

Managerial Control Benefits and Takeover Market Efficiency*

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Abstract

How and to what extent do managerial control benefits shape the efficiency of the takeover market? We revisit this question by estimating both the dark and bright sides of managerial control benefits in an industry equilibrium model. On the dark side, managers' private benefits of control distort firms' takeover incentives and hinder the reallocation role of the takeover market. On the bright side, fear of a takeover induces underperforming managers to exert more effort and enhances the disciplinary role of the takeover market. Our estimates suggest that the bright-side effect increases the value created by an active takeover market by 21%, comparable in magnitude to the dark-side effect. It is also important to account for this bright-side effect in explaining certain features of the takeover market, including a low takeover-performance sensitivity.

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1 Introduction

The takeover market plays a crucial role in reallocating assets and stimulating economic growth. In 2016 alone, public firms in the United States exchanged \$600 billion worth of assets, which accounted for 32% of their total investments. Much of this asset reallocation is shaped by entrenched managers' preferences for acquiring control benefits. As Jensen and Meckling (1976) point out, these preferences can destroy significant value in the market for corporate control.¹ However, at the same time, it is likely that incumbent managers' fear of losing their control benefits also generates a bright-side effect that is largely overlooked in the literature. Intuitively, when managers enjoys high control benefits, they have an ex ante incentive to work harder when the firm underperforms to avert a takeover threat.

In this paper, we revisit how the efficiency of the takeover market is influenced by managerial control benefits, quantifying both the traditional losses in value that stem from managers' desire for gaining more control and the positive effects of control preferences on incentivizing managerial effort. To this end, we build and estimate an industry equilibrium model of mergers and acquisitions (M&As). Consistent with the common belief in the literature, we find that managers' control benefits create a dark-side effect by distorting asset reallocation, leading to 17% of value-destroying takeovers being pursued and 12% of potential value-enhancing takeovers being blocked. In contrast, the bright-side effect induces managers to exert higher effort and speeds up the firms' self-recovery rate by 14%. Overall, the bright-side effect increases the value created by an active takeover market by 21%, which is comparable in magnitude to the dark-side effect emphasized in the literature.

Quantifying the two sides of managerial control benefits presents a few empirical challenges. First, managers' control benefits capture certain psychological aspects and cannot be directly observed from companies' financial statements. Second, common measures used in previous studies cannot differentiate between the two effects. For example, a weak takeover-performance sensitivity can be consistent with both effects.² Third, to get a comprehensive view of how

¹See Jensen (1986), Morck, Shleifer, and Vishny (1990), Hartzell, Ofek, and Yermack (2004), Masulis, Wang, and Xie (2007), and Harford, Humphery-Jenner, and Powell (2012) for similar arguments.

²The observation that underperforming firms are rarely acquired can be explained either by their managers

managers' control benefits influence the takeover market efficiency, we need to investigate not only the observed takeover deals but also the "invisible" ones. For example, we need to understand what fraction of the blocked deals could have taken place—and hence could have led to enhanced efficiency—had managers' control benefits differed. A thorough investigation of such invisible deals requires counterfactual analyses.

These empirical challenges lead us to pursue a structural estimation approach. The model we estimate embeds the classic q-theory of M&As—acquirers can partially transfer their technology and organizational structure to the targets after takeovers. It also allows takeovers to create value through other sources of synergy (e.g., asset complementarity). We incorporate managerial control benefits as a main source of friction in the model. The dark-side effect of managerial control benefits arises from their impact on the model's equilibrium path. In particular, when a firm's board makes M&A decisions, they take into account both shareholders' value and the manager's control benefits. The conflict of interest between shareholders and the manager may therefore distort efficient asset reallocation: some value-destroying deals are pursued to create control benefits for acquirer managers, whereas some value-enhancing deals are blocked to protect target managers. In addition, managers' control benefits also tilt the split of merger gains—high control benefits incentivize acquirer managers to overpay the targets, which could hurt the acquiring firms' shareholders even in deals that generate synergistic benefits.

Meanwhile, the bright-side effect of managerial control benefits arises from their impact on the takeover threats off the equilibrium path. Managers who enjoy control benefits suffer a substantial loss if their firms are acquired, and thus they would exert more effort when their firms underperform and are exposed to greater takeover threats. Although these underperforming firms are less likely to be rescued through realized takeovers, they recover faster by themselves with the managers' increased effort. The control benefits therefore materialize managers' fears of being replaced in takeovers and amplify the off-equilibrium disciplinary effect of the takeover market.

Hence, our model provides a comprehensive picture of how managers' control benefits influ-

being overly resistant to takeovers or by the fact that the takeover threat alone, instead of the realized takeovers, is sufficient to push the firm back on track.

ence the takeover market efficiency. To the best of our knowledge, this is the first model that incorporates both the dark-side and the bright-side effects of managerial control benefits in a unified framework. Such a framework allows us to analyze and compare the two opposing effects that arise from the same friction. It also provides a laboratory for addressing other quantitative questions, such as to decompose the value of participation in the takeover market. Note that we impose no priors on the relative magnitudes of these effects in the model. Instead, we estimate the model's parameters using the simulated method of moments (SMM) based on a large sample of US public firms from 1980 to 2015. We let the data put tight restrictions on our model parameters and guide the model implications.

Our estimation suggest that the bright- and the dark-side effects of managerial control benefits are both significant, and they are comparable in magnitudes, resulting in a modest influence on the overall efficiency of the takeover market in the full sample. However, there exists significant cross-sample variations in the two effects. Among firms with good performance and entrenched managers, the dark-side effect is more pronounced, leading to more value-destroying mergers being completed and larger overpayment when these firms act as acquirers. Eliminating managers' control benefits among these firms would enhance their value by 3.98%. On the contrary, among the poorly performing firms with less protected managers, the bright-side effect dominates, making the takeover threat a more effective governance mechanism. For these firms, eliminating their managers' control benefits would reduce firm value by 3.01%, mainly through a much weaker disciplinary effect from the takeover market.

In addition, our estimation reveals that both the dark-side and the bright-side effects of managerial control benefits can lead to a low takeover-performance sensitivity. On the dark side, underperforming firms whose managers have high control benefits are more resistant to takeovers and thus are less likely to be acquired; on the bright side, these firms can recover more rapidly by themselves with increased managerial effort. Thus, they rely less on the realized takeovers as a rescue. The two forces jointly dampen the takeover-performance sensitivity by a half, leading to a weak relation that is consistent with the data. This finding also suggests that the takeover-performance sensitivity is not a good measure for the efficiency of the takeover

market because it cannot differentiate between the two effects that have the opposite implications on the value of the takeover market.

We also augment our model by incorporating various internal governance practices. Our estimation results suggest that there is some degree of substitutability between the external governance provided by the takeover market and the firms' internal governance practices, such as pay/turnover for performance. By incorporating these features into a q-theoretic framework, we can quantitatively evaluate their interaction with the disciplinary role of the takeover market. We also consider cases in which the target managers can receive golden parachutes or side payments in takeover negotiations. Our results are robust to including these additional features in the model estimation.

Our paper contributes to three streams of literature. First, it adds to the literature that examines how managerial control benefits influence corporate takeover incentives. Jensen (1986), Morck, Shleifer, and Vishny (1990), and Hartzell, Ofek, and Yermack (2004), among many others, emphasize the conflicts of interest between shareholders and managers as a main driver for the observed takeovers. They show incidences where managerial objectives may drive acquisitions that reduce the value for participating firms. In a more recent study, Eisfeldt and Rampini (2008) characterize the agency cost on aggregate asset allocation and illustrate how the cost is amplified during economic downturns. More related to our work, Albuquerque and Schroth (2010) estimate a structural model to quantify the private benefits of control in block trades. They document sizable control benefits, which significantly impact the valuation and trading decisions of controlling shareholders. Albuquerque and Schroth (2015) develop and estimate a search model to quantify the value of control along with the costs of illiquidity in trades of controlling blocks. We complement this literature by focusing on not only the dark-side but also the bright-side effect of managerial control benefits. We quantify the value created when managers' control benefits can also serve as an incentive device.

Our paper also pertains to the literature on the disciplinary effect of the takeover market. Scharfstein (1988), Martin and McConnell (1991), Holmstrom and Kaplan (2001), and Kini, Kracaw, and Mian (2004), among many others, emphasize the disciplinary role of takeovers,

and they find that takeovers serve as the court of last resort, which helps restore firm efficiency. Our paper contributes to this literature by quantifying how managerial control benefits affect the disciplinary role of the takeover market.

Methodologically, our paper belongs to the growing literature that employs structural model calibration or estimation to answer standard corporate finance questions in capital investment, leverage choice, CEO turnover, market competition and valuation, and particularly M&As, as summarized in Strebulaev, Whited, et al. (2012).³ In the field of M&As, Warusawitharana (2008) constructs and estimates a model that links asset purchases and sales to firms' productivity efficiency, and his findings are consistent with the neoclassical theory of M&As. In a similar spirit, Yang (2008) hypothesizes and tests that firms with rising productivity acquire firms with declining productivity. Levine (2017) builds a model in which acquirers pursue takeovers to obtain the growth options from target firms. Gorbenko and Malenko (2014) estimate valuations of strategic and financial bidders using a hand-collected data set of preannouncement bids and conclude that different targets appeal to different types of bidders. Dimopoulos and Sacchetto (2017) estimate a search model of M&As to quantify the effect of the takeover market on firm productivity growth. They highlight the interaction between the takeover market and firms' entry and exit decisions. Our paper differs from the previous works by examining how a key friction in corporate governance, namely the managerial control benefits, affect the takeover market efficiency.

The paper is organized as follows. In Section 2, we present the model and describe the model solution. In Section 3, we introduce the data and discuss how the model parameters are identified. The estimation results are presented in Section 4. In Section 5, we use the estimated model to evaluate the effects of managerial control benefits on corporate takeovers. Specific modeling assumptions are discussed in Section 6 with robustness results reported. We conclude in Section 7.

³For example, see Whited (1992), Gomes (2001), and Alti (2003) for capital investment studies; Hennessy and Whited (2005) and Strebulaev (2007) for leverage choice; Taylor (2010, 2013) for CEO turnover and compensation; Spiegel and Tookes (2013) for market competition and valuation; and those discussed in details in this paper for M&As.

2 Model

In this section, we develop an industry equilibrium model in the spirit of Hopenhayn (1992). In the model, firms may endogenously exit the market through either death or acquisitions. We start with a description of the firm's production and merger technologies. We then move on to discuss the incentives of corporate takeovers. Last, we characterize the industry equilibrium and present the model solutions.

2.1 Model setup

The economy is populated with heterogeneous firms, and each firm is characterized by its own state variables (z, κ, B) , where z captures the firm's total factor productivity (TFP), κ captures the board's preference, and B is the firm's book value of assets. We introduce each state variable in detail below. Firms are all-equity financed, and there is no friction in raising capital or distributing residual earnings. All agents in the model are rational, and information is perfect.

Fig. 1 illustrates the timeline of the model. At the beginning of each period, the firm's current period productivity, z , is realized and observed. Shareholders first decide whether to close down the firm. If shareholders decide to close the firm, they receive a liquidation value, and the firm exits the economy immediately. Otherwise, the firm produces and generates a profit. The manager chooses an effort level that can affect the firm's profit. The firm can explore merger opportunities in the economy. The merger process is mediated by search and random matching frictions. When two firms meet, their boards negotiate and decide whether to merge together. They also determine the role (i.e., as the acquirer or the target) each firm plays in the merger and how the combined firm value is divided between them. The acquirer pays an offer price to the target and takes control of the combined entity. The target exits after the merger. If a firm refuses to merge, it remains stand-alone and continues to operate in the next period.

2.1.1 Firm production

The firm has a production technology that is subjected to decreasing returns to scale. Firm i generates an operating profit each period:

$$\Pi_{i,t} = z_{i,t} B_{i,t}^\alpha - \omega B_{i,t}, \quad (1)$$

where the parameter α captures the concavity of the production function and $\omega B_{i,t}$ is a linear operating cost.⁴ $z_{i,t}$ is the firm's TFP, which is observed by all agents in the model each period before any decisions are made and evolves according to the following process:

$$\exp[\ln(z_{i,t+1}) - \ln(\bar{z})] = \exp[\rho_z \ln(z_{i,t}) - \rho_z \ln(\bar{z}) + \sigma_z \epsilon_{i,t+1}] + e_{i,t}; \quad \epsilon_{i,t+1} \sim \mathcal{N}(0, 1), \quad (2)$$

where $e_{i,t}$ captures the manager's effort choice. Without any effort input from the manager (i.e., $e_{i,t} = 0$), a firm's log-TFP follows the standard AR(1) process. If the manager exerts an effort of $e_{i,t}$ in period t , she can boost the firm's TFP next period by $e_{i,t}$. This specification captures a potential disciplinary effect: intuitively, if a manager is strongly disciplined, she would exert more effort when the firm underperforms, which would help the firm recover faster.

