The Lifecycle Effects of Firm Takeover Defenses

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Abstract. We propose and test the hypothesis that takeover defenses confer costs and benefits to a firm's shareholders that change in systematic ways as a firm ages. In particular, the cost of managerial entrenchment increases as managerial ownership declines, and the benefits of stakeholder bonding via takeover defenses decrease, as a firm grows and diversifies. A value-maximizing response to such changes would be for firms to shed takeover defenses as they age. We document, however, that firms' use of takeover defenses is sticky, as the likelihood of a firm keeping its current takeover defenses in any given year is 98%, and 90% of firms never remove any takeover defenses during the 15 years after their IPOs. As a result of such stickiness, takeover defenses that enhance value at the firm's IPO tend to become costly over time. Consistent with this hypothesis, we find that the average relation between firm value and the use of defenses is positive at the IPO but declines and becomes negative as the firm ages. The decline is most pronounced among firms that deploy the most sticky defenses, for which the bonding benefits decrease over time, and for which entrenchment costs increase.

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1. Introduction

Are takeover defenses good or bad for shareholders? The answer depends on whom you ask. Many researchers find support for the view that takeover defenses entrench managers and decrease firm value (e.g., Gompers, Ishii and Metrick (2003), Masulis, Wang, and Xie (2007), Bebchuk, Cohen and Ferrell (2009)). But others find that takeover defenses are associated with improved value and performance (e.g., Linn and McConnell, 1983; Caton and Goh, 2008; Chemmanur and Tian, 2013; Smith 2015). Surveying the literature, Burkart and Panunzi (2006) conclude that "…there is still little consensus about the effects of takeover defenses on shareholder wealth, despite the large number of papers on this topic." Straska and Waller (2014, p. 941) concur: "… [E]vent studies have been largely inconclusive in determining how antitakeover provisions impact shareholder wealth."

In this paper we propose that previous findings are mixed because takeover defenses confer both benefits and costs that vary across firms and over a firm's lifecycle. Our idea is illustrated in Figure 1. Takeover defenses offer benefits by encouraging long-term investment (Stein, 1988; Cremers and Ferrell, 2014) and by bonding relationships with important counterparties (Johnson, Karpoff, and Yi, 2015; Cen, Dasgupta, and Sen, 2015). Johnson, Karpoff, and Yi (2015) show that these benefits are important for IPO firms because such firms rely heavily on business relationships with large customers and strategic partners that are vulnerable to hold up problems. Takeover defenses also convey costs, however, by insulating managers from the threat of outside takeover and increasing the cost of agency (e.g., DeAngelo and Rice, 1983). Such costs tend to be low for young firms because their managers own relatively large equity stakes, thus ameliorating agency problems compared to firms with more diffuse ownership.

In Figure 1, the marginal benefit and marginal cost of additional takeover protection for young firms equate at a relatively high level of takeover protection. As firms mature and rely less heavily on a small number of key customers or strategic partners, we postulate that the marginal benefit of takeover protection declines. Consistent with this argument, Johnson, Kang, and Yi (2010) find that 60% of IPO firms disclose a large customer while Cen, Dasgupta, and Sen (2015) find that 41% of mature firms rely heavily on a large customer. As firms mature, their managers tend to own smaller equity stakes, increasing the agency cost of equity and increasing the marginal cost of takeover protection. The marginal benefit and marginal cost for mature firms equate at a low level of takeover protection.

This argument implies that the value-maximizing level of takeover protection decreases as the firm ages. If firms were to adjust optimally, they would shed some takeover defenses as they mature. We observe, however, that the use of takeover defenses is sticky. In our sample of 2,283 firms that went public from 1997 – 2011, 90% never remove any defenses after their IPOs. There is some movement, as some firms in our sample shed classified boards and add poison pills and golden parachutes. But the average effect is to slightly increase the use of takeover defenses over time, not to remove them. As a result, the average E-index at the IPO is 2.41 for firms in our sample, growing to 3.09 ten years later.

There are at least four reasons firms' use of takeover defenses tends to be sticky. First, many defenses are in the firm's charter or bylaws, and changing them requires a shareholder vote to amend the charter or bylaws. Coates (2001) argues that a power conflict between managers and institutional shareholders typically results in a draw. Managers want more takeover protections while institutional shareholders want fewer such protections. Neither side, however, typically has much success in advancing its agenda because it is checked by the other side.

A second reason shareholders find it costly to force the removal of takeover defenses is that they face a free-rider problem. The very diffuseness in share ownership that gives rise to agency costs also increases the cost of making value-improving adjustments (e.g., see Shleifer and Vishny, 1986). The free-rider problem is exacerbated when shareholders do not hold unanimous views about the benefits of a takeover, perhaps because they have different cost bases and would face different tax liabilities in the event of a takeover (e.g., see Bagwell, 1991; Rice, 2006).

Third, Hannes (2005) argues that SEC regulations aggravate the collective action problem because they impose restrictive requirements on shareholders wishing to act together through the proxy process. These regulations reduce the likelihood that shareholders will work together to change firm governance by removing takeover defenses.

Fourth, the combination of bounded rationality and anchoring may contribute to stickiness in firms' use of takeover defenses. In describing the status quo bias, Samuelson and Zeckhauser (1988) show that people have a bias toward maintaining the current state rather than attempting to make value-increasing changes. In addition, Kahan and Klausner (1996) show that shareholders and managers tend to anchor their decisions on an initial reference point such as the firm's takeover defenses at its IPO. Consistent with status quo bias and anchoring, Hannes (2005) argues that governance characteristics are sticky particularly when they benefit managers: "Many frequently used corporate charter provisions that impede the ability to take over a corporation, such as provisions for staggered boards, are subject to … corporate stagnation. While seasoned firms only rarely adopt such charter provisions, firms that previously added the said provisions to their charters do not tend to repeal them."

Sticky takeover defenses have consequences for firm value. If our lifecycle hypothesis is correct and the value-maximizing number of defenses decreases as a firm ages, a firm that does not adjust its takeover defenses should experience a decrease in firm value. Suppose, for example, that the marginal cost of takeover defenses increases as the firm ages, driven by the increasing diffuseness of share ownership and the resulting increase in managerial agency costs. Suppose also that the marginal benefit of takeover defenses decreases, as the firm relies less on the quasi-rents that are generated from relationships with specific large buyers or strategic partners. A firm that is stuck with the takeover defenses it had in place at its IPO (TD_{young} in Figure 1) will experience a loss in value associated with having too many defenses compared to its optimal level. Furthermore, the loss in value will increase as the firm matures.

This outcome is depicted in Figure 2. At the IPO, TD_{young} creates value. As the firm ages and the optimal takeover defense decreases to TD_{old}, the net benefits of the firm's defenses decrease. The net benefit continues to decrease 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 reverses and can even become negative.

In this paper we conduct several experiments to test this *value reversal* implication of the lifecycle hypothesis of takeover defenses. First, we find that the relation between Tobin's *q* and a firm's use of defenses decreases as the firm ages. This relation holds using different measures of a firm's takeover defenses, including the E-index, the use of a classified board, and several other measures discussed in our robustness section. The overall pattern – that the relation between *q* and takeover protection declines with firm age – is robust to various empirical specifications in univariate comparisons and multivariate tests. In multivariate tests that examine the determinants of *q*, for example, the coefficient on the E-index is 0.235 at the time of the firm's IPO and is -0.267 ten years after the IPO (both coefficients significant at the 1% level). These coefficients imply that for the incremental takeover defense, average firm value increases by $19.1 million at the IPO stage and decreases by $64.0 million when the firm is ten years old.

Next, we construct a measure of a firm's cost of adjusting its takeover defenses based on the empirical frequency with which each of the six provisions in the E-index is removed by our sample firms. Consistent with the lifecycle hypothesis, the value reversal occurs primarily among the subset of firms for which the adjustment cost is relatively high. Among firms with relatively low costs of adjustment, the difference between firms with high and low E-index values generally declines with firm maturity, but the decline is neither monotonic nor statistically significant. These results indicate that the value reversal is most prominent when firms cannot or will not adjust their takeover defenses as they age.

We then examine four particular channels that change the benefits and costs of takeover defenses and through which the lifecycle hypothesis works. Previous research shows that takeover defenses are particularly valuable for firms with large customers, strategic alliances, and founder CEOs – all characteristics that imply the existence of valuable quasi-rents that can be bonded using takeover defenses (Johnson, Karpoff, and Yi, 2015). These findings imply that the benefits of a firm's takeover defenses decrease when firms lose large customers, end strategic partnerships, or part ways with their founder-CEOs. Consistent with this prediction, we find that the value reversal – that is, the decrease in *q* as a firm matures – is most pronounced among firms that subsequently lose large customers, end strategic partnerships, or part ways with their founder-CEOs. The value reversal also is stronger among firms whose managers' ownership stakes decrease significantly, consistent with the prediction that a decrease in managerial share ownership increases the agency cost of equity and increases the cost of takeover defenses. Importantly, the negative impacts of these channel-specific changes on firm value are not significantly related to firm age. We infer that our overall finding of a value reversal in the q – E-index relation is due not to firm age per se, but rather, the specific decreases in benefits and increases in cost that tend to occur as a firm ages.

A potential concern with our empirical analysis is that firm value and the use of takeover defenses are endogenous to the firm's competitive environment. Unlike standard analyses of the determinants of firm value, however, our tests are identified by the assumption that takeover defenses are sticky and do not adjust optimally over time. Furthermore, the lifecycle hypothesis implies that the direction of effect on firm value is monotonic with firm age. That is, among firms that survive, their previously beneficial takeover defenses become more costly over time. It is the inability of defenses to adjust optimally over time that identifies the empirical tests.

To examine any remaining influence of the endogenous selection of a firm's value and takeover defenses, we conduct three additional tests that introduce plausibly exogenous variation in firms' uses of takeover defenses. First, we use each firm's E-index value at the time of its IPO, E^{IPO}, as a proxy for its E-index in future years. Because most firms' takeover defenses are sticky, this proxy is highly correlated with future years' E-index values. But because it is pre-determined relative to any year beyond the year of the IPO, E^{IPO} is less likely to be influenced by contemporary influences on takeover vulnerability and firm performance.

Second, we estimate 2SLS models in which we develop instruments for a firm's E-index based on geography and the characteristics of the firm's law firm at the time of its IPO, similar to instruments used in Johnson, Karpoff, and Yi (2015). The results of the first-stage regressions indicate that the instruments are strong and meet the relevance condition. Below, we argue that they also plausibly meet the exclusion restriction. Our identification argument regarding law firm characteristics is based on Coates' (2001) finding that a firm's use of takeover defenses is strongly related to the identity of its law firm. Since most firms choose their law firms well before they go IPO, this influence on a firm's takeover defenses is pre-determined relative to the years of analysis in our tests.

Third, we use our law firm and geography based instruments as proxy variables for the E-index in reduced form models that examine the relation between firm value and the firm's takeover defenses. Previous research indicates that reduced form models of this type can serve as robustness checks for inferences taken from 2SLS models (see Angrist and Krueger, 2001; Murray, 2006; and Chernozhukov and Hansen, 2008). The reduced form tests are useful particularly when there is potential 2SLS bias, such as can arise when the exclusion restriction is violated. The reduced form tests also partially mitigate a concern about measurement error when we instrument for the E-index in the 2SLS tests.

The results of all of these tests are consistent with our main findings. Throughout, there is strong evidence of a value reversal as a firm matures. In particular, the relation between firm value and the use of takeover defenses is positive for firms at their IPOs, and declines steadily as the firm matures, becoming negative approximately five years after the IPO.

Another potential concern is that our results do not reflect value reversals for individual firms over time, but rather, a change in the composition of firms across age cohorts. In particular, many of our results are consistent with the interpretation that high-q/low-E and low-q/high-E firms are the firms that survive over time. According to this view, the value reversal reflects a particular form of sample attrition in which firms that leave the sample are characterized by a positive relation between firm value and takeover defenses. Evidence that supports this view would imply that previous findings of a negative relation between firm value and takeover defense (e.g., Gompers, Ishii, and Metrick 2003) are due to survivorship bias. To examine this view, we re-estimate our tests on samples of surviving firms. For example, 556 of the 2,283 firms in our sample survive into the tenth year after their IPOs. All of the results reported for the overall sample persist in this subsample of 556 firms. If anything, the evidence of value reversal is stronger among subsamples of surviving firms. We interpret these results as indicating that the value reversal does not reflect a change in sample composition over time, but rather, reflects the decreasing benefits and increasing costs of takeover defenses for individual firms as they age.

Finally, we conduct a series of additional tests to probe the robustness of these results. The results are similar using an alternate measure of firm value created by Dybvig and Warachka (2015), alternate measures of the firm's takeover defenses, and alternate measures of takeover defense stickiness. The results also 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 our results are not driven by differences in expected takeover premiums as firms age.

