0.002	-0.005	0.001	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.004)	(0.004)
Aggregate value of defenses	-0.017***	-0.017***	-0.017***	-0.014**	-0.014	-0.017***	-0.018***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.012)	(0.005)	(0.005)
Difficult to change defenses							
High c-index	-0.006***						
	(0.002)						
Shareholder information heterogeneity measures							
Big city (indicator)		0.007***					
		(0.002)					
Num analysts			0.001***				
			(0.000)				
Bid-ask spread				-0.001*			
				(0.001)			
Cost of collective action measures							
Passive shareholdings					0.018*		
					(0.010)		
Harvard SRP (indicator)						0.333***	
						(0.110)	
Hedge fund (indicator)							0.034***
							(0.013)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	13,946	13,946	13,946	12,757	6,546	13,946	13,946
R^2	1.24	1.22	1.20	1.21	2.34	2.88	1.96

Panel C. Estimates of the costs of collective action and information heterogeneity associated with the removal of takeover defenses

		Shareholder information heterogeneity measures			**Cost of collective action measures**		
	Aggregate value of defenses	Big city (indicator)	Num analysts	Bid ask spread	Passive shareholdings	Harvard SRP (indicator)	Hedge fund (indicator)
Coefficient (Panel B)	-0.017	0.007	0.001	-0.001	0.018	0.333	0.034
σ	$1,482 million	0.4926	5.2342	0.2133	0.1367	0.0342	0.1288
Change in probability from 1 σ increase (Coefficient x σ)	0.252%	0.345%	0.523%	-0.021%	0.246%	1.139%	0.438%
Magnitude relative to Aggregate value of defenses	1.00x	1.37x	2.08x	0.085x	0.98x	4.52x	1.74x

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