2.1.2 Merger technology

After a takeover, the combined firm starts operating in the next period with book value $B_A + B_T$, where the subscript denotes the acquirer (A) and target (T), respectively. The combined firm produces and generates an operating profit of $\Pi_c = z_c (B_A + B_T)^\alpha - \omega (B_A + B_T)$ per period, and its TFP, z_c , is determined by the following merger technology:

$$z_c = w_A z_A + w_T z_T + w_T \gamma (z_A - z_T), \quad (3)$$

⁴We assume that a firm's book value, $B_{i,t}$, does not change over time unless the firm is involved in an M&A. This assumption is equivalent to saying that each firm makes investments that equal its depreciated capital each period, and $\omega B_{i,t}$ captures the cost of such investment that has to be deducted from the firm's revenue.

where $w_A = \frac{B_A}{B_A+B_T}$ and $w_T = \frac{B_T}{B_A+B_T}$ are the acquirer's and the target's sizes, respectively, relative to the combined firm. Eq. (3) suggests that the combined firm's TFP contains two components: the weighted average of TFP by the acquirer and the target, $w_A z_A + w_T z_T$, and the potential gain/loss arising from transferring the acquirer's productivity to the target, $w_T \gamma (z_A - z_T)$. The parameter γ captures the transferability of acquirer productivity. For example, if $\gamma = 1$, the target's assets fully inherit the acquirer's productivity, and the combined firm's TFP becomes $z_c = z_A$. If $\gamma = 0$, the target's assets do not embrace the acquirer's productivity, and the combined firm's TFP is simply the weighted average of the acquirer's TFP and the target's TFP, $w_A z_A + w_T z_T$. For any $\gamma > 0$, this merger technology features the q-theory of M&As: outperforming acquirers may create value by acquiring underperforming targets and (partially) transferring their superior performance to the targets' assets.

Beyond the gains from performance transfer, there are other benefits and costs in M&As. For example, merger synergies may arise from combining complementary assets or acquisitions of growth options (e.g., Rhodes-Kropf and Robinson, 2008; Levine, 2017). Firms may also incur significant integration costs. To capture these effects, we model the additional merger gains/losses, beyond the performance transfer, as

$$sB_T - \chi \left(\frac{B_T}{B_A} \right)^2 (B_A + B_T), \quad (4)$$

where s captures the additional merger synergies generated from each unit of target assets. We assume that s follows a normal distribution with mean μ_s and standard deviation σ_s . Following Yang (2008), we use the term $-\chi \left(\frac{B_T}{B_A} \right)^2 (B_A + B_T)$ to capture the part of integration costs that are convex in the target's relative size. These additional synergies and costs from M&As are capitalized in the combined firm's post-merger market value.

After a takeover, the combined firm continues its operation under the acquirer's management and organizational structure, and it inherits the acquirer board's preference, κ_A . The following section provides a detailed discussion of the role of κ in M&A deals.

2.1.3 Value functions

There are three agents in our model; they make different decisions that constitute the model equilibrium: the board makes M&A decisions, the manager chooses the effort level, and shareholders decide on firm closure. We characterize each agent's value function and optimal decision rules in this section. We denote the board's value function as $V(z, \kappa, B)$, the manager's value function as $M(z, \kappa, B)$, and the shareholder's value function as $U(z, \kappa, B)$.

The board's problem

The board takes into account both the shareholders' value and the manager's control benefits when making M&A decisions. Specifically, the board maximizes the following utility function:

$$V(z, \kappa, B) = U(z, \kappa, B) + \kappa M(z, \kappa, B), \quad (5)$$

where κ is the board's preference for managerial control benefits. More specifically, it represents the degree to which the board internalizes the manager's control benefits (Taylor, 2010). Eq. (5) suggests the board is indifferent between a one-util increase in the manager's control benefit and a κ -dollar increase in the firm's market value. If the manager loses all control rights in a takeover, the board perceives that as painful as seeing a $\kappa M(z, \kappa, B)$ dollar drop in the firm's market capitalization. More broadly, κ can be interpreted as the entrenchment established between the manager and board members, indicating the governance quality of the firm. We model κ as heterogeneous across boards of directors—directors who have a greater sense of fiduciary responsibility, own more shares or options, or care more about their labor market reputation should have low κ ; on the contrary, high κ can be interpreted as captured and weak boards. For a given board-manager pair, its κ remains constant over time.

When two firms meet, their boards determine whether to merge and if so, what role each firm plays. The total value created/destroyed in a merger, from the boards' perspective, is equal

to

$$\begin{aligned} \Sigma_b(z_A, \kappa_A, B_A; z_T, \kappa_T, B_T; s) &= V(z_c, \kappa_A, B_A + B_T) + sB_T - \chi \left(\frac{B_T}{B_A} \right)^2 (B_A + B_T) \\ &\quad - E \left[V(z'_A, \kappa_A, B_A) \right] - E \left[V(z'_T, \kappa_T, B_T) \right], \end{aligned} \quad (6)$$

where Σ_b denotes the total merger gains from the joint board's perspective. This is equal to the combined firm's value to the board minus the two merging firms' reservation values, taking into account that the merger generates additional synergies beyond the performance transfer and incurs costs of integration. A merger completes if and only if $\Sigma_b > 0$.

In our model, the benefit of performance transfer and the costs of integration depend on the role of the two merging firms. Our model therefore endogenizes a firm's choice to be an acquirer or a target in a merger. Specifically, when firm i meets firm j , their boards compare three possible outcomes when making M&A decisions: if firm i acquires firm j , the total value created is $\Sigma_b(z_i, \kappa_i, B_i; z_j, \kappa_j, B_j; s)$; if firm j acquires firm i , the total value created is $\Sigma_b(z_j, \kappa_j, B_j; z_i, \kappa_i, B_i; s)$; and if they do not merge, the total value created is zero.

The M&A decision, when firm i meets firm j , is therefore represented by the following discrete choice problem solved by the board:

$$\ell_{i,j} = \underset{\{acq, tar, sa\}}{argmax} \{ \Sigma_b(z_i, \kappa_i, B_i; z_j, \kappa_j, B_j; s), \Sigma_b(z_j, \kappa_j, B_j; z_i, \kappa_i, B_i; s), 0 \}, \quad (7)$$

where $\ell_{i,j} = acq$ means firm i acquires firm j , $\ell_{i,j} = tar$ means firm j acquires firm i , and $\ell_{i,j} = sa$ means both firms stand alone.

If a merger takes place, the acquirer and the target divide the total merger gain via the standard Nash bargaining from the board's perspective, with the acquirer gaining $\theta \cdot \Sigma_b$ and the target gaining $(1 - \theta) \cdot \Sigma_b$, in which θ is the acquirer board's bargaining power. The target therefore receives an offer price of

$$P(z_A, \kappa_A, B_A; z_T, \kappa_T, B_T; s) = E \left[V(z'_T, \kappa_T, B_T) \right] + (1 - \theta) \cdot \Sigma_b. \quad (8)$$

The shareholders' problem

Shareholders receive the firm's operating profit each period, and the shareholders' value function is characterized by the following Bellman equation:

$$U(z, \kappa, B) = \max_{\iota \in \{cont, cls\}} \left\{ z \cdot B^\alpha - \omega B + \frac{1}{1+r} \cdot E \left[U(z', \kappa, B) \right] + \frac{1}{1+r} \cdot \left(E[1_{acq} \cdot \Delta_s^{acq}] + E[1_{tar} \cdot \Delta_s^{tar}] \right), \delta \cdot B \right\}, \quad (9)$$

where $z \cdot B^\alpha - \omega B$ is the firm's periodical profit specified in Eq. (1); $E \left[U(z', \kappa, B) \right]$ is the firm's continuation value; $E[1_{acq} \cdot \Delta_s^{acq}]$ and $E[1_{tar} \cdot \Delta_s^{tar}]$ are the firm's expected merger gains as an acquirer or a target, respectively, and the expectation is taken against the distribution of all potential merger partners in the economy. Note that the board, rather than the shareholders, makes M&A decisions, so the indicator functions 1_{acq} and 1_{tar} are determined by the solution to the board's optimization problem defined in Eq. (7), which equals one if $\ell = acq$ and $\ell = tar$, respectively. Shareholders choose to continue running the firm ($\iota = cont$) or to close it ($\iota = cls$), depending on the firm's going-concern value and its liquidation value, $\delta \cdot B$.

We derive the merger gains to the acquirer and the target shareholders, Δ_s^{acq} and Δ_s^{tar} , respectively, in Online Appendix A. Since the merger decision and the offer price are determined by the boards, they are influenced by the manager's control benefits through the board members' preference parameter κ . More specifically, high κ on either the target or the acquirer side serves to boost the offer price and increase the fraction of merger gains accrued to target shareholders. This is intuitive: when the board cares more about the target manager's control benefits, the acquirer has to pay high premiums to compensate the target manager for relinquishing her control; when the board cares more about the acquirer manager's control benefits, they are more willing to raise the offer price to facilitate the manager gaining control of additional assets, sometimes even at the cost of acquirer shareholders.

It is worth noting that although the board's strong preference for managers' control benefits unambiguously increases the target's share of total merger gains conditional on a deal taking place, it does not always increase the target shareholders' expected gains. This is because it also

reduces the probability of deal consummation, and some deals that create value for the target shareholders can be blocked when the target manager is not willing to give up control.

The manager's problem

Each firm is run by a manager who derives private benefit from controlling the firm. In each period, the manager enjoys a flow of control benefit, πB . Note that as in Albuquerque and Schroth (2015), we do not model the manager's control benefits as coming directly from the firm's cash flows. Instead, we interpret it as a psychological benefit that would be lost if the incumbent manager separates from the current firm when the firm is acquired or closed down.

Each period, the manager has to decide how much effort to exert to boost the firm's profit. She bears a quadratic cost from exerting effort:

$$C(e) = \frac{c}{2} \cdot e^2 \cdot B. \quad (10)$$

From the manager's perspective, the disutility from exerting effort is quadratic in the amount of effort, and it increases monotonically with firm size. The manager's optimal effort level solves the following value maximization problem:

$$M(z, \kappa, B) = \max_e \pi \cdot B - \frac{c}{2} \cdot e^2 \cdot B + \frac{1}{1+r} \cdot \left(E \left[1_{sa} \cdot 1_{cont} \cdot M(z', \kappa, B) \right] + E \left[1_{acq} \cdot 1_{cont} \cdot M(z'_c, \kappa, B_c) \right] \right). \quad (11)$$

Note that the board's preference, κ , does not enter directly into the manager's utility function. However, as shown in Eq. (5)–(6), κ plays a role in the board's M&A decisions, indirectly influencing a manager's utility and effort choice through the firm's takeover exposures. The benefit of exerting effort is to increase the firm's performance going forward, as illustrated in Eq. (2). Better performance lowers the takeover threat that the manager faces. The cost of exerting effort is captured by Eq. (10). The manager makes intraperiod optimization decisions on e . In Eq. (11), $E \left[1_{sa} \cdot 1_{cont} \cdot M(z', \kappa, B) \right]$ is the manager's continuation value derived from the firm standing alone and surviving to the next period, and $E \left[1_{acq} \cdot 1_{cont} \cdot M(z'_c, \kappa, B_c) \right]$ is the manager's continuation value derived from the firm making an acquisition and surviving to the next period. z_c and B_c are the combined firm's TFP and book value following a merger.

The indicators 1_{sa} and 1_{acq} are determined by the board's M&A decision, which equals 1 if $\ell = sa$ and $\ell = acq$, respectively. The indicator 1_{cont} is determined by the shareholder's closure decision, which equals 1 if $\iota = cont$ at the beginning of the next period. If the firm gets acquired this period ($\ell = tar$) or is closed down at the beginning of the next period ($\iota = cls$), the manager loses her continuation value.

2.1.4 Efficient and inefficient mergers

Since M&A decisions are made by board members, mergers are not always beneficial for the joint shareholders in our model. To see this, we substitute Eq. (5) into Eq. (6) and obtain

$$\Sigma_b = \Sigma_s + \kappa \Sigma_m, \quad (12)$$

where Σ_s represents the total merger gains from the joint shareholders' perspective and Σ_m represents the total merger gains from the target and the acquirer managers' perspectives:

$$\begin{aligned} \Sigma_s = & U(z_c, \kappa_A, B_A + B_T) + sB_T - \chi \left(\frac{B_T}{B_A} \right)^2 (B_A + B_T) \\ & - E \left[U(z'_A, \kappa_A, B_A) \right] - E \left[U(z'_T, \kappa_T, B_T) \right], \end{aligned} \quad (13)$$

$$\Sigma_m = M(z_c, \kappa_A, B_A + B_T) - E \left[M(z'_A, \kappa_A, B_A) \right] - E \left[M(z'_T, \kappa_T, B_T) \right]. \quad (14)$$

Eq. (12) indicates that, from the board's perspective, merger gains can arise from enhancing the shareholders' value of the combined firm or from moving the target assets to the acquirer manager, whose control benefits are valued more by the board members. Thus, our model features two types of efficient merger outcomes that benefit the combined firm's shareholders and two types of inefficient outcomes that hurt shareholders. Efficient merger outcomes include cases in which

- good mergers are consummated (i.e., $\Sigma_s > 0$ and $\Sigma_b > 0$) or
- bad mergers are avoided (i.e., $\Sigma_s < 0$ and $\Sigma_b < 0$).

Inefficient outcomes include cases in which

- good mergers are blocked by the target manager's resistance (i.e., $\Sigma_s > 0$ but $\Sigma_b < 0$ due to $\Sigma_m < 0$) or
- bad mergers are induced by the acquirer manager's empire-building (i.e., $\Sigma_s < 0$ but $\Sigma_b > 0$ due to $\Sigma_m > 0$).

The model therefore provides a lens for us to examine the causes and consequences of both efficient and inefficient mergers.

2.1.5 Firm entry and exit

Each period, a mass of new firms, E , are born and enter the economy. We assume that entrants are drawn from a common distribution $\Omega(z, \kappa, B)$, which we parameterize as a joint normal distribution of $\ln(z)$, $\ln(\kappa)$, and $\ln(B)$. Incumbents may exit the economy through two channels: an incumbent can be acquired as a target and exits the economy (Eq. 7) or it can be closed down and liquidated by the shareholders (Eq. 9).