This paper makes five contributions to our understanding of firm's use of takeover defenses. First, we document that a firm's takeover defenses are largely determined by the defenses it has at the time of its IPO and are sticky over time. Firms do increase their defenses slightly, by an average of 0.054 new (E-index) defenses per year, but remove existing defenses even more rarely. Second, we document that the relation between a firm's value and its use of takeover defenses declines as the firm ages. The relation is positive, on average, at the time of the IPO and turns negative around five years later. Third, we show that this reversal in the value of takeover defenses is attributable to takeover defense stickiness. As firms age, their takeover defenses become less beneficial and more costly, on average. If defenses were not sticky, firms would adjust by shedding defenses as they age. Because firms do not typically shed defenses, however, the defenses that contributed to firm value when the firms were young serve as a drag on firm value as these firms age. This result holds particularly for firms with the most sticky defenses. Fourth, we show that the value reversal occurs not because of age per se, but rather, because of specific changes that correlate with firm age. In particular, takeover defenses lose value and become costly as firms lose large customers, key strategic partners, or founding CEOs – thus attenuating the bonding benefits of defenses – and as top managers' shareholdings decrease and the agency cost of takeover defenses increase. Fifth, our results provide an explanation for the mixed empirical results regarding the impact of takeover defenses on firm value. Our lifecycle hypothesis implies that takeover defenses serve to increase value for some, typically younger, firms, and to decrease value for other, typically older, firms.[1]

Our paper is not the first to document lifecycle effects in firms. Lifecycle effects also occur in firms' payout policies (Fama and French 2001; Bulan and Subramanian 2014), equity issuance (DeAngelo, DeAngelo, and Stulz 2010; Warusawitharana 2016), firm acquisitions (Arikan and Stulz 2016), firm profitability (Pastor, Taylor, and Veronesi 2009), and firm value (Loderer, Stulz, and Waelchli 2016). Loderer, Stulz, and Waelchli (2016) show that Tobin's *q* declines as a firm matures and argue that this occurs because operational and organizational rigidities increase as a firm ages. We also find that *q* tends to decline with firm age, but we find that this decline occurs primarily in firms with large numbers of takeover defenses, especially sticky defenses.

This paper is organized as follows. Section 2 develops three testable hypotheses implied by the lifecycle view of takeover defenses. Section 3 describes the data we use to test these hypotheses. In Section 4 we report on firms' use of takeover defenses from the time of their IPO through 15 years later. Section 5 reports on our main tests of the lifecycle hypothesis, particularly the proposition that the positive relation between firm value and the use of takeover defenses decreases and becomes negative as the firm matures. Section 6 reports on tests in which we examine specific age-related channels that generate the value reversal pattern. Section 7 revisits the proposition noted in other papers (e.g., Loderer, Stulz, and Waelchli, 2016) that Tobin's *q* declines with firm age. In our sample, this decline occurs primarily among firms with large numbers of takeover defenses at the times of their IPOs. Section 8 reports on additional robustness tests, and Section 9 concludes.

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[1] While the lifecycle hypothesis offers a resolution of one puzzle – why empirical findings regarding the effects of takeover defenses on firm value are mixed – it raises a different puzzle: As firms age, exactly how and when do the net costs of takeover defenses become larger than the cost of overcoming the frictions that make defenses sticky? We conjecture that the costs that arise from the suboptimal use of takeover defenses are a key motivation for organizational changes via takeovers, hedge fund activism, and other external and internal governance pressures (e.g., see Alchian and Demsetz, 1972; Brav, Jiang and Kim, 2009).

2. Implications of the lifecycle hypothesis

Although many researchers have investigated the value impact of takeover defenses, the evidence remains mixed.[2] To understand the reasons for such disparate findings, we propose that it is useful to model firm value q as a function of its takeover defenses E, age since IPO t, and other control variables X:

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

Previous research (e.g., Fama and French, 2001; Loderer, Stulz, and Waelchli, 2016) implies that firm value, as measured by q, tends to decrease with firm age, i.e., $\partial q/\partial t < 0$. Our question, and the subject of much debate in the literature, is whether $\partial q/\partial E$ is positive or negative. The lifecycle hypothesis, as illustrated in Figure 1 and discussed in the introduction, posits that $\partial q/\partial E$ is not monotonic but that $\partial^2 q/\partial E\partial t < 0$. This is a statement of our first hypothesis.

> **Hypothesis 1 (Value reversal):** The relation between firm value and the firm's use of takeover defenses declines with the firm's age since its IPO.

We call the hypothesis that $\partial^2 q/\partial E\partial t < 0$ the value reversal hypothesis. It implies that the value created by the use of takeover defenses declines with firm age. In Figure 1, this is illustrated by a combination of the decreasing surplus as the optimum shifts from TD_{young} to TD_{old}, plus area *abc*, which is the loss from suboptimally sticking at TD_{young} number of defenses. The loss area *abc* increases as the firm ages and it is possible that $\partial q/\partial E$ becomes negative at some $t > 0$, as illustrated in Figure 2. In such a case the value reversal is so pronounced that takeover defenses that contribute to firm value when the firm is young end up decreasing firm value when the firm matures.

As discussed in the introduction, firms can ameliorate the value reversal by shedding takeover defenses as they age, i.e., by moving toward TD_{old} in Figure 1. Such changes, in turn, are facilitated if the firm deploys defenses that can be removed at sufficiently low cost. In Section 4 we develop an empirical

[2] For surveys, see Burkart and Panunzi (2006) and Straska and Waller (2014).

measure of the stickiness of a firm's defenses, the S-measure, based on the empirical likelihood that each type of defense is, in fact, removed during our sample period. The fact that firms deploy defenses that differ in their tendencies to be removed implies our second hypothesis.

> **Hypothesis 2 (Sticky defenses):** The decline in $\partial q/\partial E$ as the firm ages is most pronounced among firms that deploy sticky takeover defenses, i.e., defenses that are removed at relatively low rates.

Finally, the lifecycle hypothesis implies that the size of the value reversal depends on firm-specific changes that affect the costs and benefits of takeover defenses. Research by Johnson, Karpoff, and Yi (2015), Cen, Dasgupta, and Sen (2015), and Cremers, Litov and Sepe (2016) indicates that takeover defenses yield benefits particularly when the firm has important business relationships with large customers or strategic partners, and when the firm's founder remains as CEO after the IPO. The presence of large customers, strategic partners, and founder-CEOs indicates the likelihood of significant relationship-specific quasi-rents for which takeover defenses serve as a guarantee. Graphically, we could illustrate the effect of such important business relationships as an outward (i.e., rightward) placement of the MB curve in Figure 1. When such relationships terminate, however, we expect the bonding benefits of takeover defenses to decrease (i.e., the MB curve shifts to the left) and the optimal amount of takeover defense to decline. With sticky defenses that do not adjust optimally, this decrease in the benefits of takeover defenses implies that the value reversal should be most pronounced among firms that have takeover defenses and that lose their large customers or strategic partners, or whose founder-CEOs leave the firm. Similarly, the cost of takeover defenses should increase with the severity of the managerial agency problem. We use managerial share ownership (i.e., Jensen and Meckling's (1976) alpha) as an inverse measure of the potential for managerial agency costs. These considerations motivate our third hypothesis.

Hypothesis 3 (Specific channels): The decline in $\partial q/\partial E$ as the firm ages (i.e., the value reversal) is most pronounced among firms that experience a termination in their relationships with large customers, strategic partners, or founder-CEOs, or that have a significant decrease in managerial share ownership.

3. Data and sample

Our sample consists of firms going public in U.S. markets from 1997 through 2011. Our sample selection criteria are similar to that 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.[3] 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 firm's SEC filings. We track each firm through 2014 or through the last year it is included on COMPUSTAT, whichever is earlier. 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.

Our major data innovation is to document each firm's use of takeover defenses over time. We track the six defenses in the E-index, which Bebchuk, Cohen, and Ferrell (2009) argue are particularly important to shareholders and firm valuation. These defenses include classified boards, poison pills, supermajority requirements to change firm bylaws, 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, similar to Field and Karpoff (2002) and Johnson, Karpoff, and Yi (2015). We then track changes

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

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. (For further details of the takeover defense collection process, please see the Online Data Appendix.) This process results in a panel of 16,304 firm-year observations from 1997 through 2014, which forms the sample in most of our tests.

Table 1 reports on the sample by IPO year. Consistent with Gao, Ritter, and Zhu (2013), our 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.

Table 2 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 53 are delisted and also leave the sample, leaving 2,100 surviving firms in Year 1.[4] Of these surviving firms, four do not have sufficient Compustat data in Year 1 (although these four 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 599 (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. A total of 55 firms survive through age 17, although as noted in the table, 4 of these firms subsequently are acquired and 7 delist for other reasons before the end of 2014.

4. Changes in takeover defenses and firm value as a firm matures

4.1. Changes in takeover defenses

Table 3 reports on the use of the six E-index takeover defenses in the years following a firm's IPO. Our first finding is that the average E-index does not decline with firm maturity, but rather,

[4] Most of the delistings 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 all delisted firms are due to bankruptcy.

increases slightly. At the IPO, the average E-index value in our sample of 2,283 firms is 2.41. The average E-index increases to a maximum of 3.09 in year 10, decreasing to 2.69 in year 17.

The slight increase in the average E-index after the IPO reflects an increase in the fraction of firms adopting poison pills. Poison pills are in place at only 5.34% of IPO firms, increasing to 26.90% in year 10. The use of golden parachutes also increases from an average of 64.4% of firms at the IPO stage to 98.4% of firms in Year 10 relative to the IPO. This increase reflects a high number of golden parachutes adopted in recent years (see Bebchuk, Cohen, and Wang, 2014).[5] At the IPO stage, 66.5% of IPO firms have a classified board, consistent with the findings in Johnson, Karpoff, and Yi (2015), declining to 43.6% 17 years later. The removal of classified boards may reflect the effects of efforts by groups such as the Harvard Shareholder Rights Project, which have pressured many firms to declassify their boards.[6]

In tests below we investigate whether the relation between $\partial q/\partial E$ and firm age that we document is due to changes in the relation between q and E for individual firms, or a changing composition of the sample across cohort ages. In one series of tests, we limit the sample to the 556 firms that survive in the sample for at least ten years to see if our results persist in this sample of survivors. Panel B of Table 3 reports on the frequencies of each takeover defense at different age cohorts for this subsample of long-term survivors. For most provisions in years 0 through 9, the numbers are similar to those in Panel A for the overall sample. For example, 66.49% of all firms have classified boards at the IPO (from Panel A), compared to 66.55% of firms that survive for 10 or more years (from Panel B). The most significant difference regards golden parachutes, as only 58.99% of firms that survive for 10 or more years have golden parachutes at the IPO stage, compared to 64.43% for all firms (or 66.18% of firms that do not survive for 10 years, with a t-statistic on the difference equal to 3.09). The difference in the use of golden

[5] There is a substantial increase in the percent of firms with golden parachutes in cohort Years 9 and 10. We have investigated this change and are persuaded that it is genuine and not a coding error. We also find that the adoption of golden parachutes is not significantly related to CEO turnover, implying that the substantial increase in the use of golden parachutes is not related to CEO changes.

[6] See http://www.srp.law.harvard.edu/companies-entering-into-agreements.shtml.

parachutes remains statistically significant through Year 9 relative to the IPO. At the time of the IPO, however, the average E-index does not differ significantly between firms that survive for 10 or more years and firms that do not. Thus, except for a lower rate of golden parachutes – a difference that we investigate in robustness tests – long-term survivors deploy takeover defenses at similar rates to other firms in the overall sample.

The results in Table 3 reflect the net effects on firms' E-index values of the addition and deletion of takeover defenses. Table 4 reports on the number of firms adopting and removing each of the six E-index provisions in each firm age cohort. Panel A shows that very few firms adopt classified boards or supermajority vote requirements to amend bylaws or the firm's charter. Relatively large numbers of firms adopt poison pills, golden parachutes, and supermajority vote requirements to approve mergers. Golden parachutes are the most widely adopted provision in our sample, with 378 firms adopting golden parachutes during the period up to 15 years after their IPOs. Most firms, however, do not add new defenses after their IPOs. Most firms in our sample (2,253) have an E-index less than six at their IPOs and conceivably could add provisions that would increase their E-indices. But only 30% (667) of these firms ever add one or more defenses during our sample period, while 70% of the firms never add any defenses. These 667 firms add a total of 910 new defenses. This implies that the average firm adds 0.054 new defenses each year, or adds one new defense every 18.5 years.

Although new additions are infrequent, it is even less common for takeover defenses to be removed. In our sample of 2,283 firms, 2,096 had at least one takeover defense when they went public. Of these 2,096 firms, 203 (10%) firms removed one or more defense, with a total of 287 defenses removed, during our sample period through 2014. On a firm-year basis, firms with takeover defenses maintained their defenses in 98% of the firm-years in which we potentially could observe a removal. The most frequently removed provisions are classified boards, which are removed by 76 (3%) of the 1,524 firms in the sample that have classified boards at their IPO or subsequently adopt classified boards. A total of 75 firms removed poison pills, most notably in years 10-14 relative to the IPO. Most of these removals reflect the non-renewal of poison pills with sunset provisions, which frequently apply 10 years after the pill is adopted.[7]

Overall, the results in Tables 3 and 4 indicate that firms' takeover defenses do not change much after their IPOs. In the years after their IPOs, sizeable minorities of firms adopt golden parachutes, poison pills, and supermajority vote requirements to approve mergers. Some firms remove classified boards, poison pills, and other provisions. The net effect is to increase the average E-index somewhat as firms mature, from 2.41 at the IPO to 3.07 ten years after the IPO. But 90% of firms that have defenses at their IPOs never remove any of these takeover defenses after their IPOs. This implies that takeover defenses tend to be very persistent after a firm's IPO.

4.2. A measure of takeover defense stickiness

As discussed in the introduction, there are several potential explanations for takeover defense stickiness (e.g., see Hannes, 2005; Thomas and Cotter, 2007). Hypothesis 2 implies that the value reversal implied by Hypothesis 1 will be most evident in the firms with the most sticky defenses. To test Hypothesis 2, we create a firm-year specific measure of takeover defense stickiness that we call the S-measure. The S-measure is based on the fact that, for whatever reasons, some defenses are removed more frequently than others. Our basic calculation of the S-measure uses each provision's sample-wide unconditional probability of being removed, and can be thought of as a year- and firm-specific probability the firm does not remove one or more of its existing takeover defenses. Suppressing firm and year subscripts, the measure is calculated as:

$$\text{S-measure} = 1 - [\text{Prob}_{\text{Classified}} \times \text{I}_{\text{Classified}} + \text{Prob}_{\text{Pill}} \times \text{I}_{\text{Pill}} + \text{Prob}_{\text{Supermajor-bylaw}} \times \text{I}_{\text{Supermajor-bylaw}} +$$

[7] From the texts of the pills adopted, we estimate that 95% of the poison pill removals are passive in the sense that they result from sunset clause expirations. In a handful of cases, firms deliberately act to reduce the life of the original subset clause to a shorter period (e.g., three years) and then allow the poison pill to expire. For example, the board of Biomarin Pharmaceutical authorized a poison pill in September 2002 and later "…accelerated the final expiration date of the Company's preferred share purchase rights under the Rights Agreement." The board then allowed the pill to expire according to the accelerated sunset provision. (See BioMarin's 2013 Proxy Statement at http://www.sec.gov/Archives/edgar/data/1048477/000119312513077031/d455570d10k.htm.)

$\text{Prob}_{\text{Supermajor-charter}}$ x $\text{I}_{\text{charter}}$ + $\text{Prob}_{\text{Supermajor-merger}}$ x $\text{I}_{\text{Supermajor-merge}}$+

$\text{Prob}_{\text{Golden parachute}}$ x $\text{I}_{\text{Golden parachute}}$]

where Prob_{TD} is the in-sample number of firm-years in which the defense is removed divided by the total number of firm-year observations in which a firm started with the defense, and I_{TD} is an indicator variable taking a value of one if the firm has takeover defense TD at the start of the given year. A high S-measure implies that the firm is unlikely to remove any of its takeover defenses.

To calculate the S-measure, we first calculate the unconditional probability of removing each of the six governance provisions in the E-index. For example, as reported in Table 5, Panel A, there are 76 board declassifications in our sample of 16,304 firm-year observations. However, there are only 10,518 firm-years in which the firm begins with a classified board, so the unconditional probability of removing a classified board in any given firm-year is 76/10,518 = 0.72%. Using similar calculations, the unconditional likelihood is 2.75% for poison pills, 0.15% for golden parachutes, 0.59% for supermajority requirements to amend the firm's bylaws, 0.73% for supermajority requirements to approve mergers, and 0.53% for supermajority requirements to amend the firm charter.

Note that, by construction, the likelihood of removing one or more of the firm's takeover defenses increases as a firm has more defenses, or equivalently, the S-measure declines as a firm has more defenses. In Table 5, Panel B we report the mean and median S-measures for different levels of takeover defenses. For example, over all firm-years in which a firm begins with an E-index of 1, the firm removes its takeover defense in 0.46% of the firm-years. Firms that begin with two takeover defenses reduce their defenses by one or more in 1.32% of the available firm-years.

4.3. Changes in q over age cohorts

Table 6 reports the mean and median Tobin's *q* for different age cohorts relative to the year of the IPO. We winsorize Tobin's *q* at the 99^{th} percentile, although the results are similar if we winsorize at the 95^{th} percentile or do not winsorize at all. We define all our major variables in Appendix A. At the IPO stage, the mean *q* is 3.98 and the median is 2.48. Consistent with previous findings (e.g., Loderer, Stulz, and Waelchli, 2016), Tobin's *q* declines in the ensuing years, to a mean value of 2.53 one year after the IPO and 2.33 two years after the IPO. The industry-adjusted mean Tobin's *q* is 2.26 at the IPO, falling to 0.73 in year 1 and 0.57 in year 2. Unlike Loderer, Stulz, and Waelchli (2016), however, we do not find evidence of a convex decline in *q* over many years. The median industry-adjusted *q* is 0.58 at the IPO, but then becomes close to zero, with no systematic time pattern, in years 1-17 after the IPO.

5. The dynamic relation between firm value and the use of takeover defenses

5.1. Univariate results

Table 7 reports on univariate tests of Hypotheses 1 and 2. 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 E-index. Panel A reports the results for the overall sample.[8] 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 0.44 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. Indeed, the value reversal is pronounced, as a high E-index is associated with a significantly higher average *q* for young firms and a significantly lower *q* for older firms.

The results in Panel A are mainly descriptive, as they are subject to concerns about selection, omitted variables, and survivorship bias. Before examining these concerns, however, Panels B and C

[8] We report industry median adjusted results in the univariate tests to ensure that the differences are not driven by industry effects. The multivariate regressions control for industry by including industry fixed effects. 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.

present preliminary evidence about Hypothesis 2. Panel B reports on tests that are identical to those in Panel A, but for firms with higher-than-median values of the S-measure (again, medians are computed and firms are grouped separately within each age cohort). Panel C reports results for firms with low S-measures. The value reversal observed in Panel A is pronounced among the firms in Panel B, but mostly absent in Panel C. This result indicates that the value reversal concentrates among firms with the most sticky defenses.

Some researchers argue that classified boards are the most important takeover defenses that a firm can adopt (e.g., see Klausner, 2003; Bates, Beecher, and Lemmon, 2008). Panels D-F of Table 7 therefore repeat the tests in Panels A-C, but separating firms according to the presence or absence of a classified board. The results are similar to the results that use the E-index to measure a firm's takeover defenses. Using either the E-index or just classified boards, we find that firms with a high level of takeover defense have a high average *q* at the time of their IPOs. As the firms age, this pattern reverses and firms with high levels of takeover defense have a low average *q*. Furthermore, this pattern is most evident among firms with relatively sticky takeover defenses. Online Appendix Table A.5 reports similar results using *q* measures that are not adjusted by the firm's industry median *q*.

5.2. Multivariate tests

To begin to address concerns about potential omitted variables, Table 8 reports on multivariate tests of Hypotheses 1 and 2 in which (unadjusted) *q* is the dependent variable and the E-index is the key explanatory variable. We include the same 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. 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.[9] The controls include industry fixed effects (e.g., see Gormley and Matsa, 2014). When we group two or more age cohorts together (e.g., the Year 3-4 cohort), we cluster standard errors by firm. Panel A of Table 8 reports the results of cross-sectional tests in which observations are grouped by post-IPO age cohort. At the time of the IPO (Year 0), the coefficient on the E-index is 0.235 and is significant at the 5% level. Evaluated at the mean E-index value of 2.41 for these firms, this estimate implies that a one standard deviation increase in the number of takeover defenses is associated with a 19.9% 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 in the Year 7-9 cohort the coefficient is negative and significant at the 5% level. For the cohort of firms at least 10 years from their IPOs, the coefficient is negative, even larger in magnitude (-0.267), and statistically significant. Our result 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 implies that the Bebchuk et al. result is specific to older cohorts of firms.

The patterns of coefficients for the control variables raise the possibility of multicollinearity issues. For example, the coefficient on *Institutional ownership* is negative for the Year 0 cohort and positive for the other year cohorts – a pattern that is roughly the opposite of the pattern of coefficients for the E-index. We find, however, that the pattern of coefficients for the E-index is not sensitive to the inclusion or exclusion of any of the control variables. We check the correlation of our E-index measure with all the other variables in our regression and find a correlation of 0.17 with firm size, 0.20 with a Delaware indicator variable, and 0.15 with the percent of block holders. All of these correlations are statistically significant at the 5% level, but are relatively low and unlikely to cause a problem of multicollinearity in our regressions. We repeat all our analyses removing individual control variables and find nearly identical

[9] These missing cases account for 3,061 (19.8%) of our firm-year observations. The results do not appreciably change if we replace these missing observations with lagged observations or if we eliminate the 3,061 observations with missing CEO holdings. 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 8.

results. We also test the variance inflation factor after running our regressions and find that our major control variables have a mean variance inflation factor of 1.14 suggesting almost no standard error inflation caused by multicollinearity.

Panels B and C report on cross-sectional regressions for subgroups of firms partitioned by the S-measure. The pattern of a positive E-index coefficient for the Year 0 cohort, declining and becoming negative for older post-IPO cohorts, is pronounced in the sample of high S-measure firms, and is largely absent among low S-measure firms.

Figure 3 plots the E-index coefficients from Panels A-C. The pattern for the overall sample is strongly consistent with the value reversal proposition of Hypothesis 1, and the fact that the value reversal pattern appears primarily among high S-measure firms is consistent with Hypothesis 2.

Panel D of Table 8 reports the results from a panel data test that includes data from all year cohorts. To capture the IPO-adjusted age effect, we include a dummy variable that equals one for observations in year cohorts four and above. (As reported in the Online Appendix Table A.7, the results are similar using a count variable for firm time from the IPO rather than the dummy variable for *Cohort age > 4 years*. For example, the coefficient on the interaction of the count variable and the E-index> median is -0.08 with a t-statistic of 8.78.) 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 second and third columns of Panel D report on similar tests for subgroups of the sample partitioned by the S-measure. For high S-measure firms, the results are similar to, and indeed, stronger than, those for the overall sample. For low S-measure firms, however, the relation between *q* and the *E-index x Cohort age > 4 years* interaction is small and insignificant.

In the Online Appendix we conduct a series of tests using alternative measures of firm maturity such as firm age from founding (Table A.10.A), average industry age (Table A.10.B), firm sales growth rates (Table A.10.C), and average industry growth rates (Table A.10.D). In addition, in Table A.8 we report on multivariate tests that use the presence or absence of a classified board to depict strong or weak takeover defenses. In Online Appendix Table A.9 we repeat our analyses using several other variations of the E-index measure and continue to find similar results to those reported in Table 8 using the E-index. The results indicate that firms that commit to a high level of takeover defense by deploying particularly sticky defenses are not easily able to remove those defenses in subsequent years, even when removing the defenses would increase firm value. As a result, firms with many and sticky defenses suffer declines in firm value as the defenses become costly over time. [10]

5.3. Multivariate tests accounting for endogeneity

As Gompers, Ishii, and Metrick (2003) and others point out, correlation between firm value and the use of takeover defenses need not be causal. Our tests are identified by the observation that takeover defenses are sticky and our assumption that firms do not adjust their defenses optimally as the firms age. There are, however, at least two concerns about this identification strategy. First, it 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 in part on expected firm performance and takeover likelihood, our identification strategy may also fail in, say the Year 1 and Year 2 samples. Second, it is possible to conceive of pathways by which our results reflect endogenous adjustments even after the first year or two after the IPO. For example, we observe firms removing a takeover defense in 2% of all firm-years in our sample. We interpret this small rate as evidence of stickiness, but it is possible that firms are, in fact, adjusting optimally and that our priors of the rate at which such adjustment should occur are inflated. If firms are, in fact adjusting their defenses optimally, the results in Tables 7 and 8 may well reflect correlation without causation.

To further investigate whether our results reflect the endogenous determination of firm value and takeover defenses, we conduct three sets of tests. First, we repeat all our analyses using the E-index of the firm adopted at the IPO stage, E^{IPO}, as a proxy for its E-index in future years. Because most firms' takeover defenses are sticky, this proxy is highly correlated with future years' E-index values. But the

[10] Our results are not sensitive to using the unadjusted Tobin's *q* or an industry median adjusted Tobin's *q* as our dependent variable. 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.

pre-determined level of takeover defense adoption relative to any year beyond the year of the IPO means that E^{IPO} is less likely to be influenced by contemporary influences on firm value. Panels A and B of Table 9 report on tests that are analogous to Panels A and D of Table 8. The results are similar in both sets of tests.

In a second set of tests, we estimate 2SLS models in which we use data on the firm's law firm and headquarters location to create instruments for the firm's use of takeover defenses. Our instruments are indicator variables for the firm's law firm at the time of its IPO and an indicator variable if the firm's headquarters is located in California. In a related paper (Johnson, Karpoff, and Yi, 2015), we argue and show that these instruments meet the relevance criterion for a good instrument. We also argue that they meet the exclusion restriction. Our argument is based on prior findings that an IPO firm's law firm and geography strongly influence its use of takeover defenses and the observation that firms tend to choose their law firms and headquarters locations long before their IPOs (e.g., see Coates, 2001).

Panel C of Table 9 reports the second stage regressions from seven different 2SLS models using law firm indicators as instruments. (First stage models are reported in the Online Appendix.) In model 1, the instrument for the E-index is significantly positively correlated with firm value, but the instrument for the interaction term, *Instrumented (E-index x Cohort age > 4 yrs)*, is negative and significant. This result strongly suggests that the lifecycle effect reflects the impact of a firm's takeover defenses on firm value, rather than the endogenous selection of takeover defenses to match firms whose *q* values decline rapidly over time.

As Karpoff, Schonlau, and Wehrly (2016) point out, the instrument for an index of takeover defenses is valid only if all of the component provisions have equal and interchangeable effects on takeover deterrence. (For more discussion about this issue, please see the Online Appendix.) To help mitigate this concern, Panel C reports the second stage of 2SLS tests for six different models, one each for each provision in the E-index and for which we construct unique instruments for each provision and its interaction with a firm age variable. On one hand, these tests allow us to investigate the impact of each provision individually on firm value over time, thereby avoiding problems that arise from instrumenting for an index. A problem with these tests, however, is that they omit the potential influence of the omitted provisions of the E-index. We recognize the resulting specification error, but report these tests to help pinpoint, at least descriptively, which provisions are most likely driving our overall results. The results for three of the six provisions in the E-index – classified boards, supermajority vote requirements to amend bylaws, and supermajority vote requirements to amend the corporate charter – are similar to the results for the overall E-index. In each case, the interaction of the provision with *Cohort age > 4 yrs* is negatively related to firm value. These results suggest that these four provisions have lifecycle-related effects on firm value that drive our results regarding the overall E-index.