2.2 The steady-state equilibrium

In the model, each firm is represented by its beginning-of-period state variable (z, κ, B) . We characterize the economic structure by the joint distribution of firm state variables, $G(z, \kappa, B)$. In general, the joint distribution may vary over time, driven by two sources of dynamics. The first source arises from the evolution of firm log-TFP, governed by the law of motion specified in Eq. (2); the second is driven by firms' entry, exit, and M&A decisions. We define the transition function that captures the transition probability from the current state (z, κ, B) to a given state (z', κ', B') in the next period as $Q(z', \kappa', B'; z, \kappa, B) \equiv \text{Prob}(z', \kappa', B' | z, \kappa, B)$. This transition function captures both dynamics. The joint distribution $G(z, \kappa, B)$ evolves according to the following:

$$G(z, \kappa, B) = \int Q(z', \kappa', B'; z, \kappa, B) G(z, \kappa, B) dz d\kappa dB + \Omega(z, \kappa, B) \cdot E, \quad (15)$$

where $\Omega(z, \kappa, B)$ is the entrants' distribution. We define a stationary equilibrium, in which $G(z, \kappa, B)$ is time invariant, as follows.

Definition. A stationary equilibrium consists of the shareholders' value function (U), the manager's value function (M), the shareholders' optimal decision on firm closure, the manager's optimal decision on effort, the board's optimal decision on M&As, the joint distribution (G), and the transition function (Q) such that the following are true:

1. The board makes the M&A decision by solving Eq. (7), given their conjectures of the shareholders' decision on firm closure, the manager's effort choice, Q , and G in equilibrium.
2. The shareholders make the firm closure decision by solving the value function in Eq. (9) given their conjectures of the manager's effort choice, the board's M&A decision, Q , and G in equilibrium.
3. The manager chooses the level of e by solving the value function in Eq. (11) given her conjecture of the shareholders' closure decision, the board's M&A decision, Q , and G in equilibrium.
4. The transition function Q is determined by the law of motion described in Eq. (2), firms' M&A decisions, and firm entry and exits in equilibrium.
5. The joint distribution G evolves following Eq. (15) and is stationary over time; that is, $G(z', \kappa', B') = G(z, \kappa, B)$.
6. G and Q specified in conditions 4 and 5 are consistent with the conjectures by the board, the shareholders, and the manager in conditions 1–3.

Intuitively, the stationary equilibrium requires that the board members, the shareholders, and the manager have rational expectations of the equilibrium outcomes and maximize their values in making decisions and the distribution of firms evolves according to the equilibrium outcomes and remains stationary over time.

2.3 Model solutions

We solve the model following the definition listed in Section 2 with the parameters set to their estimated values.⁵ We illustrate how a firm's exposure to takeovers, the manager's optimal

⁵Parameter estimates are reported in Table 4, and we defer their discussion to the next section.

effort choice, and the likelihood of firm closure vary with various firm characteristics.

Panel A of Fig. 2 shows how a firm's likelihood of being acquired varies with its TFP and board preference. It corresponds to a three-dimensional heat map with the board's preference on the x-axis and the firm's TFP on the y-axis. The probability that the firm gets acquired is measured by the depth of color on the heat map—darker color means that the firm is less likely to get acquired, while lighter color suggests the opposite. As expected, we find that underperforming firms are more likely to be acquired. Holding all else equal, a firm is also more likely to get acquired if the board members are less prone to internalize their managers' control benefits.

Panel B illustrates the firm's probability of being an acquirer. Intuitively, firms with higher TFP can seize larger efficiency gains from transferring their productivity to other firms and are more likely to become acquirers. Boards with higher κ tend to internalize their managers' benefits from gaining additional control rights; thus they also make more acquisitions.

Having anticipated these effects, shareholders are more likely to close down an underperforming firm if it also has high κ , as suggested in Panel C. Such firms exhibit high takeover deterrence and are less likely to be rescued by future takeovers. Moreover, even if firms can recover by themselves, subsequent value-destroying takeovers can occur due to their managers' empire-building incentives. Both effects imply that the continuation value is low, which makes closing down the firm today relatively more profitable.

Panel D examines the managers' optimal effort choice, where effort is measured by the extent to which it increases a firm's operating performance. For managers in an average firm, the threat of being taken over is modest, and the marginal benefit from exerting effort is relatively low. We therefore observe small effort provision. However, when the firm's TFP starts to deteriorate, the manager faces an increasing risk of being replaced in takeovers, and thus effort provision increases monotonically with the decline in TFP. This effect is the strongest among firms with low κ , where the managers receive little protection from the board because their fear of losing control serves as a strong intrinsic stimulus for working harder.

It is worth noting that in a plain-vanilla q-theoretic setting where managers receive no

control benefits, a firm’s takeover exposure depends only on its TFP relative to other firms in the economy, and thus the contour curves in Panels A and B are strictly horizontal. Comparing the predictions by the plain-vanilla q-theory model with the results presented in Fig. 2, our model highlights the dark-side effect of managerial control benefits—they serve as a takeover deterrence among underperforming firms and incentivize empire-building among outperformers, distorting the boards’ takeover decisions. The results, however, do not necessarily suggest that the takeover market becomes less efficient overall. This is because managers’ control benefits also amplify the disciplinary effect of the takeover threat. More specifically, the likelihood of being taken over, combined with managers’ fear of losing their control in such events, stimulates more effort provision that in turn helps firms recover more rapidly, even without actual takeovers taking place. We label this effect as the bright-side effect of managerial control benefits.

For any given firm, this bright-side effect always coexists with the dark-side effect, but the relative magnitudes could vary widely cross-sectionally based on the firms’ economic states and the role they are likely to play in future takeovers. In the following sections, we explore empirically which aspect dominates in certain subgroups of firms and what the aggregate effect is among all firms in the economy.

3 Estimation

In this section, we describe sample construction, the SMM estimator, and the intuition behind the estimation method.

3.1 Data and sample construction

We obtain firms’ accounting data from the CRSP-Compustat Merged Database (CCM). Our sample covers the period from 1980 to 2015. We measure firm i ’s performance using its TFP, $z_{i,t}$. Since our model features a representative industry, it is important to remove the heterogeneity across industries. We do so by taking out the industry fixed effect from $z_{i,t}$, following Hennessy and Whited (2007). We then collect information on other firm characteristics, such as firm size, market-to-book equity ratio, market leverage, and cash holdings. All variables are winsorized

at the 1% level. Detailed variable definitions are in Table 1.

Data on M&As are from the Thomson Reuters SDC Platinum. We examine all bids announced during the sample period. To be included in the final sample, a bid has to satisfy the following criteria:

1. Both the acquirer and the target are publicly traded firms in the US.
2. The deal can be clearly classified as successfully completed or a failure, and the date of the bid completion or the bid withdrawal is available.
3. The acquirer seeks to acquire more than 50% of the target's shares to gain control of the firm and holds less than 50% of the target's shares beforehand.
4. The deal value exceeds \$1 million.
5. The deal is classified as a merger, not a tender offer or a block trade.

Our final sample includes a panel of 169,487 firm-year observations. Panel A of Table 2 presents the characteristics of all firms covered by the CCM database, along with those of the acquirers and targets. Consistent with the findings in previous studies (e.g., Betton, Eckbo, and Thorburn, 2008), acquirers are, on average, much larger than targets in size, and they also exhibit better performance.

Panel B of Table 2 shows the deal characteristics of all M&As in our sample. We find that offer premiums are high and average 49% of the targets' pre-acquisition market value. The acquirer announcement-period abnormal returns, computed based on the market model, are indifferent from zero. The target firms earn much higher announcement-period abnormal returns, which average 30%. To account for possible information leakage before bid announcements, we include the 22-day price run-up in computing the announcement-period abnormal returns. The combined firm's announcement return is calculated as the value-weighted average of the acquirer's and the target's announcement returns. The method of payment may reveal acquirers' misvaluation and lead the market to reprice the acquirers' stand-alone value on takeover announcements (i.e., the revelation effect). The revelation effect confounds the acquirer announcement return as a measure of synergistic gains. To correct for the revelation effect, we follow

Golubov, Petmezas, and Travlos (2015) and make an adjustment to the acquirer announcement returns based on the payment method and the deal and firm characteristics.

Firms enter or exit the CCM database for various reasons during their life cycles. To track firm dynamics in the CCM database, we use the variable *Research company reason for deletion* (i.e., *dlrsn*) provided by CCM. *dlrsn* is a categorical variable that indicates the reason why a firm loses CCM coverage. Common reasons for a firm to lose CCM coverage include being acquired, going bankrupt or being liquidated, going private, and failing to fit the original reporting format. We then merge *dlrsn* with the panel of firms in our sample; thus, each firm in our sample is either still operating by the end of the sample period or has exited the CCM at some point in time during the sample period, with its *dlrsn* flag indicating the reason of exit. On average, about 4.3% of firms are acquired, and 0.6% of firms go bankrupt or get liquidated each year.

3.2 SMM estimator

We estimate the model using SMM, which chooses parameter values that minimize the distance between the moments generated by the model and their analogs in the data. In this section, we present the data moments used in the estimation and explain how they help identify the model parameters.

There are 20 parameters in the model. The subjective discount rate is r . The firm's production process involves two parameters, as described in Eq. (1): α is the concavity of the production function, and ω is the variable cost. The evolution of the firm's productivity involves three parameters, as described in Eq. (2): $\ln(\bar{z})$ and ρ_z are the long-run mean and persistence of firm log-TFP when the manager exerts no effort, and σ_z captures the standard deviation of innovation to log-TFP.

The merger technology is characterized by five parameters: γ captures the performance transferability in M&As, χ controls how the integration costs grow with the relative size of targets, and μ_s and σ_s capture the mean and standard deviation of s , which is the additional synergy beyond the performance transfer in M&As, as described in Eq. (4). In addition, θ determines the fraction of merger gains accrued to the acquirer when the acquirer board and

the target board negotiate via Nash bargaining.

The entrant distribution is governed by $\Omega(z, \kappa, B)$, as in Eq. (15). We assume that entrants' z , κ , and B follow a joint log-normal distribution, and we parameterize it using six parameters: the means $\mu_{\ln(z)}$, $\mu_{\ln(\kappa)}$, and $\mu_{\ln(B)}$, and the cross-sectional dispersion $\vartheta_{\ln(z)}$, $\vartheta_{\ln(\kappa)}$, and $\vartheta_{\ln(B)}$. We assume zero correlation between state variables for entrants in the baseline estimation.⁶

The last three parameters are π , c , and δ : π measures the manager's flow control benefit, c captures the manager's cost of exerting effort, as described in Eq. (10); and δ measures the liquidation value per unit of book assets, which determines the option value of closing down the firm in Eq. (9).

3.3 Identification and selection of moments

We start with the parameters that are standard in the literature. We set the annual subjective discount rate r to 0.1, a value commonly used in the literature. We choose the parameter $\theta = 0.5$ so that the target and acquirer have intrinsically equal bargaining power, as in Dimopoulos and Sacchetto (2017). It is intuitive to set $\theta = 0.5$ in an industry equilibrium model where all targets and acquirers are drawn from the same cross-section of firms, and they are ex ante identical before a merger pair is formed and their roles are endogenously chosen. Equal bargaining power, however, does not translate into equal gains for the target and the acquirer because the acquirer always needs to compensate the target for the loss of managerial control benefits, which influences the split of merger gains between the two parties. The model cannot separately identify the parameter π and the mean of κ because the manager's effort decision is scale invariant, and the board's M&A decision is influenced by the combination of κ and π , which determines the relative importance of managerial control benefits versus shareholder values. We therefore normalize $\mu_{\ln(\kappa)}$ to zero following Taylor (2010). In Online Appendix B., we prove that our model yields identical solutions with and without this normalization.

We then calibrate a few parameters that are clearly tied to certain data moments. Since we

⁶Note that correlations between incumbents' state variables can differ from zero even if the correlations between entrants' state variables are zero. This is because incumbent distribution is determined endogenously in the steady-state equilibrium. Our estimation takes into account this effect because it is built on the steady-state equilibrium outcomes.

can directly observe the performance and size of entrants in data, we calibrate $\mu_{ln(z)}$, $\mu_{ln(B)}$, $\vartheta_{ln(z)}$, and $\vartheta_{ln(B)}$ to match the mean and cross-sectional dispersion of the entrants' log-TFP and log book equity. We set ω to 0.23 so that the average firm size in the model matches that in the data. As discussed in Section 2.1.1 (footnote 4), ω can also be viewed as the depreciation rate of firm capital in steady state, and a depreciation rate of 23% per annum is close to what is used in previous studies (e.g., Yang, 2008). Lastly, we calibrate $ln(\bar{z})$ to match the long-run firm performance in the model to that in the data.

We are left with ten parameters to estimate. Since we conduct a structural estimation, identification requires choosing moments whose predicted values are sensitive to the model's underlying parameters. We use 12 moments to identify the remaining 10 model parameters. Our identification strategy ensures a unique parameter vector that makes the model fit the data most closely. Since we estimate these parameters in one big SMM system, we essentially allow each moment to respond to all parameters in estimation. We explain below which moments are the most informative in identifying each parameter. When we map the model to the data, we compare the model-implied moments, generated in the steady-state equilibrium, to the empirical data moments, implicitly assuming that the economy we observe is in steady state.