Note that in these regressions we do not include industry fixed effects or year fixed effects due to the industry-specific component of takeover defense adoption. This is consistent with the 2SLS process utilized by Cliff and Denis (2004) and Johnson, Karpoff, and Yi (2015). We find that including year and/or industry fixed effects sometimes reduces the p-values to below significant levels. For instance, including industry fixed effects in Table 9.C model 1 yields a p-value of 0.13 for the coefficient on the interaction between *Instrumented (E-index x Cohort age > 4 yrs).* Of all the 2SLS regressions, only the interaction term in model 4, *Instrumented (supermajority_charter x Cohort age > 4 yrs)* remains statistically significant with both year and industry fixed effects. This result implies that the supermajority requirement to amend the charter may in fact be the strongest driver of our overall results.

In a third set of tests, we use our law firm and geography-based instruments as proxy variables for the E-index in reduced form models that examine the relation between firm value and the firm's takeover defenses. Reduced form models can partially mitigate concerns of measurement errors in 2SLS tests and may be useful when there is potential 2SLS bias, such as can arise when the exclusion restriction is violated (see Angrist and Krueger, 2001; Murray, 2006; and Chernozhukov and Hansen, 2008). The results, which are reported in the Online Appendix, reveal the same lifecycle pattern as in our main tests, although some of the results are not significant. The law firm and California variables are positively related to firm value in Year 0 and 1, but only the Year 0 coefficient is statistically significant at the 10% level. The coefficients on the proxy variables are negative in all age cohorts beyond Year 2, although none of the coefficients are statistically significant. These results are reported in Online Appendix Table A.17.

Overall, our tests that examine the lifecycle effects of takeover defenses on firm value may be influenced by the endogeneous determination of firm value and firm defenses. The tests reported in this section explore whether our main results reflect such endogeneity. We cannot rule out endogeneity as a potential explanation for our results, but it is important to consider the channel by which such endogeneity would have to work. For our results to reflect merely endogenous correlation, we would need to assume that firms deploying strong takeover defenses when they go public (i) have high *q*'s at their IPOs, and (ii) have a systematic decline in their *q* values, such that (iii) they have relatively low *q*'s several years after their IPOs. We could surmise that some firms have high *q*'s and implement takeover defenses at their IPOs because they are likely takeover targets. But to explain our results, we then would need to accept an assertion that such firms later have low *q*'s, perhaps because they lose any potential interest from bidders. (See Section 8.5 for an additional test of such an interpretation.)

6. Specific channels by which the benefits and costs of takeover defenses change

Hypothesis 3 holds that firm-specific characteristics affect the benefits and costs of takeover defenses and the magnitude of the value reversal. In this section we report on tests of this hypothesis using data on changes in four firm characteristics to identify specific changes in the benefits and costs of takeover defenses over time. We hypothesize that bonding-related benefits of takeover defenses are relatively high for firms with large customers, strategic partners, or founder CEOs. The rationale for this hypothesis is that takeover defenses yield bonding benefits when the firm has important business relationships that put their counterparties at risk of a costly hold-up problem. Consistent with this hypothesis, Johnson, Karpoff, and Yi (2015), Cen, Dasgupta, and Sen (2015), and Cremers, Litov and Sepe (2015), find that takeover defenses are valuable particularly for firms with large customers and strategic partners. Shleifer and Summers (1988) conjecture that the bonding-related benefits of takeover defenses will be large also when the firm's CEO has a personal reputation at stake in the firm's business relationships. We therefore use the presence of a founder CEO as an additional indicator of a high benefit to takeover defense.

Using these proxies for high benefits of takeover defenses, we hypothesize that firms that lose a large customer, strategic partner, or founder-CEO will experience a decrease in the benefits of takeover defense. For such firms that have pre-existing defenses that are sticky and not easily removed, the effect of such changes is to impose relatively high costs. That is, firms that optimally had high takeover defenses to bond an important counterparty relationship get stuck with those defenses when the relationship disappears. This implies that the value reversal will be stronger among firms with takeover defenses that lose their relationships with large customers, strategic partners, and founder-CEOs.

Similarly, the cost of takeover defenses – that is, the cost of entrenchment – is likely to be relatively high when managers' shareholdings are small. As Jensen and Meckling (1976) demonstrate, it is the divergence of the manager's shareholdings from 100% that gives rise to the agency costs of equity. We therefore use decreases in the CEO's shareholdings after the IPO to identify firms for which the costs of takeover defenses increase the most. We hypothesize that the value reversal will be stronger among firms with larger decreases in CEO ownership.

Table 10 reports on the fractions of firms with large customers, strategic partners, and founder-CEOs, and also average CEO ownership, by age cohort relative to the IPO. All four fractions decline with firm age. For example, 44.9% of IPO firms rely heavily on one or more large customer. But among firms that survive 15 years, this fraction drops to 1%. Johnson et al. (2015) show that IPO firms with large customers are more likely to deploy takeover defenses. It is among such firms that lose the large customers, but that are stuck with the takeover defenses, that we expect to see a large value reversal.

Table 11 reports on tests of this hypothesis. In column 1, Tobin's q is positively related to the E-index and *Cohort age > 4 yrs*, and negatively related to the interaction of the two variables. These results are similar to the results reported in Table 8, Panel D. Here, we include an additional indicator for firms that have a large customer at the time of the IPO, *Large customer*, and for all firm-years for which a firm that previously had a large customer no longer does, *Large customer leaves*. (See Appendix A for descriptions of *Large customer* and the other variables.) The key result is the negative and statistically significant coefficient on the interaction of *E-index x Large customer leaves*. This result indicates that a specific channel by which *q* declines with firm age is that a specific benefit attributable to takeover defenses – the bonding of the firm's business relationship with its large customer – declines.[11]

In untabulated tests, we included the triple interaction of *E-index x Large customer leaves x Cohort age > 4 yrs.* The coefficient, while negative, is not statistically significant. This result indicates that the effect of (a) having takeover defenses and (b) losing an important business relationship that was supported by the defenses, does not depend on whether the firm is young or old. The reason firms with takeover defenses lose value is because of the specific decrease in the marginal benefit of takeover defenses associated with no longer having a large customer. This reveals an important insight: firm age, by itself, is not the driving force behind the value reversal. Rather, firm age is a proxy for the decreasing benefits and increasing costs of takeover defenses that arise from specific changes in the firm's production function. Notice that, in Column 1, the coefficient on *E-index x Cohort age > 4 yrs* is negative and significant. We interpret this result as indicating that, in addition to the effect of losing a large customer, there are other changes in the benefits and costs of takeover defenses that contribute to the value reversal and are correlated with firm age.

The results in columns 2-4 of Table 11 identify three additional channels by which the value reversal occurs. Specifically, the value reversal is more pronounced among firms with takeover defenses

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[11] Following the literature (e.g., Fee and Thomas, 2004; and Fee, Hadlock, and Thomas, 2006) and as discussed in Appendix A, we identify large customers as customers that account for 10% of more of the firm's sales, using the Compustat segment data. Firms can lose large customers either by having the business relationship terminate or diminish, or by growing sales such that a previous 10% customer now accounts for less than 10% of total firm sales. Either pathway is consistent with the bonding hypothesis, because in either case the value of the specific counterparty quasi-rents become less important to the firm, especially on a proportional basis. Nevertheless, to ameliorate concerns that our results reflect sales growth rather than the termination of the business relationship, we report on tests that control for the firm's sales growth and obtain similar results. We note that the tests that examine other channels by which the benefits and costs of takeover defenses change are not subject to this concern.

that: lose joint ventures, lose their founder-CEOs, or have their CEO's shareholdings decrease significantly.[12]

7. The decline in Tobin's *q* over a firm's lifecycle

Previous researchers have noted that Tobin's *q* tends to decrease with firm age and maturity. Loderer, Stulz, and Waelchli (2016) argue that this decline occurs because firms find it difficult to replenish their growth opportunities, as mature firms sacrifice their organizational and operational flexibility to efficiently manage their sizable assets in place (Holmstrom, 1989) or self-interested managers of mature firms prefer predictable and easy-to-understand investment projects over innovation (Bernstein, 2015). Our lifecycle hypothesis of takeover defenses provides an alternative explanation, namely, that the value of a firm's takeover defenses declines with firm age.

To illustrate this implication of the lifecycle hypothesis, recall that Hypothesis 1 states that $\partial^2 q/\partial E \partial t < 0$. Tables 4 and 5 report on one testable form of this hypothesis, that $\partial q/\partial E$ decreases with firm age t. An alternate testable implication of Hypothesis 1 is that $\partial q/\partial t$ decreases with the firm's (fixed) level of takeover defenses E, that is, the secular decline in q is most pronounced among firms with many takeover defenses.

Table 12 reports on tests of this prediction. In Panel A, we partition the sample of IPO firms into subgroups with above-median and below-median numbers of takeover defenses at the times of their IPOs, and tabulate the average cumulative change in q as the firms mature through Year 10. The cumulative change in q is negative for both high E-index and low E-index firms in all years. But the decrease in q is larger among the high E-index firms, and the difference is statistically significant beginning in year 3. Overall, the average Tobin's q of high E-index firms declines almost monotonically over time whereas the q of low E-index firms does not continue to decrease after Year 3.

[12] When we repeat the tests in Table 11 for the subsamples of high S-measure and low S-measure firms, the effects reflected in Table 11 are most prominent among the high S-measure subsample.

Panels B and C of Table 12 yield further insight into the secular decline in *q*. Panel B reports on firms with relatively high S-measures, i.e., firms with relatively sticky takeover defenses at the times of their IPOs, while Panel C reports on firms with low S-measures. The largest age-related declines in *q* occur among firms with the most sticky takeover defenses. Among firms with less sticky defenses (Panel C), the difference between high E-index and low E-index firms is not statistically significant until 8 years after the IPO. Among firms with more sticky defenses (Panel B), the difference is significant by Year 2 relative to the IPO and continues to get larger as the firms age. These results indicate that the decline in Tobin's *q* as firms age is most pronounced among firms that have many takeover defenses particularly when the defenses are sticky and infrequently removed.

Table 13 provides analogous tests in a multivariate framework. The dependent variable in these tests is the cumulative change in Tobin's *q* from the IPO event to Year t. We use the same industry fixed effects and control variables as in Table 8. The results indicate that the coefficient on the E-index is negative and significant. Furthermore, the relation becomes larger in magnitude as the firm ages. (We report on yearly cross-sectional regressions only through Year 7 because changes beyond Year 7 are similar to the Year 7 results.) Panels B and C repeat the analyses for firms with above and below the median S-measure. Again, the relation between firm value and the E-index is most apparent among firms with relatively sticky defenses. These results indicate that the decline in Tobin's *q* over time is directly attributable to a firm's takeover defenses that are adopted at the time of the IPO, but which become costly to the firm in later years.

8. Robustness tests

Our main tests reflect a series of decisions about how best to measure firm value, firm maturity, takeover defense, and the stickiness of takeover defenses, as well as how to control for industry effects and other potential influences on firm value and firms' uses of takeover defenses. In this section we summarize a number of additional tests that examine the sensitivity of our inferences to alternate measures and model specifications.

8.1. Alternative measures of firm value, industry groupings, and time periods

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*, Dybvig and Warachka (2015) calculate two measures of firm operating efficiency, R_y (scale efficiency) and R_c (cost discipline). R_y is measured as (sales – cost of goods sold)/total capital and R_c is measured as (selling, general, and administrative expense – R&D expense – advertising expense)/total capital. 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 a zero.[13]

For robustness tests, we conduct multivariate regressions using $\mathrm{R_y}$ and $\mathrm{R_c}$ as the dependent variables. We include the same control variables as in our other multivariate tests, including a Delaware indicator variable, firm age, log (assets), and an indicator variable that takes a value of one if the firm is in the S&P 500. Our variables of interest are the E-index, an indicator for firms that have been public more than four years (the median value in our sample), and the interaction of these two variables. Dybvig and Warachka (2015) point out that "positive…coefficients would support the hypothesis that a higher [E-index] (more entrenchment) corresponds to worse operating efficiency." Thus, our Hypothesis 1 implies that the Dybvig and Warachka (2015) cost efficiency measure is positively related to the interaction of *E-index* and *Cohort age > 4 yrs*. Online Table 4.A reports results that are consistent with this prediction.

[13] Dybvig and Warachka (2015) subtract R&D and advertising expenses from selling, general, and administrative expenses because 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.

This result implies that, as a firm ages, a high level of takeover defenses leads to lax cost discipline at the firm, consistent with a value-reducing entrenchment effect.[14]

In further tests we do not find evidence of a strong industry effect in the value reversal pattern. Repeating our analysis 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 Years 5-6 – 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. Again, the value reversal pattern appears in both the early and late subperiods. These results indicate that our primary results apply across most industries and in different time periods in our sample.

8.2. Alternative measures of takeover defense and stickiness

In our main tests, we report results using the E-index and the existence of a classified board as two different measures of a firm's takeover defense, and the S-measure as a measure of stickiness in a firm's defenses. In robustness tests, we continue to find that the value reversal pattern appears primarily among firms that deploy defenses that provide strong takeover defense and that are difficult to remove. For example, previous results suggest that golden parachutes are not strongly associated with takeover deterrence (e.g., Eckbo, 1990; Karpoff, Schonlau, and Wehrly, 2016). Consistent with such evidence, we do not find a value reversal pattern in tests that use just the existence of a golden parachute as a measure of takeover defense. The results strongly appear, however, using an adjusted E-index that excludes golden parachutes.

We also replicate our tests using a subset of E-index provisions that Karpoff, Schonlau, and Wehrly (2016) find are empirically most strongly related to takeover deterrence. This subset of provisions, which we call the modified E-index, consists of classified boards, supermajority requirements to approve

[14] Additionally, we use a measure of Tobin's q adjusted for intangible assets developed by Peters and Taylor (2016) and graciously provided to us by Luke Taylor. Using this measure, there remains a large and statistically significant lifecycle effect. In firms' early years, the relation between the intangible asset-adjusted Tobin's q and the use of takeover defenses is positive (but insignificant), becoming negative and significant as firms age.

mergers, and golden parachutes. Unlike the assumption behind the E-index, however, Karpoff et al. (2016) find that golden parachutes are positively related to takeover likelihood, so we add one to the modified E-index if the firm does not have a golden parachute. Online Appendix Table A.9 reports the results using the modified E-index. Once again, the results indicate strong support for a value reversal, as the relation between *q* and a firm's takeover defenses is positive for young firms and negative for older firms. And once again, this relation concentrates among firms with relatively sticky defenses. Consistent with the argument that golden parachutes facilitate rather than impede takeovers, the results using this modified E-index generally are stronger than using the unmodified E-index.

It is plausible that our measure of stickiness simply proxies for managerial influence at the time of the IPO. To determine if this is the case, we measure the stickiness of our takeover defenses for firms with founder CEOs and compare the measure to non-founder CEOs. At the time of the IPO, founder CEO firms do not adopt more sticky takeover defenses than non-founder CEOs, suggesting that stickiness is not highly correlated with managerial influence.

As an alternate measure of takeover defense stickiness, we create an index that consists only of the E-index provisions that require a shareholder vote to change: classified boards and supermajority vote requirements to approve a merger or amend the firm charter. This results in an adjusted E-index that omits golden parachutes and poison pills. As noted above, a rationale for omitting golden parachutes is that, empirically, they are not strongly related to takeover defense. A rationale for excluding poison pills is that, as Coates (2000) point out, virtually all firms have ready access to implement a poison pill at any time without requiring shareholder approval. Because of this, Klausner (2003) argues that a firm's actual deployment of a poison pill offers little incremental takeover defense. Once again, the value reversal pattern is particularly pronounced among firms for which this adjusted E-index is high. These results are tabulated in the Online Appendix Table A.15.

8.3. Alternative measures of firm maturity

Our main tests use the years from IPO to measure firm maturity. As one alternative measure, we use the firm's total age from the date of its founding. Loughran and Ritter (2002) provide the founding dates of IPO firms and use this measure as a proxy for the uncertainty of the IPO firms. In our sample, the correlation coefficient for total firm age and age measured as the years since the IPO is 0.18. Online Appendix Table A.10.A tabulates the multivariate regression results using total firm age to measure firm maturity for firms at their IPOs. The results indicate that during the early life of the firm the relation between the E-index and firm value is positive and significant at the 1% and 10% level in models 1 and 2. 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 12-14 (model 4), 15-18 (model 5), and 19-23 (model 6) the relation is negative and statistically significant. In model 7, for firms that are older than 24 years, the relationship between firm value and takeover defenses is no longer statistically significant, but the coefficient remains negative. Overall, these results are consistent with the value reversal pattern reported in our main tests.

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 less mature firms, we should expect to observe a more positive value-E-index relation 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. The results are in Online Appendix Table A.10.B Firm age and industry mean age have a correlation of 0.36. The results for Model 1 show that, 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. As we move to industries with higher average firm ages, the coefficient on the E-index becomes negative. For firms from industries with average firm ages of 15-17 (model 6) or above 17 years (model 7), the relation is negative and statistically significant. These results show that the value reversal pattern (our Hypothesis 1) appears using both firm-specific and industry-specific measures of firm maturity.

Finally, we partition our sample into subgroups based on the values of two measures that are correlated with firm age since IPO, the sales growth rate at the firm level and at the industry level. The results, which are reported in Online Appendix Tables A.10.C and A.10.D, show that the value reversal pattern appears when we use sales growth as an inverse proxy for firm maturity.

8.4. Survivorship bias

As reported above, our results are not attributable to a change in the composition of the sample as firms age. This indicates that our results are not driven by survivorship bias. In fact, one way to describe our lifecycle hypothesis is that previous papers' results – not our results – reflect survivorship bias. That is, samples based on seasoned firms are drawn from firms that have survived for some time beyond their IPOs and for which the net benefits of their takeover defenses have become negative. Test results from such samples therefore do not generalize to all firms, especially firms that are young or are acquired and do not survive to appear in the samples.

Nevertheless, to further investigate whether survivorship issues affect our results, 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 these tests are similar to our main tests, and are reported in the Online Appendix Table A.4.

In addition, we consider the impact of a firm's E-index on leaving the sample. Firms leave our sample because of a merger in 1,038 (6.4%) of our 16,304 firm-year observations. The rate at which firms with above the median number of takeover defenses in a given year are acquired is 5.80%, compared to a rate of 6.66% for firms with below the median number of defenses. The difference is significant at the 5% level (t-statistic = 1.99), suggesting that, in our sample, a high E-index is associated with a lower acquisition likelihood.

8.5. Additional controls

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 detail in the Online Appendix.

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.11, the results are not substantially affected when we include controls that allow for such a non-linear relation. For example, the interaction between the E-index and firm age still has a negative coefficient (-0.243 with a t-statistic of -7.77).

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. As an additional test, we examine the potential influence of a firm's coverage by state antitakeover laws. State-level defenses and firm level defenses may serve as substitutes, implying that the firm-level defenses deployed by firms incorporated in states with high takeover protection have a relatively small effect on takeover deterrence. We find this to be the case, as firms incorporated in states with more antitakeover laws exhibit a significantly reduced lifecycle effect. It is important to note, however, that, while such lifecycle effects are attenuated in such firms, they still appear and are statistically significant.[15]

[15] To measure a state's antitakeover protections we use the data from Bebchuk and Cohen (2003), as made available by Lucian Bebchuk at: http://www.law.harvard.edu/faculty/bebchuk/data.shtml.

Next, we re-run our tests including high dimensional firm-industry fixed effects and continue to find results of a strong lifecycle (i.e., value reversal) effect. We consider the impact of industry competition and find that both high competition industry and low competition industry firms (as measured by the Herfindahl index) have statistically significant lifecycle effects. 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. In addition, we consider that Tobin's *q* may be related to investment or growth opportunities, and 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 about lifecycle effects regarding firms' takeover defenses.

9. Conclusions

This paper proposes and tests the proposition that the benefits and costs of takeover defenses change in systematic ways as a firm ages. In particular, the bonding-related benefits of takeover defenses tend to decline, and the agency-related costs of defenses tend to increase, as a firm ages. Without frictions, firms would adjust by decreasing their takeover defenses over time. We find, however, that takeover defenses are sticky. The average firm in our sample has 2.42 defenses at the time of its IPO and acquires an additional 0.67 defense during the following ten years. Yet, 90% of the firms in our sample never remove any existing defense, and, the unconditional probability that a firm will keep all of its existing defenses in any given year is 98%.

We use the stickiness of takeover defenses to identify tests of the relation between firm value and the use of defenses. Consistent with the lifecycle hypothesis, the relation between *q* and a firm's E-index declines steadily as a firm matures. In multivariate tests that examine the determinants of *q*, the coefficient on the E-index is 0.235 at the time of the firm's IPO and is -0.267 ten years after the IPO. These coefficients imply that for the incremental takeover defense, average firm value increases by $19.1 million at the IPO stage and decreases by $64.0 million when the firm is ten years old. Further tests reveal that this value reversal, i.e., the decrease in the relation between q and E, concentrates among firms with the most sticky defenses. These results indicate that takeover defenses that help to create value when firms are young become less valuable over time until they become costly to the firms that have them.

We do not argue that the value reversal occurs automatically with firm age, but rather, that specific changes occur that decrease the benefits and increase the costs of takeover defenses, and that the incidence of these changes correlate with firm age. In additional tests, we examine four specific channels by which the benefits and costs change, including a firm's loss of a large customer, strategic partner, or founder-CEO, and a significant decrease in the CEO's shareholdings. The results of these tests indicate that the value reversal occurs around such changes, which in turn tend to occur as a firm ages.

The lifecycle hypothesis offers a resolution of long-standing puzzle in the corporate governance literature, namely why previous tests yield mixed 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). We find that the relation between firm value and takeover defenses is not monotonic and is specific to firm age and characteristics. In general, tests using data from young firms find that takeover defenses are associated with increases in value, while tests using data from seasoned firms find that defenses are associated with decreases in value. Put simply, younger firms are more likely to increase firm value by deploying defenses. But among firms that survive several years, the defenses become costly, on net.

Although these results help to resolve one puzzle, they raise others. As firms age, exactly how and when do the net costs of takeover defenses become larger than the costly frictions that make defenses sticky? We conjecture that the costs that arise from the suboptimal use of takeover defenses help motivate organizational change via takeovers, hedge fund activism, and other external and internal governance changes (e.g., see Alchian and Demsetz, 1972; Brav, Jiang and Kim, 2009). Also, do our results support the view that firms should include sunset provisions when they deploy takeover defenses, as suggested by Bebchuk (2003)? Or might sunset provisions weaken the bonding benefits of takeover defenses when they are adopted? We leave these questions for future research.

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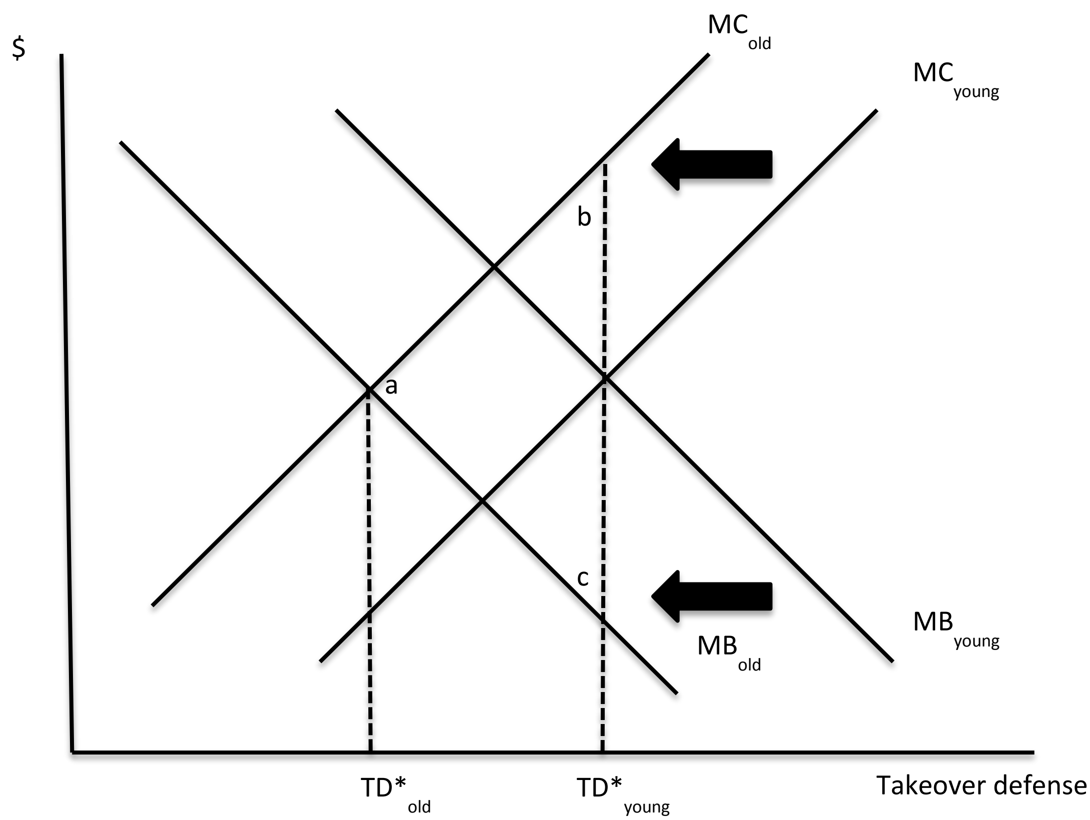

Figure 1. This figure shows the marginal cost and marginal benefits of the use of takeover defenses for a firm at two stages in its lifecycle.