First, if performance transfer is a key motive of M&A in our model, acquirers are expected to have better performance than their targets. We therefore use the difference between the acquirer's TFP and the target's TFP to help identify γ . Intuitively, γ increases with the moment $E[z_{acq} - z_{tar}]$. Second, to gauge the outcome of performance transferability more directly, we run the following regression:

$$z_c - w_A z_A - w_T z_T = \Upsilon \cdot w_T (z_A - z_T) + bX + \varepsilon, \quad (16)$$

which is the counterpart of Eq. (3) estimated using the actual data. The left-hand side variable $z_c - w_A z_A - w_T z_T$ is the improvement in the combined firm's TFP relative to the weighted average of the acquirer and target premerger TFP, and the variable $w_T (z_A - z_T)$ on the right hand side captures the acquirer-target TFP differential scaled by the target's size relative to the acquirer. In the regression, we also control for acquirer and target characteristics (e.g.,

size, market-to-book equity, leverage, cash holdings) and the industry and year fixed effect through the control vector X . Doing so helps purge confounding factors that may affect the combined firm's TFP but are left out of our model. The coefficient Υ is informative of the model parameter γ : intuitively, a high Υ indicates a larger fraction of performance transfer, which can be generated by increasing γ in the model.

The manager's control benefits, π , the board's preference, κ , and the additional synergy, s , are all unobservable, but they affect merger outcomes in various dimensions. Therefore, we infer their underlying distributions from the observed deal characteristics. A higher π implies higher average control benefits for both the acquirer and the target managers. In this case, the target manager demands a higher offer premium to sell the firm, and the acquirer manager is more willing to pay for the control rights, which raises the transaction price and thus the target's gain unambiguously. Following Ahern (2012), we measure the fraction of the merger gains captured by the target shareholders using the target's dollar value gain minus the acquirer's dollar value gain, scaled by the total per-acquisition market value of the acquirer and the target. The parameter π increases with the target's fraction of merger gains.

The parameter $\vartheta_{ln(\kappa)}$ controls the dispersion of board preference. If $\vartheta_{ln(\kappa)}$ is zero, all boards internalize their managers' control benefits to the same degree, leaving heterogeneity in firms' productivity and s as the only drivers for mergers. In this case, any M&A decisions made by the board must maximize the joint shareholders' value, and thus all mergers must be value enhancing for the combined firm. As $\vartheta_{ln(\kappa)}$ increases, boards have more dispersed preferences, and they facilitate private benefit-motivated deals to different degrees. Some boards with high κ are more permissive toward their managers' empire-building incentives, and these firms are more likely to acquire assets from other firms with lower κ , even if such acquisitions may destroy shareholder value. We therefore use the fraction of value-destroying mergers to identify $\vartheta_{ln(\kappa)}$. We define a merger as value destroying if the combined firm's announcement return, after adjusting for the revelation effect, is negative. The fraction of value-destroying mergers increases with $\vartheta_{ln(\kappa)}$.

The parameters μ_s and σ_s determine the average level and dispersion of s , which captures the value of additional gains from mergers beyond performance transfer. Obviously, a large

value of μ_s elevates the total value created in mergers, leading to more M&As and a higher announcement return for the combined firm. We therefore use the probability of M&As and the average combined firm return to identify μ_s .

The probability of low-profitability firms acquiring high-profitability firms helps identify σ_s . As σ_s increases, there is more room for firms to gain from factors other than performance transfer (e.g., asset complementarity). In these mergers, acquirer profitability may be lower than target profitability, leading to a higher incidence of low-profitability firms acquiring high-profitability firms. We therefore use this moment to help identify σ_s .

It is worth noting that although σ_s increases the incidence of low-profitability acquirers, it does not induce value-destroying mergers as $\vartheta_{\ln(\kappa)}$ does. Hence, we rely on two moments—the probability of value-destroying mergers and the probability of low-profitability firms acquiring high-profitability firms—to identify σ_s and $\vartheta_{\ln(\kappa)}$ separately. As Fig. 3 shows, both $\vartheta_{\ln(\kappa)}$ and σ_s increase the probability of low-profitability firms acquiring high-profitability firms. However, they have opposite implications on the probability of value-destroying mergers. The distinct trends in Panels A and B allow us to identify $\vartheta_{\ln(\kappa)}$ and σ_s sharply with the two moments.

We notice that in the data, firm performance, measured by log-TFP, is mean reverting. The speed of mean reverting, however, is strongly asymmetric. When firms underperform relative to their long-run mean, the speed of mean reverting is much faster. In other words, bad performance is much less persistent than good performance (with an autoregressive coefficient of 0.67 versus 0.90). Our model endogenizes this asymmetric persistence of performance by allowing the managers to exert effort and affect their firms' future performance, subject to the costs of effort. We run the following regression:

$$\ln(z_{i,t+1}) - \ln(\bar{z}) = \rho_{z+} [\ln(z_{i,t}) - \ln(\bar{z})]^+ + \rho_{z-} [\ln(z_{i,t}) - \ln(\bar{z})]^- + \varphi_z \epsilon_{t+1}, \quad (17)$$

where we denote $[x]^+ = \max(x, 0)$ and $[x]^- = \min(x, 0)$.

There are three key coefficients in the regression above. The regression coefficients ρ_{z+} and ρ_{z-} help us identify the parameters ρ_z and c in the model. Intuitively, ρ_z controls the performance persistence without the manager's effort, as described in Equation (2), and it determines

the average level of ρ_{z+} and ρ_{z-} ; parameter c controls the cost of managerial effort. When c decreases, it triggers two consequences. First, lower c implies that managers can influence firm performance more effectively; therefore, we see higher effort levels in all firms and across all states of the economy. Moreover, the incentive to boost performance is particularly strong when a firm underperforms and becomes more vulnerable to takeover threats. The second consequence, therefore, is that lower c also widens the gap between ρ_{z+} and ρ_{z-} by inducing asymmetrically higher efforts among firms with relatively poor performance. Following this idea, we use the difference between ρ_{z+} and ρ_{z-} to identify the cost parameter, c . The coefficient φ_z captures the standard deviation of innovation to the firm’s performance, which helps us identify σ_z .

Last, we identify χ off the relative size of the target (*TarRltSz* defined in Table 1). When χ is larger, integration costs increase much faster with the relative size of the target, making acquisitions of large targets less profitable. As a result, χ decreases with the average size of targets relative to the acquirers. The probability of bankruptcy in the data helps identify δ . Strictly speaking, there is no role for bankruptcy in our model because all firms are fully equity financed. The model construction of firm closure, however, plays the role of bankruptcies in the data because when shareholders decide to close down a firm in the model, it corresponds to the reality that shareholders refuse to inject more funds into the firm to save it from bankruptcy.

4 Empirical Results

We begin by assessing how the model fits the data, and then we present the parameter estimates. We use the estimated model to analyze how managerial control benefits affect firms’ takeover decisions and quantify the welfare consequences associated with various features of the takeover market.

4.1 Model Fit

Panel A of Table 3 presents moments we target to match in the SMM estimation. The model can match data moments fairly closely—both M&A and firm closure (bankruptcy) are rare events in the model. The model predicts that 4.1% of firms are acquired each year and

0.7% of firms are closed down. Target firms are estimated to gain more from M&As than acquirers, even in dollar value. The model implies that target firms, on average, gain 3.7% more than acquirers in terms of the combined firm's value. Because targets are usually much smaller than acquirers and the merged entities, this number translates into a significant proportional gain to target shareholders. Some M&As are driven by the acquirer manager's desire to gain additional control benefits (i.e., empire-building incentives) and thus might be harmful to the shareholders. In the model, we find that about 16.8% of deals are value destroying in the sense that the combined firm value decreases post-merger. The empirical analog is 15.9%, which is fairly close to what the model predicts, both economically and statistically. The model also fits very well the average combined firm announcement returns. This result, combined with the fit of the overall merger rate, ensures that our model captures the total synergistic gains created by M&As in the economy.

Acquirers, on average, outperform targets. The average acquirer-target TFP differential is 1.047 in the model, compared with 0.971 in the data. This pattern suggests that q-theory is an important motive in M&As. Meanwhile, the model also captures the stylized fact that in about 30% of deals, the target has better performance than the acquirer. This is mainly driven by the cross-sectional dispersion in the board's preference for managerial control benefits, as well as the unobservable synergy, s , in the model. The q-theory motive is further confirmed by the performance transferability measured in the data and in the model. The model-implied performance transferability is slightly lower than that in the data measured through regression Eq. (16) (0.237 versus 0.431), but the difference is statistically insignificant.

With managerial effort provision, the model can closely match the asymmetric persistence of firm performance. In the model, good performance is much more persistent than bad performance, and the autoregressive coefficients are 0.89 and 0.66, respectively, which match their empirical analog (0.90 and 0.67) closely. Lastly, the model matches the size of targets relative to acquirers with the help of a quadratic integration cost.

Panel B of Table 3 shows how the model fits additional features of the data that are not directly targeted in our estimation. We examine nine untargeted moments that describe the

evolution of underperforming firms in the economy. Specifically, they measure how long a firm stays underperforming (i.e., underperformance duration), the channel by which a firm exits underperformance, and the conditional underperformance duration based on each exit channel. We define a firm as underperforming if its profit falls into the bottom quintile. We define a firm as exiting the underperforming group if it recovers by itself and moves to upper performance quintiles, gets acquired by another firm, or is closed down. These moments are of particular importance in testing the model’s predictions because they are determined jointly by the key modeling ingredients and are sensitive to the relative importance of the takeover motives that the model is designed to capture. We do not explicitly target these moments in our estimation but leave them as critical validations of the model post estimation.

The model can fit all nine untargeted moments. Among all underperforming firms in the model simulation, approximately 64% (63% in the data) exit the bottom performance quintile within three years, 27% (26% in the data) stay underperforming for three to five years before exiting, and the remaining 10% (11% in the data) underperform for more than five years. Therefore, both the model and the actual data suggest that underperformance is not highly persistent for an average firm. However, there is also a nontrivial fraction of firms that has remained underperforming for a significant period of time. The model also closely tracks how firms evolve over time once they become underperforming. Over 79% of underperforming firms eventually recover by themselves, and firms who self-recover experience the shortest underperformance duration.

4.2 Parameter estimates

Table 4 reports the parameter estimates. Panel A presents the calibrated parameters as discussed in Section 3.3. These parameters are less model specific, so we calibrate them separately outside of our model to ensure that these parameter choices are consistent with the observed data characteristics and the consensus in the literature.

Panel B of Table 4 reports the point estimates and standard errors of the ten key model parameters. π captures the managers’ periodical control benefits, and $\vartheta_{ln(\kappa)}$ is the cross-sectional dispersion of the boards’ preferences among the entrant firms (in logarithm). These two param-

ters, together with the evolution of z , govern the distribution of incumbent managers' expected lifetime utility, $M(z, \kappa, B)$, in equilibrium. We can then multiply $M(z, \kappa, B)$ by κ to calculate the overall effect of the manager's control benefits on the board's value function. The multiplicative term, $\kappa M(z, \kappa, B)$, determines the price that the acquirer (target) board is willing to pay (needs to be compensated) for the transfer of control rights in future M&As. Our results suggest that, from the board's perspective, the manager's lifetime control benefits equal 7.4% of the firm value (i.e., $E \left[\frac{\kappa M(z, \kappa, B)}{U(z, \kappa, B)} \right] = 0.074$) with a standard deviation of 10.9%. These estimates imply that each dollar gain or loss, denominated in managerial control benefit util, is viewed equivalent to a seven-cent gain or loss of shareholder value by the board. In other words, the board, on average, places a 7% weight on the manager's private benefit of control and a 93% weight on shareholder value when making M&A decisions. This finding suggests that managerial control benefits play a modest role in an average firm. However, the effect can vary significantly across firms depending on the entrenchment level established between the managers and the board members. Among firms with κ in the upper 10th percentile, the board puts 19.8% of the weight on the managers. This significant cross-sectional variation in κ allows the managerial control benefits to play a pivotal role in driving some M&As.

We estimate μ_s to be 0.62 and σ_s to be 1.94. Recall that s is defined based on each unit of target assets; thus we need to adjust for the target's relative size and market-to-book ratio when gauging its influence on the shareholders' value in the combined firm. Our estimates suggest that, on average, mergers can generate additional synergy that equals 7% of the combined firm's market value (before the integration costs are deducted). The large estimated value of σ_s implies that the additional gains from mergers vary widely across different target-acquirer pairs. For some pairs, they may expect substantial synergy beyond performance transfer; thus, a significant fraction of the M&A deals in the data is driven by this type of benefits.

The parameter that controls the performance transferability, γ , is estimated to be 0.237. This estimate suggests that, on average, about 24% of the performance differential, in terms of TFP, between the acquirer and the target can be transferred to the target assets. Given that acquirers outperform targets in about 70% of the M&As in our sample, this finding is consistent

with Maksimovic and Phillips (2001), who show that M&A deals improve the allocation of resources and are consistent with the neoclassical theory of M&A.

The parameter χ is estimated to be 1.264, which suggests that the part of integration costs that are proportional to the target's relative size averages about 4% of the combined firm's value in our simulated data. The estimated χ helps the model fit an average target relative size of 0.39 in the data.

We estimate the autoregressive coefficient of firms' intrinsic log-TFP, ρ_z , to be 0.854; managers' effort reduces the persistence of bad performance to 0.66. These numbers lie in close proximity to what is documented in prior studies (Hennessy and Whited, 2007; Cooper and Haltiwanger, 2006). The standard deviation of log-TFP, σ_z , is estimated to be 0.792, which is higher than what the literature typically finds. One critical factor leading to this discrepancy is that most prior studies model a representative firm, and thus they identify σ_z using the time-series variation in TFP for a given firm, after purging out the firm-level fixed effects. Our model, however, features an industry equilibrium, and our identification of σ_z is designed to capture not only the time-series variation in TFP but also the extent to which it could vary across firms within the same industry. Therefore, it naturally produces a larger standard deviation estimate.

The cost parameter, c , is estimated to be 1.21. The cost of exerting effort is modeled as a disutility to the manager, as in Eq. (11). On average, the marginal cost of effort is about 29.7% of the control benefits a manager receives each period; that is, $E\left[\frac{ce}{\pi}\right] = 0.297$.

5 Model implications

In this section, we use the estimated model as the laboratory to analyze a few key implications. We start with a decomposition of firm value, which illustrates how an active takeover market contributes to a firm's market value. The value created by an active takeover market is then used as the benchmark to evaluate the role of managerial control benefits in shaping corporate takeovers.

5.1 Decomposition of firm value

In an active takeover market, a firm’s market value incorporates its expected gains from future mergers. Using the estimated model, we can decompose a firm’s market value into four components:

$$U = U_{sa} + OU_{acq} + OU_{tar} + OU_{cls}, \quad (18)$$

where U_{sa} represents a firm’s pure stand-alone value, OU_{acq} and OU_{tar} represent the firm’s option value of acting as an acquirer and a target in the future, and OU_{cls} represents the firm’s option value of closing down. We derive each component in Eq. (18) in Online Appendix C.

Table 5 presents the results of this value decomposition. We report the results for the full sample that contains all simulated firms and subsamples partitioned based on different criteria. The top (bottom) performer subsample contains simulated firms whose performance falls into the top (bottom) quintile. The top (bottom) board preference subsample contains firms whose boards value managerial control benefits the most (the least) with the firms’ κ falling into the top (bottom) quintile.

For the full sample, the stand-alone value of firms accounts for a large fraction (91.55%) of the market value. Cross-sectionally, a firm’s stand-alone value accounts for a larger fraction of the firm’s market value when the firm performs well and when its board puts a higher value on the incumbent manager’s control benefits, both of which prompt the firm to remain stand-alone.

The option value to become a potential target is also significant, which amounts to 5.21% of the firm’s market value in the full sample. The option value to be a target is particularly large for underperforming firms (7.38%) because these firms are more likely to be targeted. The option value to be an acquirer is only slightly positive for the full sample. This result is mainly driven by the fact that some acquirers may overpay the targets and end up destroying shareholder value. In our model, the board internalizes the manager’s empire-building motive in making acquisition decisions, which results in mergers that destroy shareholder value. We find that the option value to be an acquirer is -0.34% for firms whose board internalizes this motive more, and it increases to 0.79% for firms whose board places a lower value on their managers’ control benefits.

5.2 Efficiency analyses

Our model incorporates different takeover motives and features both efficient and inefficient M&As. In this section, we use the estimated model to examine the likelihood and consequences of these M&A outcomes.

We first simulate a panel of randomly matched firms in our model economy. For each matched pair of firms, we classify its M&A outcome into one of the four categories: (1) value-enhancing deal completed, (2) value-destroying deal blocked, (3) value-enhancing deal blocked, and (4) value-destroying deal completed, as discussed in Section 2.1.4.

As shown in Table 6, among all matched pairs, 6.90% lead to consummated M&A deals that create value for the joint shareholders; 90.72% of the matched pairs do not result in a completed deal because a hypothetical merger between the two matched firms either lacks synergistic benefits or incurs a large integration cost. These two categories of M&A outcomes are considered to be efficient.

If merged together, 0.99% of the matched pairs would have created a value for shareholders, but they are rejected by the board. The remaining 1.39% of the matched pairs result in consummated deals that destroy the joint shareholders' value. These two categories of M&A outcomes are considered to be inefficient.

To reconcile these numbers with our model estimation, note that the total fraction of matched pairs that eventually lead to completed M&As is 8.29% (6.90% + 1.39%). Since each pair contains two firms, the probability of M&As, expressed as a fraction of the total number of firms in the economy, is half of it (i.e., 4.14%), as reported in Table 3. Among all completed deals, 16.77% are value destroying (i.e., $16.77\% = \frac{1.39\%}{8.29\%}$), which is the model-implied fraction of deals with negative combined firm returns in Table 3.

We next analyze the value implications of different M&A outcomes for the board, the shareholders, and the managers. First, the consummated value-enhancing deals create, on average, 6.58% of firm value from the board's perspective. About 90% of it arises from value creation for the shareholders (5.95% of the combined firm value) and 10% for the managers (0.63% of the combined firm value). Some value-enhancing deals are blocked by the board. Overall, these

deals create value for the shareholders (1.61% of the combined firm value) but cause large disutility to the target managers who enjoy a high level of control benefits (-3.49% of the combined firm value). These deals are usually described as target managers being entrenched and resistant to the takeovers. To the opposite, some value-destroying deals are approved by the board, which create significant control benefits for the acquirer managers (4.41% of the combined firm value). These deals result in decreases in the shareholders' value (-2.32% of the combined firm value) and are often described as acquirer managers being entrenched and pursuing takeovers for empire-building purposes.

5.3 The Effects of Managerial Control Benefits

Using the estimated model as a laboratory, we next evaluate how managers' control benefits influence the aggregate outcomes in the takeover market. In particular, we quantify the dark-side effect and the bright-side effect of managerial control benefits in the full sample and across different subsamples of firms.

In Panel A of Table 7, we compare takeover outcomes across three different scenarios for all firms in our simulated economy. Specifically, in row (1), we report the implications of the benchmark model where parameters are set as in Table 4. The results from this exercise capture both the dark-side and bright-side effects of managerial control benefits. In row (2), we provide results of a counterfactual analysis in which we assume managers' control benefits do not induce them to exert effort; that is, $e = 0$ for all firms. This exercise essentially shuts down the bright-side effect of managerial control benefits. Any difference in the results between row (1) and row (2), i.e., (1)–(2), therefore captures the bright-side effect. In row (3), we completely eliminate the effect of managerial control benefits by assuming that control benefits are zero for all managers at all times. Setting $\pi = 0$ eliminates both the dark-side and the bright-side effects, bringing us back to a standard entry and exit model with no incentive conflict between the shareholders and the managers. Any difference in the results between row (2) and row (3), i.e., (2)–(3), therefore arises from the dark-side effect.

In each exercise, we examine the total value created by the takeover market as well as a

breakdown through its two roles: asset reallocation and disciplining. We measure the value created through asset reallocation using firms' expected gains from mergers that take place in the model equilibrium. This component includes not only the merger gains realized in the current period but also the expected gains from all future anticipated mergers.⁷

We measure the value of the disciplinary effect by calculating $\frac{U-U_{e=0}}{U}$, where $U_{e=0}$ is the value of the firm when managers commit to a zero-effort strategy; that is, $e = 0$ at all times and in all states. In this case, managers' control benefits no longer incentivize effort, so the disciplinary effect of managerial control benefits is absent.

We also examine firms' takeover-performance sensitivity and the underperformance duration. Takeover-performance sensitivity is measured by the correlation between a firm's TFP and its subsequent takeover exposure (i.e., the probability of being acquired). The underperformance duration is the average number of years a firm remains in the bottom performance quintile before it recovers by itself or exits through acquisitions.

In the baseline model, an active takeover market increases firm value by 8.25%. About 66% ($\frac{5.43}{8.25}$) of the value creation arises from the asset reallocation role, and the remaining 34% arises from the disciplinary role. Takeover-performance sensitivity is weak, with a correlation of -0.052, and firms, on average, remain underperforming for 2.68 years.⁸

Shutting down the bright-side effect of managerial control benefits reduces the total value created by the takeover market to 6.51%, which implies that the bright-side effect enhances the value of an active takeover market by 21.1% ($\frac{8.25-6.51}{8.25}$). This reduction is largely driven by a decrease in the disciplinary role played by the takeover market. Intuitively, when control benefits induce no more effort from managers, underperforming firms recover more slowly by themselves. This is consistent with the longer duration of underperformance (3.13 versus 2.68) we show in row (2) of Table 7. Meanwhile, the reallocation role of the takeover market becomes more important because some underperforming firms that would self-recover in the benchmark model now have to be rescued through takeovers. This leads to more value created through the

⁷Since firm market value capitalizes all expected gains from takeovers, this component can be measured as $\frac{OU_{aq}+OU_{tar}}{U}$, where OU_{aq} and OU_{tar} are defined in Eq. (C.4) and (C.5) in Online Appendix C.

⁸This number is slightly larger than that reported in Table 7 because we do not count firm closure as a channel to exit underperformance in this exercise.

actual asset reallocation (6.51% versus 5.43%) and a higher takeover-performance sensitivity (-0.083 versus -0.052). The enhanced reallocation role, however, does not fully compensate for the weakened disciplinary effect,⁹ and the overall value created by the takeover market decreases (6.51% versus 8.25%).

When we further eliminate the dark-side effect of managerial control benefits by setting $\pi = 0$, the total value of the takeover market rebounds from 6.51% to 8.10%. With $\pi = 0$, all value-enhancing deals take place, and no value-destroying mergers are pursued; hence, the takeover market achieves its full potential in reallocating assets efficiently across firms. Comparing the results in rows (2) and (3) in Table 7, when we have more efficient asset reallocation through the takeover market, firms exit underperformance more quickly through takeovers, and we observe an even stronger takeover-performance sensitivity (-0.095 versus -0.083).

The dark-side effect and the bright-side effect have similar magnitudes in the full sample (-1.59% and 1.74% of firm value, respectively). Once we aggregate the two effects, they largely offset each other, leaving a small overall impact on the takeover market. In this regard, we find no evidence suggesting that managerial control benefits weaken the overall efficiency of the takeover market.

Our findings also indicate that the takeover-performance sensitivity is not a good measure of the takeover market efficiency. This is because both the dark side and the bright side of managerial control benefits can lead to a weaker takeover-performance sensitivity, but they have opposite implications on the takeover market efficiency. In other words, by observing a weak takeover-performance sensitivity, we still cannot tell whether it is due to weak asset reallocation (i.e., an inefficient takeover market) or strong disciplining (i.e., an efficient takeover market).

Although managers' control benefits have only a modest overall impact in the full sample, we find significant variations across different subsamples. Panel B of Table 7 reports the dark-side, the bright-side, and the overall effects of managerial control benefits for subsamples that are partitioned based on firm performance and the board preference for managerial control benefits (κ). Unsurprisingly, holding firm performance fixed, the dark-side effect intensifies among boards

⁹This is because takeovers are usually more costly than self-recovery due to the integration costs and search and matching friction, which is why they are often considered as the court of last resort.

with high κ . These boards' takeover decisions are more influenced by the managers' control benefits. On the other hand, the bright-side effect of managerial control benefits declines with κ . Higher κ implies that the board internalizes the managers' control benefits to a greater extent, which better protects the managers against future takeover threats and lowers their effort incentive.

In the cross-section, the dark-side effect is most pronounced among the outperforming firms with entrenched managers, which have a higher ex ante likelihood of becoming acquirers, while the gain from the bright-side effect is most significant among underperforming firms with less protected managers who are strongly disciplined by the external takeover market. This differential trends lead to another interesting prediction from the model: managerial control benefits are a double-edged sword for shareholders, and their costs and benefits depend critically on the current state of the company. As a result, we do not have a "one size fits all" management style that can always deliver the best result. If a firm has good performance but weak historical governance practices, it is in the shareholders' best interest to curtail or eliminate managers' control benefits because it saves the firm from pursuing wasteful acquisitions. On the other hand, for a firm that underperforms and faces severe takeover threats, its shareholders can actually benefit from leveraging on their manager's preference of control. In such a case, the manager's control benefits can substitute for monetary incentives and serve as intrinsic stimuli for her to work harder. In Table 7, we estimate the net gain from managerial control benefits to be 3.01% among the subsample of firms with both low z and low κ . This effect is economically significant, which corresponds to a 40% increase in the value that a typical firm can derive from the takeover market.

6 Robustness checks and model discussion

Just as all economic models do, our model necessarily leaves out some important ingredients and makes simplifying assumptions. We analyze how managerial compensation, executive turnover, and other missing factors may affect our estimation results in this section.

6.1 Incentive payments and executive turnover

In the baseline model, the key friction we capture is the managers' control benefits. We analyze how this friction interacts with the specific external governance arising from the takeover market and shapes managers' effort incentives. One important consideration that we leave out in the baseline model is the internal governance that managers face. These governance practices, such as pay for performance, can also have important impacts on how much effort managers exert.

To allay concerns that our quantitative predictions are biased by the missing factor, we conduct three additional exercises. In all exercises, we explicitly include in the model an incentive payment to managers. Moreover, we assume that upon being separated, all incentive payments will be forfeited, and managers will receive zero wages in the years to come. Thus, our results should be considered an upper bound on how managerial incentive compensation could influence our quantitative results. In our first exercise, we capture the incentive payment using a general functional form, $\beta \cdot z_{i,t} + \lambda \cdot \ln B_{i,t}$. This functional form is also consistent with Gabaix and Landier (2008), who document a log-linear relation between an executive's total compensation and the size of the company. We calibrate the coefficient λ to be 0.36 by matching the model-implied size-total compensation relation to the data, and this point estimate is very similar to that documented in Gabaix and Landier (2008), where the coefficient is estimated to be roughly one-third. We identify β by matching the model-implied pay-performance sensitivity (PPS) with that calculated from the data.¹⁰ In this exercise, β is estimated together with the ten parameters reported in Table 4 in one big SMM system.