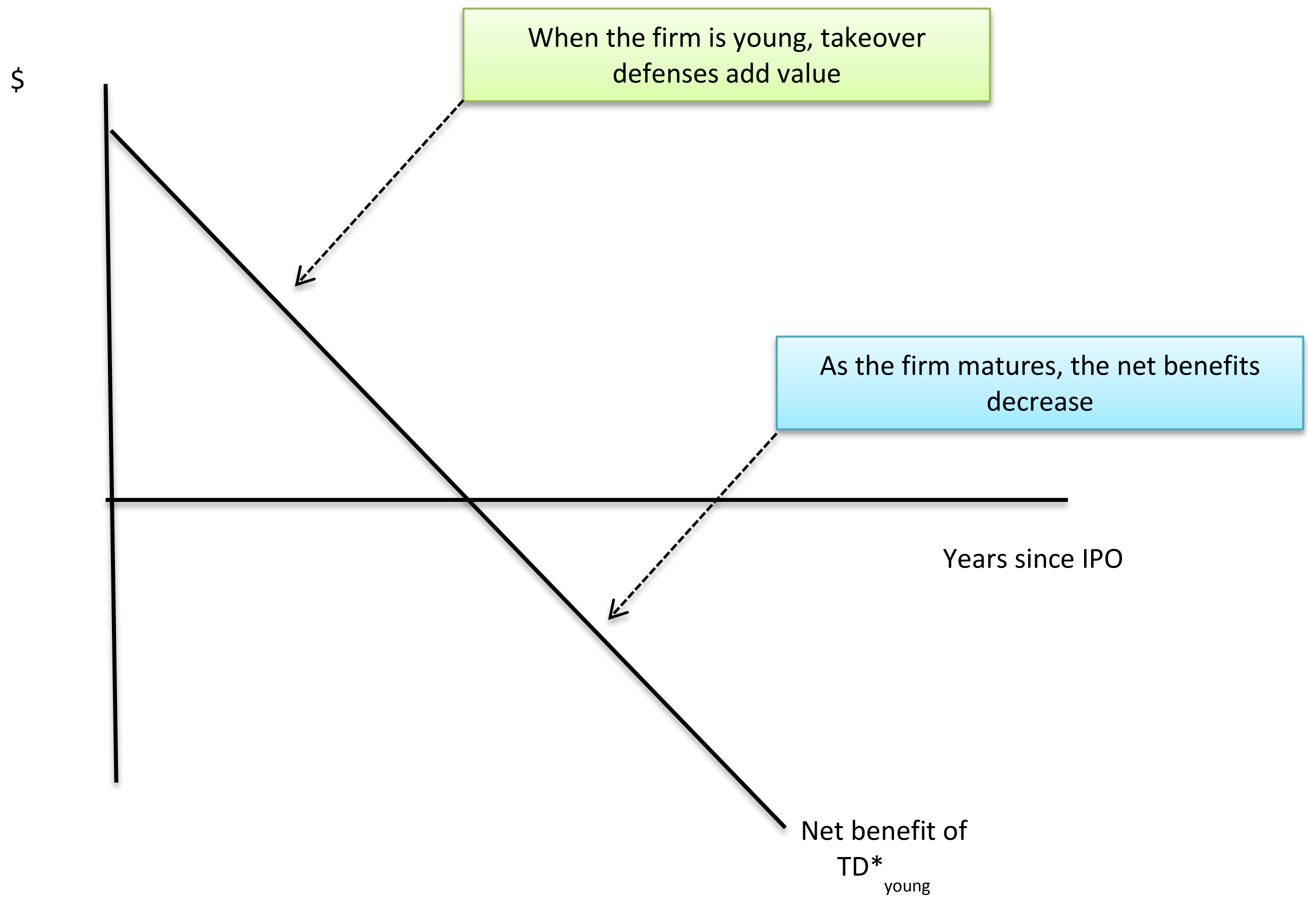

Figure 2. This figure illustrates the value reversal effect of a fixed level of takeover defense (labeled here as TD^*_{young}) as a firm matures. As the firm matures, the benefits of takeover defenses decrease and the costs increase. A level of defense that created value at early stages of the firm's life becomes more costly as the firm matures.

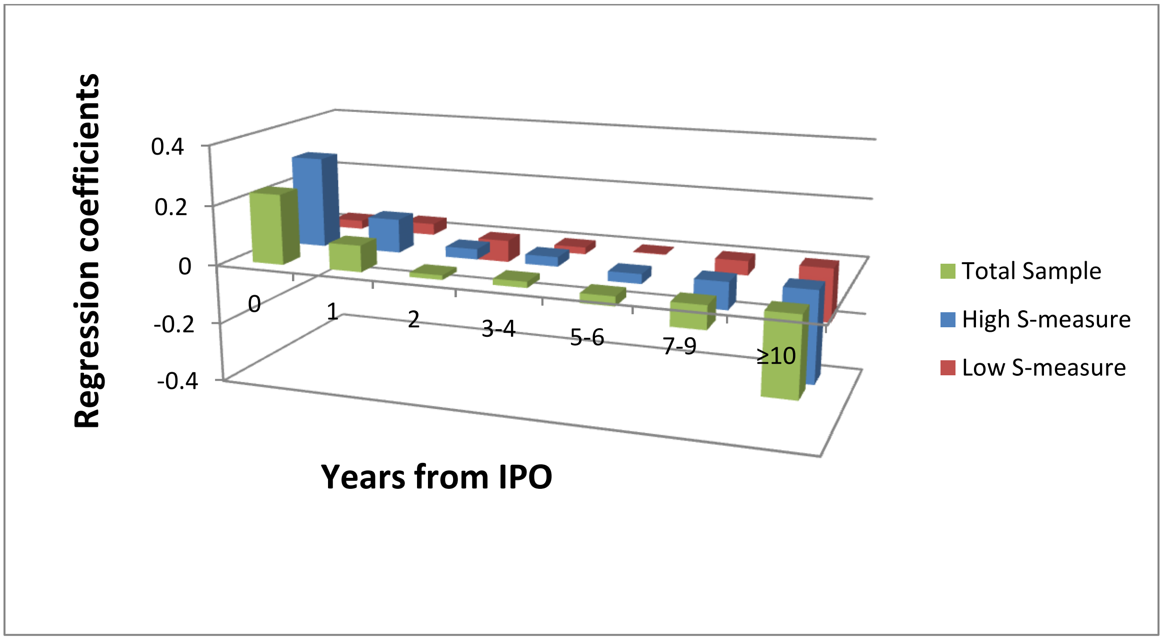

Figure 3. This figure illustrates the changing relation between firm value, measured by Tobin's *q*, and the use of takeover defenses as a firm ages. The bars reflect the regression coefficients from Table 8, Panels A-C. Green bars report results for the overall sample, blue bars report results for firms with above-median S-measures, and red bars report results for firms with below-median S-measures. The S-measure is a measure of the stickiness of the firm's takeover defenses.

Appendix A: Variable definitions

This table reports the definitions for the major variables utilized in the paper.

Variable	Definition
Above median drop in CEO holdings	An indicator variable taking a value of one if the decline in CEO holdings of the firm is larger than the median CEO decline in holdings.
After joint venture (indicator)	An indicator variable taking a value of one if the firm disclosed a joint venture in prior years, but no longer discloses one based on the SDC data.
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 values for CEO ownership are set to zero.
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.
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; supermajority to amend 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.
Founder CEO (indicator)	An indicator variable taking a value of one if the founder of the firm is also the CEO.
Founder CEO leaves	An indicator variable taking a value of one if the firm had a founder CEO in prior years, but the founder CEO is no longer acting as CEO.
Institutional ownership	The sum of the institutional ownership as reported in the 13D filings data.
Joint venture (indicator)	An indicator variable taking a value of one if the firm announces a new joint venture in that particular fiscal year based on the SDC data.
Large customer (indicator)	An indicator variable taking a value of one if the firm has a large customer as reported in the COMPUSTAT segment level data.
Large customer leaves (indicator)	An indicator variable taking a value of one if the firm had a large customer, but this customer is no longer disclosed as a large customer of the firm in the COMPUSTAT segment level 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.
S-measure	This measure is a proxy for the likelihood that a firm removes its takeover defenses. First, the unconditional probability that a firm removes the six components of the E-index are calculated by dividing the number of defense removals in our sample by the number of firm-year observations for firms having that particular takeover defense. This calculate the six probabilities of removing takeover defenses for each of the E-index components: $Prob_{Classified}$; $Prob_{Pill}$; $Prob_{Supermajor\text{-}bylaw}$; $Prob_{Supermajor\text{-}charter}$; $Prob_{Supermajor\text{-}merger}$; $Prob_{Golden\ parachute}$. To calculate the likelihood that a firm will not remove a takeover defense in any one year, we subtract from one the probability of each E-index component being removed times an indicator taking a value of one if the firm has this E-index component.
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.

Table 1: IPO years of the sample firms

This table 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.

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

Table 2: Sample attrition at different cohort ages

This table describes the attrition in sample firms in the years after their IPOs. The beginning sample consists of 2,283 IPO firms from 1997-2011 as described in Table 1. 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.

Years from IPO	Number of firms surviving	Number of firms with data for year *t*	Firms leaving by merger	Firms leaving by delisting	Firms leaving by truncation	Total attrition
0	2,283	2,283	130	53	0	183
1	2,100	2,096	175	88	0	263
2	1,842	1,827	132	83	7	222
3	1,610	1,607	102	61	47	210
4	1,402	1,396	90	56	48	194
5	1,210	1,196	81	33	20	134
6	1,064	1,065	61	32	20	113
7	954	955	53	34	59	146
8	809	812	51	30	64	145
9	667	668	36	26	55	117
10	551	554	28	18	49	95
11	462	457	19	21	19	59
12	398	400	17	15	17	49
13	351	351	23	9	33	65
14	286	287	19	15	62	96
15	191	191	15	13	60	88
16	103	104	2	5	42	49
17	55	55	4	7	44	55
Total	16,338	16,304	1,038	599	646	2,283

Table 3: Takeover provision frequencies and E-index values by years from IPO

This table reports the frequencies with which each provision in the E-index are used by the sample firms, and the mean E-index values, for different age cohorts 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.

Panel A. Individual takeover defenses and E-index for the total sample

Years from IPO	N	Classified board	Poison Pill	Supermajority to amend bylaw	Supermajority to amend charter	Supermajority to approve mergers	Golden Parachute	E-index
0	2,283	66.49%	5.34%	33.86%	30.09%	40.65%	64.43%	2.41
1	2,096	66.56%	9.11%	34.97%	31.30%	42.27%	65.60%	2.50
2	1,827	66.67%	12.53%	36.56%	32.68%	44.55%	67.87%	2.61
3	1,607	66.33%	15.56%	36.71%	32.98%	46.73%	71.06%	2.69
4	1,396	65.62%	17.98%	36.82%	32.95%	47.78%	72.64%	2.74
5	1,196	65.13%	20.90%	36.87%	32.86%	48.41%	74.16%	2.78
6	1,065	64.60%	22.72%	36.71%	32.30%	49.11%	74.84%	2.80
7	955	63.35%	23.14%	36.34%	31.94%	52.04%	80.52%	2.87
8	812	62.32%	25.37%	36.08%	31.77%	54.56%	85.47%	2.96
9	668	61.38%	26.50%	35.03%	30.54%	55.09%	90.42%	2.99
10	554	62.45%	26.90%	34.48%	29.06%	57.58%	98.38%	3.09
11	457	61.05%	25.60%	33.70%	28.67%	56.67%	98.03%	3.04
12	400	60.25%	23.25%	33.00%	28.25%	56.25%	98.25%	2.99
13	351	58.97%	23.36%	32.48%	27.35%	55.84%	97.72%	2.96
14	287	57.84%	20.21%	32.06%	28.57%	56.45%	97.21%	2.92
15	191	53.40%	17.80%	31.94%	28.80%	55.50%	98.43%	2.86
16	104	50.00%	15.38%	31.73%	29.81%	49.04%	97.12%	2.73
17	55	43.64%	12.73%	32.73%	36.36%	49.09%	94.55%	2.69
Total	16,304	64.51%	16.53%	35.45%	31.42%	47.85%	75.70%	2.71

Panel B. Individual takeover defenses and E-index for IPO firms that survive at least 10 years and have Compustat data

Years from IPO	N	Classified board	Poison Pill	Supermajority to amend bylaw	Supermajority to amend charter	Supermajority to approve mergers	Golden Parachute	E-index
0	556	66.55%	5.76%	36.87%	30.76%	43.17%	58.99%	2.42
1	556	66.73%	10.43%	36.69%	30.58%	42.99%	60.07%	2.47
2	551	67.33%	14.88%	37.02%	30.85%	43.19%	59.53%	2.53
3	550	67.09%	17.82%	36.91%	30.73%	45.09%	63.82%	2.61
4	549	66.85%	20.95%	36.79%	30.60%	45.90%	65.76%	2.67
5	548	66.97%	23.91%	36.68%	30.47%	46.35%	67.15%	2.72
6	548	66.06%	26.46%	36.68%	30.47%	47.26%	68.98%	2.76
7	550	65.45%	26.18%	36.18%	30.36%	50.36%	76.00%	2.85
8	550	65.27%	27.27%	35.82%	30.00%	54.00%	84.00%	2.96
9	551	63.52%	27.95%	35.03%	29.58%	55.35%	89.47%	3.01
10	554	62.45%	26.90%	34.48%	29.06%	57.58%	98.38%	3.09
11	457	61.05%	25.60%	33.70%	28.67%	56.67%	98.03%	3.04
12	400	60.25%	23.25%	33.00%	28.25%	56.25%	98.25%	2.99
13	351	58.97%	23.36%	32.48%	27.35%	55.84%	97.72%	2.96
14	287	57.84%	20.21%	32.06%	28.57%	56.45%	97.21%	2.92
15	191	53.40%	17.80%	31.94%	28.80%	55.50%	98.43%	2.86
16	104	50.00%	15.38%	31.73%	29.81%	49.04%	97.12%	2.73
17	55	43.64%	12.73%	32.73%	36.36%	49.09%	94.55%	2.69
Total	7,908	64.02%	21.05%	35.46%	29.92%	50.00%	78.02%	2.78

Table 4: Number of IPO firms adopting and removing takeover defenses by years from IPO

This table reports the numbers of firms adopting and removing each provision in the E-index for 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.