In the second exercise, we consider another important internal governance practice, managerial turnover. In this exercise, we retain managers' PPS and include managers' turnover hazard on top of it as a logit function of firm TFP and size. Every period, after the manager's effort is decided and output realized, there is a probability of $\frac{1}{1+\exp(-\text{const}-a \cdot z_{i,t}-b \cdot \ln B_{i,t})}$ that the manager gets fired.¹¹ Similar to Fee, Hadlock, and Pierce (2013), executive forced turnover in our

¹⁰In the data, the PPS is measured as the dollar increase in managers' total compensation if the industry-adjusted TFP of her company increases by one unit. Our results are robust to using alternative performance measures, such as return on assets (ROA) or operating income.

¹¹ $z_{i,t}$ denotes the firm's TFP, and $B_{i,t}$ denotes the book equity of the firm. We calibrate the logit coefficients

exercise can be viewed as initiated by the board, by the shareholders, or by hedge fund activists. If a shareholders' campaign or hedge fund activism eventually results in the incumbent manager forfeiting her control rights (or stepping down from the CEO position), it is captured by our turnover measure.

Last, we consider more flexible forms of incentive payments. Ideally, we want to analyze, in an optimal contracting setting, what contracts will be offered and how that interacts with managerial control benefits. However, embedding the current setup in an optimal contract framework seems infeasible given the model's complexity. Therefore, we take an alternative approach by considering four commonly used incentive contracts in the data: contingent fixed salary, performance bonus, stock grant, and option awards. Contingent fixed salary promises a fixed payment to the manager as long as the firm is not taken over or shut down. A performance bonus gives the manager a fixed share of the firm's operating profit while the firm is in operation; both the stock grant and option awards are offered annually as long as the firm operates. The option awards are issued at par, have a vesting period of four years, and can be exercised anytime within five years of vesting. These features are constructed to match the characteristics of executive compensation we observe in reality. The share of each incentive payment is calibrated to the data.¹² We then take these calibrated values as given and reestimate the remaining ten parameters.

Table 8 contains the results for our model reestimates. Based on the estimated parameters, we recalculate the dark-side and bright-side effects following the algorithm described in Table 7. We find that the dark-side effect remains similar to that in the baseline case because the estimated managerial control benefits and dispersion of board preference for managerial control stay similar across multiple settings. They are what drive inefficient takeovers, which, in turn, shape the dark-side effect.

On the other hand, we find some degree of substitution between firms' internal governance (e.g., PPS, forced turnover, and compensation) and the external governance that arises from the takeover market. In all cases, the estimated cost of effort becomes significantly greater than the

to the data, with $\{const, a, b\} = \{-2.93, -0.13, -0.09\}$.

¹²In the data, the median manager receives 0.107% of firm assets as annual fixed salary; she shares 0.07% of firm profit and receives 0.07% and 0.02% of total shares outstanding as option and stock awards, respectively.

baseline estimate, suggesting that it is harder to further incentivize managers once we take into account the incentives already embedded in their pay-for-performance contracts. The increased effort cost leads to lower estimated values of the bright-side effect.¹³ In all cases, the bright-side and dark-side effects of managerial control benefits remain comparable in magnitude.

6.2 Golden parachutes and side payments

In this section, we discuss the effect of golden parachute agreements in managers' compensation contracts. In takeover negotiations, golden parachutes compensate the target managers for their loss of control rights, thereby reducing their resistance to takeovers. Meanwhile, golden parachutes also make the managers less concerned about future takeover risk, which lowers their incentives to exert effort. In an extreme case, if the value of a golden parachute contract is equal to the present value of the manager's control benefits, she faces no disutility from the firm being taken over. At the same time, the takeover market poses no threat on her, suggesting that there is no longer a valuable disciplinary effect from the takeover market.

We consider a scenario in which the manager's compensation package includes a golden parachute agreement that equals 30% of her private control benefits (30% of M). The choice of this value is motivated by Murphy (2013) and Rau and Xu (2013), who find that 70% of large US public firms offer golden parachutes to their top executives, which covers up to 300% of their annualized income loss in a change-of-control event.¹⁴ We reestimate the model and report the results in Panel E of Table 8. Our result suggests that a few key parameters have sizable changes in this exercise, but the bright-side effect remains similar to that in the baseline case. To better understand this result, we start by fixing the model parameters to the baseline case. In this case, introducing a golden parachute is equivalent to having managers who are 30% less concerned about losing their control benefits. This results in a lower level of effort

¹³In all cases, the change in the bright-side effect is smaller than that of the estimated effort cost. This is because the managers' disutility is quadratic in the amount of effort, while the bright-side effect, measured in terms of firm value, is approximately linear in managers' effort levels. Therefore, an increase in the effort cost translates into a less than proportional change in the bright-side effect.

¹⁴Murphy (2013) also documents a sharp increase in the prevalence of golden parachute agreements. In our calculation, we take the upper bounds in both the time trend and the face value of the payment. Applying an annualized discount rate of 10%, the expected value of the golden parachute agreement is equal to 30% of the managers' M .

provision, and hence firms also recover more slowly from bad performance. Next, we allow the model parameters to adjust in the reestimation. To enable the model to match the speed of recovery in the data again requires a higher $\ln(\pi)$ and $\vartheta_{\ln(\kappa)}$ (i.e., the manager enjoys more control benefits from each unit of assets under control and the board could have a stronger preference for managers), which offsets the effects of the golden parachute agreement, thereby generating similar bright-side effects on the economy level.

Besides payments from golden parachutes, target managers may also receive side payments from acquirers during takeover negotiations in various forms (e.g., Hartzell, Ofek, and Yermack, 2004; Fich, Cai, and Tran, 2011). The effect of side payments depends critically on whether they are anticipated by the target managers beforehand. If the likelihood of receiving a side payment is fully anticipated, the side payment will have a similar effect as a golden parachute analyzed above. However, if side payments are not anticipated by the manager before a takeover bid is made, then she will exert the same amount of effort as in our baseline case based on the belief that all control benefits will be lost once a takeover happens. In this case, the bright-side effect of the manager’s control benefits remains in place. On the other hand, when a profitable takeover deal is proposed, the manager will be offered an unexpected side payment, which compensates for the loss of control rights and makes her less resistant to the takeover. This effect reduces the dark-side effect of managerial control benefits and improves asset reallocation in the takeover market.

6.3 Other Potential Issues and Robustness

In our baseline model, we assume that firms participating in the takeover market engage in undirected search and random matching. An alternative approach is to allow firms to engage in directed search in which they can form assortative matching. When search and matching costs are absent or small, we expect this alternative specification to have limited effects on our model’s implications. Intuitively, as we switch from an undirected search model to a directed search model, the matching quality improves. Therefore, a larger fraction of the matched pairs will merge together, leading to a higher model-implied rate of M&As if all other parameters are

held constant. For the model to fit the data again, the matching rate has to decrease, and thus fewer matched pairs will be formed in each period, which offsets the higher deal completion rate.

With nontrivial search and matching costs, we expect a model with directed search to generate more efficient matching between acquirers and targets, leading to a higher rate of completed mergers and more value created if other parameters are held constant. To make the model fit the data again, other parameters have to change, which can potentially alter the model's quantitative implications. We leave this extension to future research.

Our model rests on the important assumption that all managers enjoy the same level of control benefit, but this control benefit is accommodated to different degrees in different firms because some boards are more entrenched than others (they have higher κ). An alternative modeling choice is to fix κ and assume that the control benefits, π , are heterogeneous across managers. The two approaches generate identical predictions regarding the dark-side effect, which is determined by the product of κ and π in any deal negotiation. On the other hand, while firms with higher π see enhanced disciplinary effect from the takeover market, having higher κ in the cross-section dampens this effect—these entrenched managers are less likely to be incentivized and rescue their firms from underperformance because they are protected by the board against potential takeover threats. Therefore, the model predicts smaller gain from managerial control benefits among this subsample of firms; these firms also experience slower speed of recovery and longer underperformance duration. In an untabulated exercise, we also analyze a counterfactual situation when we set $\kappa = 0$. Intuitively, once we shut down κ , agency costs disappear and boards have perfectly aligned interests with shareholders, which eliminates the dark-side effect of managerial control benefits. In the meantime, it strengthens the bright-side effect by roughly one-fifth.

Because our model features an industry equilibrium, we therefore remove heterogeneity across industries by taking out the industry fixed effects from firm TFP before estimation. In the data, a substantial fraction of M&As are nonhorizontal and involve acquirers and targets from different industries. One potential question is whether the industry-level performance can be transferred from the acquirer to the target in these diversifying deals. The concern is that if industry-

level performance can be transferred, then removing the industry fixed effects and modeling an industry equilibrium may underestimate the benefits of performance transfer in M&As.

To address this concern, we decompose firm TFP into the industry-level TFP and the firm-specific TFP. We replace the parameter of transferability γ in the baseline model with two parameters γ_{ind} and γ_{fm} , which capture the performance transferability at the industry and firm level, respectively. Accordingly, we also replace the moment of the acquirer-target TFP differential in the baseline estimation with two moments that capture the acquirer-target TFP differential at the industry and firm level. We reestimate the model without taking out the industry fixed effects and find that γ_{ind} is very close to zero and γ_{fm} is similar to γ in our baseline estimation (untabulated). This exercise suggests that only the firm-specific performance, which is likely tied to the acquirer's own comparative advantage relative to its industry peers, can be partially transferred to the target in M&As.

7 Conclusions

To determine how managerial control benefits influence the outcomes in the takeover market, we build and estimate an industry equilibrium model in which mergers can happen either to enhance firm performance or to create control benefits for managers. The model endogenizes firms' takeover decisions and their roles as targets or acquirers in these deals. The model incorporates both the bright-side and dark-side effects of managerial control benefits, providing a more comprehensive picture of how managers' control benefits influence the functioning of the takeover market.

Our results suggest that managers' control benefits can influence the value of the takeover market through two important channels. On the equilibrium path, managers' control benefits distort firms' takeover decisions, causing 17% of value-destroying mergers to be pursued and 12% of potential value-enhancing mergers to be blocked. Off the equilibrium path, the fear of being taken over induces managers to exert more effort, and this disciplinary effect is amplified by managerial control benefits. The two effects exhibit a significant cross-sectional variation. For outperforming firms with more entrenched managers, the dark-side effect dominates, implying

that shareholders from those firms should seek ways to alleviate this incentive conflict and mitigate inefficiencies in the takeover market. On the other hand, for underperforming firms with less protected managers, the bright-side effect prevails, suggesting that these firms should fully exploit the takeover threat as a cost-efficient way to incentivize their managers. Determining whether firms in reality choose the optimal mix of internal versus external governance practices given their current economic standing and managerial characteristics could be an interesting topic for future research.

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Fig. 1. Timeline of the model

This figure illustrates the timeline of the model. At the beginning of period t , firm i 's profitability is realized and observed by agents. Shareholders first decide whether to close down the firm. If the firm is closed down, shareholders get their liquidation value and the manager loses her position. If shareholders keep the firm running this period, the manager then chooses her effort level. The firm can meet a potential merger partner on the takeover market. The boards of the two matched firms decide whether to pursue the deal and if so, what role each firm plays in the merger. If the deal is consummated, target shareholders obtain a terminal payoff and the target firm exits the economy. If the deal fails, both firms remain stand-alone.

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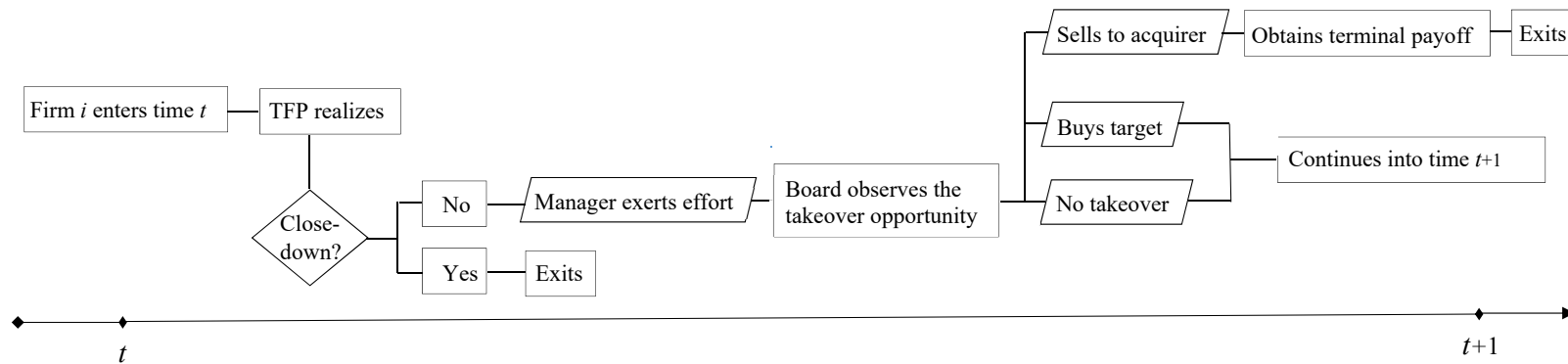


Fig. 2. Productivity, control benefits, and model solutions

This figure illustrates how firm TFP, z , and the board preference for managerial control benefits, κ , affect the model solution. Each panel is a three-dimensional heat map, with the x-axis measuring the board's preference (in unit of standard deviation from the mean), the y-axis measuring firm TFP (in unit of standard deviation from the mean), and the color indicating the magnitude of the variable of interest. Panels A and B show the firms' probability of being a target (P_{tar}) and an acquirer (P_{acq}), respectively. Panel C illustrates the probability of firm closure, and Panel D demonstrates the manager's effort provision.

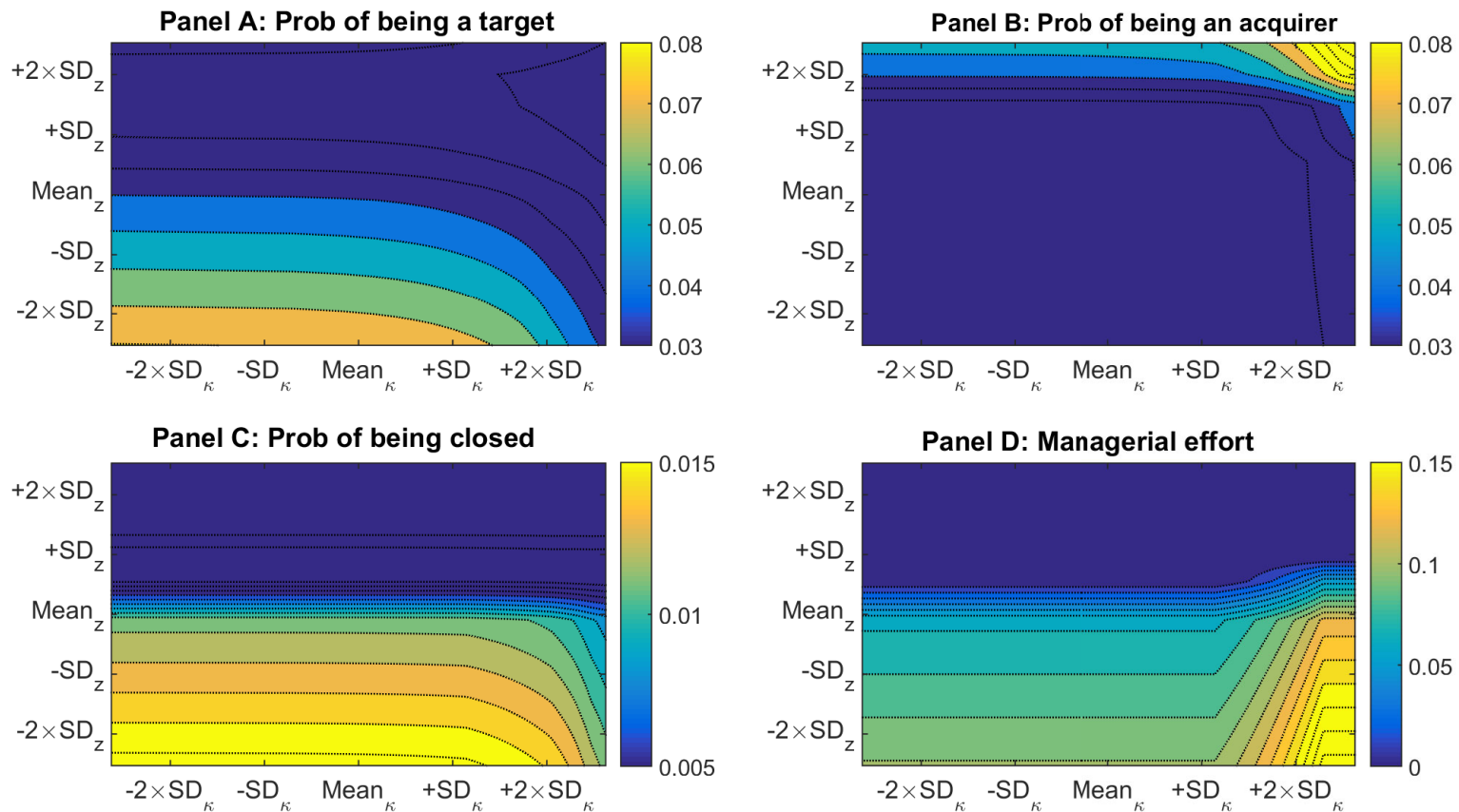


Fig. 3. Managerial control benefits versus additional synergy

This figure illustrates how the two parameters, $\vartheta_{\ln(\kappa)}$ and σ_s , are identified separately in the model. $\vartheta_{\ln(\kappa)}$ controls the dispersion of board preference for managerial control benefits across firms, and σ_s captures the dispersion of additional gains and losses from mergers beyond the performance transfer. The two identifying moments are the probability of low-TFP firms buying high-TFP firms (reported in Panel A), and the probability of value-destroying mergers (reported in Panel B). On the x-axis, $\vartheta_{\ln(\kappa)}$ and σ_s are normalized by the estimated values reported in Table 4; on the y-axis, the identifying moments are scaled by the corresponding simulated values reported in Panel A, Table 3.

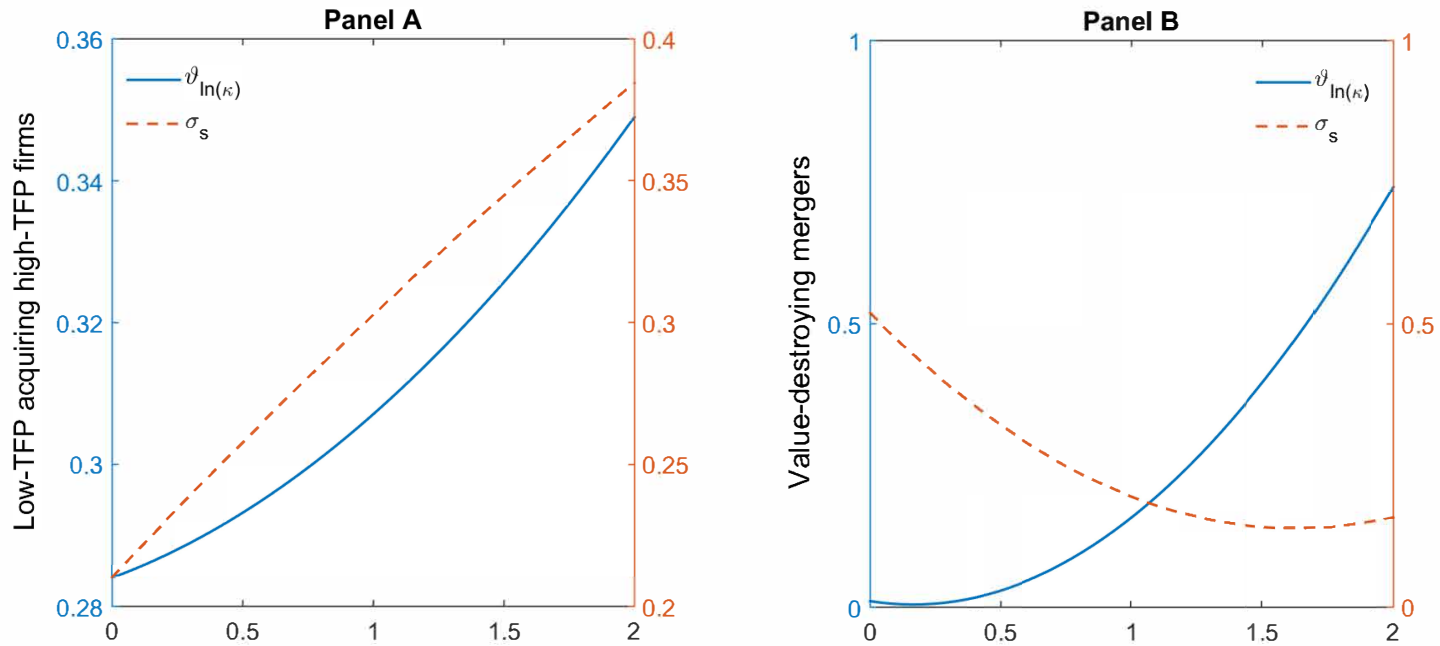


Table 1

Variable definitions

This table provides the variable definitions. Variables are either obtained directly from the CRSP-Compustat Merged Database or created using the definitions presented in the table. $PSLV$ takes the value of $pstkl$, $pstkrv$, or $pstk$ in sequence if the corresponding variable is not missing, and $PSLV$ is set to zero if all three variables are missing. ME is defined as $prcc.c * cshpri$; BE is defined as $seq + txditc - PSLV$, and we set BE as missing if it is negative. CAR is the cumulative abnormal return computed using the market model; $TranVal$ is the transaction value the acquirer proposes to pay to the target shareholders; $CashVal$ is the total value of cash in the bid; and $ME_{Tar,-22}$ is the target firm’s market equity value measured 22 trading days before the date of bid announcement. Payment method may reveal acquirer misvaluation and lead the market to reprice the acquirer’s stand-alone value (i.e., the revelation effect). This revelation effect confounds the acquirer announcement return as a proper measure of merger gains. We follow Golubov, Petmezas, and Travlos (2015) and make adjustments to the acquirer’s announcement-period abnormal return to remove the revelation effect related to the method of payment. The combined firm announcement return is computed from the acquirer announcement return and hence is adjusted accordingly.

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| Notation | Variable | Definition |
|-------------|--|---|
| z | firm total factor of productivity | firm TFP adjusted for industry heterogeneity |
| $Size$ | logarithm of market equity | $\ln(ME)$ |
| $MktLv$ | market leverage | $\frac{dltt+dlc}{dltt+dlc+ME+PSLV-txditc}$ |
| MB | market-to-book equity ratio | $\frac{ME}{BE}$ |
| $Cash$ | cash holdings | $\frac{che}{at}$ |
| $TarRltSz$ | target book equity to acquirer book equity | $\frac{BE_{Tar}}{BE_{Acq}}$ |
| $OfferPrem$ | offer premium | $\frac{TranVal}{ME_{Acq,-22}} - 1$ |
| $CashFrac$ | fraction of cash payment in the deal | $\frac{CashVal}{TranVal}$ |
| $AcqRet$ | acquirer abnormal return | acquirer 3-day CAR plus 22-day run-up, adjusted |
| $TarRet$ | target abnormal return | target 3-day CAR plus 22-day run-up, adjusted |
| $CombRet$ | the combined firm abnormal return | the combined firm 3-day CAR plus 22-day run-up |

Table 2

Summary statistics

This table shows the summary statistics. Panel A presents firm characteristics for the full sample (*all*), acquirers (*acq*), and targets (*tar*). Panel B presents deal characteristics in our sample. Variables are defined as in Table 1.

| Panel A: Firm characteristics | | | | | | | |
|-------------------------------|------|--------|-------|-------|------|------|-------|
| Variable | Mean | Stdev. | p5 | p25 | p50 | p75 | p95 |
| <i>Size_{all}</i> | 4.96 | 2.27 | 1.36 | 3.34 | 4.86 | 6.49 | 8.98 |
| <i>MktLv_{all}</i> | 0.28 | 0.26 | 0.00 | 0.03 | 0.21 | 0.46 | 0.80 |
| <i>MB_{all}</i> | 3.31 | 5.99 | 0.44 | 0.98 | 1.64 | 3.05 | 10.72 |
| <i>Cash_{all}</i> | 0.17 | 0.21 | 0.00 | 0.02 | 0.08 | 0.23 | 0.67 |
| <i>z_{all}</i> | 1.15 | 1.78 | 0.02 | 0.20 | 0.59 | 1.25 | 4.46 |
| <i>Size_{acq}</i> | 7.43 | 2.03 | 3.88 | 6.06 | 7.44 | 8.94 | 10.66 |
| <i>MktLv_{acq}</i> | 0.15 | 0.17 | 0.00 | 0.01 | 0.10 | 0.23 | 0.51 |
| <i>MB_{acq}</i> | 4.24 | 5.39 | 0.90 | 1.67 | 2.82 | 4.76 | 11.15 |
| <i>Cash_{acq}</i> | 0.19 | 0.21 | 0.01 | 0.04 | 0.12 | 0.29 | 0.66 |
| <i>z_{acq}</i> | 2.43 | 2.53 | 0.05 | 0.73 | 1.46 | 3.25 | 9.15 |
| <i>Size_{tar}</i> | 5.14 | 1.86 | 2.28 | 3.79 | 5.04 | 6.42 | 8.38 |
| <i>MktLv_{tar}</i> | 0.18 | 0.22 | 0.00 | 0.00 | 0.09 | 0.30 | 0.65 |
| <i>MB_{tar}</i> | 3.57 | 5.56 | 0.60 | 1.29 | 2.13 | 3.50 | 10.26 |
| <i>Cash_{tar}</i> | 0.24 | 0.25 | 0.00 | 0.03 | 0.15 | 0.41 | 0.75 |
| <i>z_{tar}</i> | 1.44 | 2.03 | 0.02 | 0.21 | 0.74 | 1.65 | 5.94 |
| Panel B: Deal characteristics | | | | | | | |
| Variable | Mean | Stdev. | p5 | p25 | p50 | p75 | p95 |
| <i>TarRltSz</i> | 0.39 | 0.70 | 0.00 | 0.04 | 0.17 | 0.44 | 1.47 |
| <i>OfferPrem</i> | 0.49 | 0.35 | 0.09 | 0.25 | 0.40 | 0.62 | 1.19 |
| <i>CashFrac</i> | 0.38 | 0.42 | 0.00 | 0.00 | 0.18 | 1.00 | 1.00 |
| <i>AcqRet</i> | 0.00 | 0.16 | -0.26 | -0.07 | 0.01 | 0.08 | 0.26 |
| <i>TarRet</i> | 0.30 | 0.29 | -0.11 | 0.13 | 0.27 | 0.43 | 0.87 |
| <i>CombRet</i> | 0.04 | 0.14 | -0.21 | -0.03 | 0.04 | 0.11 | 0.28 |

Table 3

Model fit

Panel A shows how the model matches the 12 targeted moments (i.e., moments used in SMM): the probability of M&A is defined as the total number of M&As divided by the total number of firms in the economy; the target’s fraction of merger gains is the target’s dollar value gain/loss minus the acquirer’s dollar value gain/loss scaled by the combined firm’s premerger market value; the probability of value-destroying merger is the fraction of M&As that have negative combined firm announcement returns after adjusting for the measurement errors (see Online Appendix D); average combined firm return is the mean of the combined firm’s abnormal announcement returns; the probability of low-TFP firms acquiring high-TFP firms is the fraction of M&As in which the acquirer’s TFP is lower than the target’s TFP; acquirer-target TFP differential is the average difference between the acquirer’s TFP and the target’s TFP; performance transferability is measured by the regression coefficient Υ obtained from regression Eq. (16); target’s relative size is the target’s book equity divided by the acquirer’s book equity; probability of bankruptcy is the fraction of firms that go bankrupt; and the persistence of good and bad performance, as well as the variance of innovation to firm TFP, are obtained as coefficient ρ_{z+} , ρ_{z-} , and φ_z^2 , from the regression Eq. (17).