Panel A. Number of firms adopting new takeover defenses

Years from IPO	N	Classified board	Poison Pill	Supermajority to amend bylaw	Supermajority to amend charter	Supermajority to approve mergers	Golden Parachute	Total
0	2,283	2	20	0	0	0	0	22
1	2,096	3	81	0	0	11	39	134
2	1,827	2	65	1	1	14	35	118
3	1,607	1	44	0	0	20	47	112
4	1,396	1	35	0	0	9	21	66
5	1,196	4	28	0	0	5	17	54
6	1,065	1	16	0	0	11	16	44
7	955	0	4	0	0	34	59	97
8	812	3	12	1	1	31	54	102
9	668	0	6	0	0	13	37	56
10	554	1	6	1	0	21	52	81
11	457	2	5	0	0	0	0	7
12	400	0	5	0	0	0	0	5
13	351	1	4	0	0	1	0	6
14	287	1	1	0	0	0	0	2
15	191	0	3	0	0	0	1	4
16	104	0	0	0	0	0	0	0
17	55	0	0	0	0	0	0	0
Total	16,304	22	335	3	2	170	378	910

Panel B. Number of firms removing takeover defenses

Years from IPO	N	Classified board	Poison Pill	Supermajority to amend bylaw	Supermajority to amend charter	Supermajority to approve mergers	Golden Parachute	Total
0	2,283	0	0	0	0	0	0	0
1	2,096	4	0	2	2	12	0	20
2	1,827	1	1	1	2	1	4	10
3	1,607	6	0	3	4	4	3	20
4	1,396	6	2	0	0	3	1	12
5	1,196	1	0	2	2	3	2	10
6	1,065	8	0	3	3	4	1	19
7	955	5	1	2	0	4	2	14
8	812	5	5	4	3	7	0	24
9	668	9	2	4	2	4	2	23
10	554	6	11	3	1	8	1	30
11	457	5	12	4	4	2	0	27
12	400	6	19	2	1	3	1	32
13	351	5	9	1	1	0	1	17
14	287	6	8	1	1	0	0	16
15	191	2	2	2	1	1	1	9
16	104	1	1	0	0	1	0	3
17	55	0	1	0	0	0	0	1
Total	16,304	76	74	34	27	57	19	287

Table 5: Number of IPO firms removing takeover defenses by S-measure of takeover defenses

This table reports on the rates at which the takeover defenses in the E-index are removed. The sample consists of 16,304 firm-years based on 2,283 firms going public from 1997-2011. Panel A reports on the number of firm-years in which each defense was in place and potentially could be removed, and the number and fraction of times the defense was removed. These fractions are used to calculate the S-measure as follows:

$$\text{S-measure} = 1 - [\text{Prob}_{\text{Classified}} \times \text{I}_{\text{Classified}} + \text{Prob}_{\text{Pill}} \times \text{I}_{\text{Pill}} + \text{Prob}_{\text{Supermajor - bylaw}} \times \text{I}_{\text{Supermajor - bylaw}} + \text{Prob}_{\text{Supermajor - charter}} \times \text{I}_{\text{charter}} + \text{Prob}_{\text{Supermajor - merger}} \times \text{I}_{\text{Supermajor - merge}} + \text{Prob}_{\text{Golden parachute}} \times \text{I}_{\text{Golden parachute}}]$$

where Prob_{TD} is the number of removals of takeover defense TD divided by the total number of firm-years TD could have been removed, and I_{TD} is an indicator variable taking a value of one if the firm has takeover defense TD in the given year. Panel B reports on the mean and median values of the S-measure for the sample firms partitioned by a firm's E-index in a given firm-year.

Panel A. IPO firms removing takeover defenses

	Classified board	Poison Pill	Supermajority to amend bylaw	Supermajority to amend charter	Supermajority to approve mergers	Golden Parachute
Number of removals	76	74	34	27	57	19
Total firm-year observations beginning with the defense	10,518	2,695	5,779	5,123	7,801	12,342
Probability of removing defense	0.72%	2.75%	0.59%	0.53%	0.73%	0.15%

Panel B. Takeover defense stickiness (S-measure) by firm-year E-index value

E-index level	Number of firm-years	Mean S-measure likelihood of not removing defenses	Median S-measure likelihood of not removing defenses
0	830	100.00%	100.00%
1	3,625	99.54%	99.81%
2	3,849	98.68%	99.06%
3	2,665	97.48%	98.17%
4	2,320	96.90%	97.46%
5	2,430	96.31%	96.83%
6	585	93.54%	93.54%
Total	16,304	97.95%	98.28%

Table 6: Tobin's *q* and industry adjusted Tobin's *q* by years from IPO

This table reports on the mean and median Tobin's *q* for each age cohort in our sample of 2,283 IPO firms from 1997-2011. Tobin's *q* is winsorized at the 99th percentile.

Years from IPO	N	Mean q	Median q	Industry adjusted mean q	Industry adjusted median q
0	2,283	3.98	2.48	2.26	0.58
1	2,096	2.53	1.69	0.73	0.02
2	1,827	2.33	1.49	0.57	-0.01
3	1,607	2.36	1.53	0.59	-0.01
4	1,396	2.41	1.62	0.62	0.00
5	1,196	2.46	1.63	0.74	0.00
6	1,065	2.53	1.72	0.66	0.01
7	955	2.40	1.66	0.51	0.01
8	812	2.29	1.56	0.50	-0.02
9	668	2.32	1.52	0.59	-0.01
10	554	2.38	1.54	0.76	0.00
11	457	2.26	1.37	0.71	-0.02
12	400	2.44	1.47	1.06	-0.01
13	351	2.37	1.51	0.49	-0.02
14	287	2.50	1.58	1.17	-0.01
15	191	2.30	1.53	0.38	-0.09
16	104	2.56	1.73	0.62	0.06
17	55	2.50	1.90	0.17	-0.02
Total	16,304	2.63	1.68	0.88	0.03

Table 7: IPO firm industry adjusted Tobin's *q* by years from IPO and takeover defenses

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. The S-measure, which is defined in Table 6, reflects the stickiness of the firm's takeover defenses and equals the likelihood the firm will not remove a takeover defense in the next year. Panels A – C report on differences in *q* between firms with low and high E-index values, and Panels D – F report on differences in *q* between firms with and without classified boards.

Panel A. 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	0.44	2.02**	1.95*
1	2,096	0.59	0.93	0.33	3.22***	3.06***
2	1,827	0.52	0.63	0.11	1.11	1.70*
3-4	3,003	0.65	0.58	-0.05	-0.62	0.37
5-6	2,261	0.90	0.48	-0.42	-3.69***	-2.88***
7-9	2,435	0.71	0.40	-0.30	-3.47***	-3.20***
≥10	2,399	1.43	0.35	-1.06	-5.73***	-3.51***
Total	16,304	0.99	0.77	-0.22	-4.32***	-2.54***

Panel B. Industry adjusted Tobin's q by E-index and years from IPO, high S-measure firms

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	1,563	1.75	2.56	0.81	3.22***	2.98***
1	1,414	0.53	0.94	0.41	3.38***	3.69***
2	1,230	0.45	0.66	0.21	1.80*	2.44**
3-4	1,993	0.60	0.64	-0.04	-0.44	1.39
5-6	1,444	1.05	0.47	-0.59	-3.68***	-2.93***
7-9	1,590	0.79	0.39	-0.40	-3.49***	-3.93***
≥10	1,650	1.30	0.38	-0.92	-4.28***	-3.69***
Total	10,884	0.93	0.81	-0.12	-1.89*	-0.26

Panel C. Industry adjusted Tobin's q by E-index and years from IPO, low S-measure firms

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	720	2.75	2.41	-0.34	-0.86	-0.60
1	682	0.72	0.89	0.17	0.90	-0.17
2	597	0.67	0.57	-0.10	0.52	-0.39
3-4	1,010	0.67	0.45	-0.22	-1.79*	-1.17
5-6	817	0.65	0.52	-0.14	-0.97	-0.91
7-9	845	0.57	0.44	0.13	1.00	-1.43
≥10	749	1.79	0.27	-1.43	-3.77***	-2.03**
Total	5,420	1.12	0.70	-0.42	-4.72***	-3.86***

Panel D. Industry adjusted Tobin's q by classified board and years from IPO

Years from IPO	N	Mean industry adjusted q		Difference	t-stat	Mann-Whitney test (z-stat)
		Firms without classified boards	Firms with classified boards			
0	2,283	1.83	2.47	0.63	2.83***	1.81*
1	2,096	0.74	0.73	-0.01	-0.10	0.22
2	1,827	0.68	0.51	-0.17	-1.61	-0.95
3-4	3,003	0.60	0.60	0.00	-0.05	1.11
5-6	2,261	0.97	0.56	-0.42	-3.46***	-1.50
7-9	2,435	0.63	0.47	-0.17	-1.85*	-1.05
≥10	2,399	1.28	0.40	-0.88	-5.07***	-0.23
Total	16,304	0.96	0.83	-0.13	-2.58***	0.03

Panel E. Industry adjusted Tobin's q by classified board and years from IPO, high S-measure firms

Years from IPO	N	Mean industry adjusted q		Difference	t-stat	Mann-Whitney test (z-stat)
		Firms without classified boards	Firms with classified boards			
0	1,563	1.70	2.34	0.63	2.51**	1.21
1	1,414	0.68	0.72	0.03	0.27	0.93
2	1,230	0.62	0.49	-0.13	-1.14	-0.28
3-4	1,993	0.61	0.62	0.01	0.13	0.70
5-6	1,444	1.10	0.57	-0.53	-3.18***	-2.31**
7-9	1,590	0.74	0.43	-0.31	-2.71***	-1.94*
≥10	1,650	1.24	0.47	-0.77	-3.75***	-0.59
Total	10,884	0.95	0.80	-0.14	-2.48**	-0.83

Panel F. Industry adjusted Tobin's q by classified board and years from IPO, low S-measure firms

Years from IPO	N	Mean industry adjusted q		Difference	t-stat	Mann-Whitney test (z-stat)
		Firms without classified boards	Firms with classified boards			
0	720	2.39	2.69	0.30	0.62	0.22
1	682	0.96	0.75	0.21	-0.91	-1.13
2	597	0.90	0.55	-0.35	-1.56	-1.05
3-4	1,010	0.59	0.56	-0.20	0.32	1.14
5-6	817	0.70	0.53	-0.17	-1.10	0.50
7-9	845	0.46	0.54	0.08	0.57	0.77
≥10	749	1.34	0.16	-1.17	-3.33***	-1.85*
Total	5,420	0.98	0.88	-0.09	-1.05	-1.30

Table 8: Multivariate regressions of Tobin's *q* on takeover defenses by years from IPO

Panels A – C report 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 includes only firms with above-median S-measures at the time of their IPOs, where the S-measure is a measure of the stickiness of the firm's defenses. Panel C includes only firms with below-median S-measures. Panel D reports estimates from panel data consisting of 16,304 firm-years in the sample. Columns 2 and 3 of Panel D report on subsamples of firms with high and low S-measures at the times of their IPOs. 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.

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

	(1) Year = 0	(2) Year = 1	(3) Year=2	(4) Year=3, 4	(5) Year = 5-6	(6) Year = 7-9	(7) Year≥10
Delaware (indicator)	0.203**	0.150	0.149**	0.185	0.408**	0.429***	0.123
	(0.197)	(0.159)	(0.166)	(0.160)	(0.199)	(0.143)	(0.229)
Firm age (years)	-0.014***	-0.007**	-0.002	-0.001	0.000	0.001	0.005*
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Log(assets)	-0.294***	-0.130***	-0.380***	-0.590***	-0.815***	-0.667***	-0.827***
	(0.071)	(0.057)	(0.088)	(0.086)	(0.111)	(0.095)	(0.150)
S&P 500 firm (indicator)	6.335*	0.557	1.734***	2.058***	2.756***	2.241***	2.989***
	(0.500)	(0.401)	(0.456)	(0.339)	(0.529)	(0.352)	(0.466)
CEO ownership	-0.724	0.470	-0.385	-0.898**	0.210	-0.898*	-0.554
	(0.581)	(0.563)	(0.692)	(0.402)	(0.543)	(0.610)	(1.036)
Missing CEO ownership (indicator)	-0.551***	-0.007	-0.125	0.293*	0.254*	0.468***	0.069
	(0.179)	(0.131)	(0.145)	(0.157)	(0.183)	(0.203)	(0.349)
Institutional ownership	-1.043**	0.969***	1.319***	1.204***	1.348***	1.115***	1.580***
	(0.419)	(0.236)	(0.213)	(0.168)	(0.201)	(0.188)	(0.375)
E-index	0.235***	0.088**	0.015	0.020	-0.032	-0.078*	-0.267***
	(0.052)	(0.040)	(0.037)	(0.030)	(0.039)	(0.042)	(0.061)
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	3,003	2,261	2,435	2,399
Adj R^2	29.93	9.93	15.23	21.47	27.09	24.64	32.28

Panel B. Regressions of Tobin's q by years from IPO, high S-measure firms only

	(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	0.305***	0.114***	0.035	0.032	-0.033	-0.093*	-0.310***
	(0.060)	(0.045)	(0.043)	(0.036)	(0.049)	(0.048)	(0.072)
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	1,563	1,414	1,230	1,993	1,444	1,590	1,650
Adj R^2	29.20	9.35	15.98	22.70	31.46	27.70	32.55

Panel C. Regressions of Tobin's q by years from IPO, low S-measure firms only

	(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	0.029	0.039	-0.076	-0.024	-0.002	-0.049	-0.185
	(0.122)	(0.096)	(0.082)	(0.058)	(0.070)	(0.097)	(0.139)
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	720	682	597	1,010	817	845	749
Adj R^2	27.29	8.44	13.03	17.49	16.70	20.16	37.35

Panel D. Panel data regressions of Tobin's q in all years after IPO

	(1) Total sample	(2) High S-measure	(3) Low S-measure
E-index	0.096***	0.132***	-0.022
	(0.028)	(0.032)	(0.061)
Cohort age > 4 yrs (indicator)	0.392***	0.556***	-0.051
	(0.140)	(0.168)	(0.267)
E-index x Cohort age > 4 yrs	-0.238***	-0.286***	-0.080
	(0.038)	(0.043)	(0.081)
Controls	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	16,304	10,884	5,420
Adj R^2	20.26	21.60	18.17

Table 9: Multivariate robustness tests accounting for endogeneity

Panels A and B reports tests that are similar to those reported in Panels A and D of Table 8, respectively, but that use the firm's E-index at the time of its IPO for all future years for that firm. Panel C reports the second stage of 2SLS regres sions in which instrumental variables for the E-index (in column 1) or each component of the E-index (columns 2-7) are constructed using law firm indicator variables plus a California indicator variable. 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 and Panel B report standard errors clustered by firm.

Panel A. Cross-sectional regressions of Tobin's q by firm age relative to the year of the IPO (Year = 0) using the IPO stage 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
IPO stage E-index	0.235***	0.096***	0.017	0.021	-0.042	-0.078**	-0.247***
	(0.052)	(0.040)	(0.036)	(0.030)	(0.038)	(0.037)	(0.052)
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	3,003	2,261	2,435	2,399
Adj R^2	29.93	9.97	15.23	21.47	27.11	24.99	32.25

Panel B. OLS regressions of Tobin's q on IPO-stage E-index

	(1) Total sample	(2) High S-measure	(3) Low S-measure
IPO stage E-index	0.109***	0.138***	0.028
	(0.028)	(0.032)	(0.064)
Cohort age > 4 yrs (indicator)	0.330**	0.536***	-0.050
	(0.127)	(0.159)	(0.216)
IPO stage E-index x Cohort age > 4 yrs	-0.240***	-0.299***	-0.101
	(0.036)	(0.043)	(0.074)
Control variables	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	16,304	10,884	5,420
Adj R^2	20.28	21.63	18.15

Panel C. 2SLS regressions of Tobin's q on instrumented takeover defense measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Instrumented E-index	0.215***						
	(0.093)						
Cohort age > 4 yrs (indicator)	0.609	0.961*	-0.386	0.418	0.526*	-0.375	0.435
	(0.472)	(0.569)	(0.261)	(0.350)	(0.320)	(0.384)	(1.005)
Instrumented E-index x Cohort age > 4 yrs	-0.387*						
	(0.216)						
Instrumented Classified board		1.494***					
		(0.412)					
Instrumented classified board x Cohort age > 4 yrs		-1.917**					
		(0.897)					
Instrumented Poison Pill			0.246				
			(0.877)				
Instrumented Poison Pill x Cohort age > 4 yrs			0.272				
			(1.430)				
Instrumented supermajority, bylaws				1.245**			
				(0.486)			
Instrumented supermajority, bylaws x Cohort age > 4 yrs				-2.005**			
				(0.958)			
Instrumented supermajority, charter					1.430 ***		
					(0.493)		
Instrumented supermajority, charter x Cohort age > 4 yrs					-2.613***		
					(0.978)		
Instrumented supermajority, merger						0.301	
						(0.393)	
Instrumented supermajority, merger x Cohort age > 4 yrs						0.105	
						(0.789)	
Instrumented Parachute							0.511
							(0.397)
Instrumented Parachute x Cohort age > 4 yrs							-0.959
							(1.237)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No	No
Year fixed effects	No	No	No	No	No	No	No
N	16,304	16,304	16,304	16,304	16,304	16,304	16,304
R^2	10.72	9.57	11.25	10.38	9.39	11.41	11.24

Table 10: Firm characteristics associated with different benefits and costs of takeover defenses

This table reports on four firm characteristics that we use to identify changes in the benefits or costs of takeover defenses for our sample firms after their IPOs. We hypothesize that bonding-related benefits of takeover defenses are relatively high for firms with founder CEOs, large customers, and joint ventures. The potential agency cost of equity and the cost of takeover defenses decrease with CEO ownership. The sample consists of 2,283 IPO firms from 1997-2011.

		Fraction of firms with:			
Years from IPO	N	Large customers	Joint Venture	Founder CEO	Average CEO ownership
0	2,283	44.85%	18.75%	17.96%	10.26%
1	2,096	42.80%	22.09%	16.32%	7.48%
2	1,827	43.13%	16.48%	18.61%	7.15%
3	1,607	42.81%	15.43%	21.28%	6.58%
4	1,396	41.19%	15.40%	19.13%	6.48%
5	1,196	37.37%	16.72%	17.98%	5.98%
6	1,065	36.24%	15.87%	15.77%	5.95%
7	955	34.66%	16.13%	14.66%	5.16%
8	812	34.24%	15.15%	14.66%	5.14%
9	668	29.34%	13.32%	13.32%	4.78%
10	554	21.48%	12.27%	12.64%	4.33%
11	457	15.97%	10.50%	12.04%	4.63%
12	400	2.75%	9.00%	12.75%	4.41%
13	351	2.28%	12.54%	13.39%	4.28%
14	287	2.44%	13.24%	12.89%	3.50%
15	191	1.05%	10.47%	12.04%	3.11%
16	104	0.00%	6.73%	13.46%	2.38%
17	55	0.00%	9.09%	12.73%	0.17%
Total	16,304	35.76%	16.29%	16.78%	5.14%

Table 11: The effects of changes in the benefits and costs of takeover defenses

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 a change in a firm characteristic that is hypothesized to affect the benefits or costs of takeover defenses. Column 1 reports results from changes in which a firm's dependence on a large customer declines. Column 2 reports results from changes in which the firm's joint venture ends. Column 3 examines the effect of a departure of a founder-CEO. And column 4 examines a change in which the CEO's shareholdings decrease. All regressions include industry and year fixed effects and standard errors clustered by firm, which are reported below the regression coefficients.

	(1)	(2)	(3)	(4)
E-index	0.110***	0.105***	0.101***	0.123***
	(0.029)	(0.027)	(0.029)	(0.033)
Cohort age > 4 yrs (indicator)	0.371***	0.326**	0.353***	0.389***
	(0.141)	(0.141)	(0.136)	(0.141)
E-index x Cohort age > 4 yrs	-0.219***	-0.241***	-0.214***	-0.216***
	(0.039)	(0.038)	(0.036)	(0.038)
Large customer (indicator)	-0.132			
	(0.101)			
Large customer leaves	0.110			
	(0.170)			
E-index x Large customer leaves	-0.075*			
	(0.046)			
Joint venture (indicator)		0.486***		
		(0.092)		
After joint ventures		1.225***		
		(0.235)		
E-index x After joint ventures		-0.135**		
		(0.069)		
Founder CEO (indicator)			0.090	
			(0.112)	
Founder CEO leaves			0.885	
			(0.884)	
E-index x Founder CEO leaves			-0.394*	
			(0.213)	
Above median drop in CEO holdings				-0.027
				(0.136)
E-index x Above median drop in CEO holdings				-0.070*
				(0.040)
Controls	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	16,304	16,304	16,304	16,304
Adj R^2	20.30	21.19	20.46	20.39

Table 12: Takeover defenses and the cumulative change in Tobin's *q* after the IPO

This table reports the mean change in Tobin's *q* from the IPO for different age cohorts, using data from 2,283 firms going public from 1997-2011. Tobin's *q* is winsorized at the 99th percentile. Panel A compares the cumulative change for firms with below median E-index values at the time of the IPO with firms with above median E-index values using data on all sample firms. Panel B includes only firms with higher than median S-measures among firms with the same E-index, evaluated at the time of the IPO. Panel C includes only firms with below median S-measures (again, among firms with the same E-index) evaluated at the time of the IPO.

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

Years from IPO	N	Below median E-index firms	Above median E-index firms	Difference	t-stat	Mann-Whitney test (z-stat)
0-1	2,096	-1.46	-1.44	0.02	0.09	-0.06
0-2	1,827	-1.57	-1.84	-0.28	-1.33	-0.31
0-3	1,607	-1.56	-1.99	-0.44	-1.85*	-0.74
0-4	1,396	-1.39	-2.09	-0.70	-2.89***	-2.29**
0-5	1,196	-1.26	-2.21	-0.95	-3.53***	-3.06***
0-6	1,065	-1.29	-2.10	-0.81	-2.78***	-2.54**
0-7	955	-1.35	-2.17	-0.82	-2.63***	-2.09**
0-8	812	-1.21	-2.50	-1.29	-3.55***	-2.74***
0-9	668	-1.28	-2.61	-1.33	-3.12***	-2.49**
0-10	554	-1.06	-2.93	-1.87	-3.81***	-2.91***

Panel B. Change in Tobin's q by E-index and years from IPO, high S-measure firms

Years from IPO	N	Below median E-index firms	Above median E-index firms	Difference	t-stat	Mann-Whitney test (z-stat)
0-1	1,414	-1.24	-1.39	-0.14	-0.68	-0.66
0-2	1,230	-1.30	-1.73	-0.43	-1.79*	-0.82
0-3	1,073	-1.11	-1.79	-0.67	-2.53**	-0.99
0-4	920	-1.09	-1.95	-0.86	-3.03***	-2.04**
0-5	773	-0.87	-2.18	-1.30	-4.10***	-3.10***
0-6	671	-0.75	-2.14	-1.39	-3.97***	-3.08***
0-7	622	-1.01	-2.15	-1.14	-3.10***	-2.15**
0-8	529	-1.32	-2.70	-1.38	3.07***	-2.09**
0-9	439	-1.36	-2.72	-1.35	2.69***	-1.57
0-10	382	-1.14	-3.00	-1.86	3.30***	-2.26**

Panel C. Change in Tobin's q by E-index and years from IPO, low S-measure firms

Years from IPO	N	Below median E-index firms	Above median E-index firms	Difference	t-stat	Mann-Whitney test (z-stat)
0-1	682	-1.96	-1.56	0.40	1.13	0.89
0-2	597	-2.26	-2.08	0.18	0.44	0.93
0-3	534	-2.75	-2.40	0.35	0.75	0.83
0-4	476	-2.16	-2.36	-0.20	-0.44	-0.68
0-5	423	-2.24	-2.26	-0.03	-0.05	-0.55
0-6	394	-2.63	-2.01	0.62	1.19	-0.48
0-7	333	-2.41	-2.19	0.22	0.37	-0.12
0-8	283	-0.71	-2.16	-1.45	-2.17**	-2.03**
0-9	229	-0.86	-2.42	-1.55	-1.76*	-2.12**
0-10	172	-0.19	-2.76	-2.57	-2.09**	-2.25**

Table 13: Multivariate regressions of the cumulative change in Tobin's *q* on takeover defenses

Estimates from cross-sectional OLS regressions in which the dependent variable is the cumulative change in Tobin's *q* from the IPO date through year t, where t = 1, … , 7. The cumulative change in *q* is winsorized at the 99th percentile. Each cross-section consists of firms in the same age cohort, defined as years from the IPO. Panel B includes only firms with above-median S-measures at the time of their IPOs, where the S-measure is a measure of the stickiness of the firm's defenses. Panel C includes only firms with below-median S-measures. All regressions include industry and year fixed effects and robust standard errors, which are reported below the regression coefficients.

Panel A. OLS regressions of the cumulative change in Tobin's q from the time of the IPO on the E-index at the time of the IPO, all firms

	(1) Year = 0-1	(2) Year = 0-2	(3) Year=0-3	(4) Year=0- 4	(5) Year = 0-5	(6) Year = 0-6	(7) Year = 0-7
E-index	-0.116**	-0.197***	-0.194***	-0.215**	-0.276**	-0.332***	-0.357***
	(0.053)	(0.059)	(0.065)	(0.070)	(0.079)	(0.088)	(0.093)
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	2,096	1,827	1,607	1,396	1,196	1,065	955
Adj R^2	30.83	29.44	29.40	24.06	24.21	27.16	25.98

Panel B. OLS regressions of the cumulative change in Tobin's q from the time of the IPO on the E-index at the time of the IPO, high S-measure firms only

	(1) Year = 0-1	(2) Year = 0-2	(3) Year=0-3	(4) Year=0- 4	(5) Year = 0-5	(6) Year = 0-6	(7) Year = 0-7
E-index	-0.166***	-0.238***	-0.249***	-0.240***	-0.358***	-0.439***	-0.383***
	(0.061)	(0.068)	(0.075)	(0.081)	(0.092)	(0.102)	(0.107)
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	1,414	1,230	1,073	920	773	671	622
Adj R^2	310.83	28.66	27.19	24.00	25.80	29.62	27.38

Panel C. OLS regressions of the cumulative change in Tobin's q from the time of the IPO on the E-index at the time of the IPO, low S-measure firms only

	(1) Year = 0-1	(2) Year = 0-2	(3) Year=0-3	(4) Year=0- 4	(5) Year = 0-5	(6) Year = 0-6	(7) Year = 0-7
E-index	0.064	-0.071	-0.005	-0.159	-0.029	0.067	-0.222
	(0.130)	(0.142)	(0.154)	(0.174)	(0.182)	(0.197)	(0.231)
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	682	597	534	476	423	394	333
Adj R^2	26.83	27.14	30.38	19.61	17.57	21.88	19.27