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| Panel A: Targeted moments | | | | |
|---|--|-----------------|----------------|-----------------|
| Moment | Definition | Data | | Model |
| | | Empirical value | Standard error | Simulated value |
| Probability of M&A | $Prob(M\&A)$ | 0.043 | 0.002 | 0.041 |
| Target’s fraction of merger gains | $E \left[\frac{MergerGain_{tar} - MergerGain_{acq}}{MV_{acq} + MV_{tar}} \right]$ | 0.031 | 0.004 | 0.037 |
| Probability of value-destroying mergers | $Prob(CombRet < 0)$ | 0.159 | 0.014 | 0.163 |
| Average combined firm return | $E[CombRet]$ | 0.040 | 0.005 | 0.046 |
| Prob. of low-TFP acquiring high-TFP | $Prob(z_{acq} < z_{tar})$ | 0.298 | 0.018 | 0.276 |
| Acquirer-target TFP differential | $E[z_{acq} - z_{tar}]$ | 0.971 | 0.113 | 1.047 |
| Performance transferability | Υ | 0.431 | 0.161 | 0.237 |
| Target’s relative size | $TarRltSz$ | 0.390 | 0.030 | 0.385 |
| Probability of bankruptcy | $Prob(bankruptcy)$ | 0.006 | 0.001 | 0.007 |
| Persistence of good performance | ρ_{z+} | 0.901 | 0.012 | 0.890 |
| Persistence of bad performance | ρ_{z-} | 0.670 | 0.007 | 0.661 |
| Variance of innovation to firm log-TFP | φ_z^2 | 0.635 | 0.031 | 0.630 |

Panel B shows how the model fits the nine untargeted moments (i.e., moments not used in SMM): distribution of underperformance duration describes how long firms remain underperforming (i.e., stay in the bottom performance quintile) before they exit; channel of exiting underperformance describes the fraction of underperforming firms that exit the bottom performance quintile through different channels, including self-recovery, being acquired, or going bankrupt; and average underperformance duration, breakdown by exit channels, summarizes the average years that firms stay underperforming, conditional on their channels of exit.

| Panel B: Untargeted moments | | |
|---|-----------------|-----------------|
| Moment | Data | Model |
| | Empirical value | Simulated value |
| Distribution of underperformance duration | | |
| Less than 3 years | 0.629 | 0.640 |
| 3 to 5 years | 0.257 | 0.265 |
| More than 5 years | 0.114 | 0.095 |
| Channel of exiting underperformance | | |
| Self-recovery | 0.745 | 0.786 |
| Acquired | 0.186 | 0.161 |
| Bankruptcy | 0.068 | 0.053 |
| Average underperformance duration, breakdown by exit channels | | |
| Self-recovery | 2.49 years | 2.62 years |
| Acquired | 3.00 years | 2.95 years |
| Bankruptcy | 2.71 years | 2.79 years |

Table 4

Parameter estimates

This table reports the parameter estimates. Panel A contains the parameters calibrated separately. Panel B presents the parameter estimates obtained from the SMM, together with the estimation standard errors. In Panel A, r is the discount rate, θ is the bargaining power of the acquirer, α is the concavity of production function, $\ln(\bar{z})$ is the long-run mean of log-TFP without managerial effort, $\mu_{\ln(z)}$ and $\vartheta_{\ln(z)}$ are the mean and dispersion of entrants' log-TFP, $\mu_{\ln(B)}$ and $\vartheta_{\ln(B)}$ are the mean and dispersion of entrants' log book equity, and ω is the variable cost of production. In Panel B, π is the managers' control benefits derived from each unit of firm asset, $\vartheta_{\ln(\kappa)}$ is the dispersion of the entrant boards' preference for managerial control benefits (in logarithm), μ_s and σ_s are the mean and standard deviation of the additional synergies beyond performance transfer, γ is the performance transferability, χ is the coefficient of integration costs, δ is the liquidation value of firm book assets, ρ_z is the persistence of log-TFP without managerial effort, c is the coefficient associated with the manager's cost of effort, and σ_z is the standard deviation of innovation to log-TFP.

| Panel A: Calibrated parameters | | | | | | | | | | |
|--------------------------------|-------|---------------------------|----------|----------------|----------------|----------------------|----------------|----------------------|----------|------------|
| | r | θ | α | $\ln(\bar{z})$ | $\mu_{\ln(z)}$ | $\vartheta_{\ln(z)}$ | $\mu_{\ln(B)}$ | $\vartheta_{\ln(B)}$ | ω | |
| Calibrate | 0.100 | 0.500 | 0.788 | -0.799 | -0.711 | 1.640 | 3.07 | 4.01 | 0.23 | |
| Panel B: Estimated parameters | | | | | | | | | | |
| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z |
| Estimate | 0.053 | 1.904 | 0.621 | 1.937 | 0.237 | 1.264 | 0.712 | 0.854 | 1.209 | 0.792 |
| Standard errors | 0.018 | 0.211 | 0.132 | 0.093 | 0.051 | 0.136 | 0.069 | 0.008 | 0.467 | 0.021 |

Table 5

Decomposition of firm value

This table reports the decomposition of firm market value into the stand-alone value (U_{sa}), the option value to be a target (OU_{tar}), the option value to be an acquirer (OU_{acq}), and the option value to close down (OU_{cls}) for different samples. The full sample contains all firms simulated from the steady-state equilibrium; top (bottom) performer sample contains firms whose TFP falls into the top (bottom) quintile; and top (bottom) board preference sample contains firms whose boards care about the manager's control benefits the most (the least) with κ falling into the top (bottom) quintile. All values are scaled by the firm value (i.e., scaled by U).

| | $\frac{U_{sa}}{U}$ | $\frac{OU_{tar}}{U}$ | $\frac{OU_{acq}}{U}$ | $\frac{OU_{cls}}{U}$ |
|-------------------------|--------------------|----------------------|----------------------|----------------------|
| Full sample | 91.55 | 5.21 | 0.22 | 3.02 |
| Top performers | 95.64 | 3.03 | 0.18 | 1.15 |
| Bottom performers | 87.46 | 7.38 | 0.27 | 4.89 |
| Top board preference | 91.81 | 5.49 | -0.34 | 3.03 |
| Bottom board preference | 91.28 | 4.92 | 0.79 | 3.01 |

Table 6

The efficiency of M&A outcomes

This table reports the efficiency analysis of M&A outcomes. We simulate the matched firm pairs and classify the outcome of M&As into four categories: the efficient deal outcomes include value-enhancing deals completed and value-destroying deals blocked; the inefficient deal outcomes include value-enhancing deals blocked and value-destroying deals completed. Value to the board is the total value created/destroyed to the acquirer and target board if the M&A deal completes, captured by Σ_b in Eq. (12) and scaled by the combined firm's pre-acquisition value $U_{Acq} + U_{Tar}$; value to the shareholders is the total value created/destroyed to the acquirer and target joint shareholders if the M&A deal completes, captured by Σ_s in Eq. (13) and scaled by the combined firm's pre-acquisition value; and value to the managers is the total value created/destroyed to the acquirer and target managers if the M&A deal completes, captured by Σ_m in Eq. (14) and scaled by the combined firm's pre-acquisition value.

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| | Efficient M&A outcomes | | Inefficient M&A outcomes | |
|-----------------------------------|---------------------------------|--------------------------------|-------------------------------|----------------------------------|
| | Value-enhancing deals completed | Value-destroying deals blocked | Value-enhancing deals blocked | Value-destroying deals completed |
| As % of all matched pairs | 6.90 | 90.72 | 0.99 | 1.39 |
| As % of all completed deals | 83.23 | — | — | 16.77 |
| As % of all value-enhancing deals | 87.45 | — | 12.55 | — |
| Value to the board (%) | 6.58 | -18.18 | -1.88 | 2.09 |
| Value to the shareholders (%) | 5.95 | -18.03 | 1.61 | -2.32 |
| Value to the managers (%) | 0.63 | -0.15 | -3.49 | 4.41 |

Table 7

The effects of managerial control benefits

This table reports the dark-side and the bright-side effects of managerial control benefits estimated based on the full sample (Panel A) and different subsamples (Panel B). In Panel A, row (1) reports the outcome under the baseline model; row (2) provides the results of a counterfactual scenario in which we assume managers' control benefits do not induce them to exert effort when facing takeover threats (i.e., $e = 0$), shutting down the bright-side effect of managerial control benefits; and row (3) corresponds to a counterfactual scenario in which all managers' control benefits are set to zero (i.e., $\pi = 0$), shutting down both the dark-side and the bright-side effects of managerial control benefits simultaneously. We examine value of reallocation by the takeover market (i.e., value created by realized takeovers in the equilibrium), value of disciplining by takeover market (i.e., value of increased managerial effort due to the off-equilibrium takeover threats), takeover-performance sensitivity (i.e., the correlation between firms' TFP and their takeover exposure), firms' underperformance duration (i.e., the average years that firms remain underperforming), and total value of the takeover market (i.e., the total value created by reallocation and disciplining). In Panel B, we report the bright-side, the dark-side, and the overall effects of managerial control benefits in different subsamples, split based on firm performance (z) and board preference (κ). High κ means the board puts a large weight on their managers' control benefits when making M&A decisions.

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| Panel A: Full sample | | | | | |
|-----------------------------------|--|---|---|--|-----------------------------------|
| | Value of reallocation by takeover market | Value of disciplining by takeover market | Takeover-performance sensitivity | Underperformance duration (yrs) | Total value of takeover market |
| (1) Baseline (dark+bright) | 5.43% | 2.82% | -0.052 | 2.68 | 8.25% |
| (2) $e = 0$ (dark only) | 6.51% | 0.00% | -0.083 | 3.13 | 6.51% |
| (3) $\pi = 0$ (no effect) | 8.14% | 0.00% | -0.095 | 2.94 | 8.10% |
| The bright-side effect, (1) - (2) | | | | | 1.74% |
| The dark-side effect, (2) - (3) | | | | | -1.59% |
| Panel B: Subsamples | | | | | |
| | High performance (z) High board preference (κ) | High performance (z) Low board preference (κ) | Low performance (z) High board preference (κ) | Low performance (z) Low board preference (κ) | |
| The dark-side effect | -4.05% | -0.21% | -1.48% | -0.28% | |
| The bright-side effect | 0.07% | 0.71% | 2.19% | 3.29% | |
| The overall effect | -3.98% | 0.50% | 0.71% | 3.01% | |

Table 8

Parameter estimates under alternative models

This table reports the parameter estimates under five alternative models. Panel A summarizes the results we have under the baseline model, Panel B reports the results with pay for performance, Panel C presents the results when we calibrate executives' turnover hazard to the data, Panel D corresponds to the case when we calibrate executives' compensation structure to the data, and Panel E examines the case when managers have golden parachute clauses in their contracts. π is the manager's control benefits derived from each unit of firm asset, $\vartheta_{\ln(\kappa)}$ is the dispersion of entrant boards' preference for managerial control benefits (in logarithm), μ_s and σ_s are the mean and standard deviation of the additional synergies beyond performance transfer, γ is the performance transferability, χ is the coefficient of integration costs, δ is the liquidation value of firm book assets, ρ_z is the persistence of log-TFP without managerial effort, c is the coefficient associated with the manager's cost of effort, σ_z is the standard deviation of innovation to log-TFP, and β stands for managers' pay-performance sensitivity (PPS).

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| Panel A: Baseline model | | | | | | | | | | | | | |
|---|-------|---------------------------|---------|------------|----------|--------|----------|----------|-------|------------|---------|----------------------|------------------------|
| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z | | The dark-side effect | The bright-side effect |
| Estimate | 0.053 | 1.904 | 0.621 | 1.937 | 0.237 | 1.264 | 0.712 | 0.854 | 1.209 | 0.792 | | | |
| Standard errors | 0.018 | 0.181 | 0.155 | 0.241 | 0.094 | 0.122 | 0.968 | 0.008 | 0.143 | 0.015 | | -1.59% | 1.74% |
| Panel B: Parameter estimates with pay for performance | | | | | | | | | | | | | |
| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z | β | The dark-side effect | The bright-side effect |
| Estimate | 0.046 | 1.865 | 0.851 | 2.149 | 0.201 | 1.302 | 0.882 | 0.867 | 2.234 | 0.795 | 0.056 | | |
| Standard errors | 0.027 | 0.163 | 0.057 | 0.209 | 0.038 | 0.157 | 0.252 | 0.016 | 0.262 | 0.058 | 0.006 | -1.80% | 1.18% |

Panel C: Parameter estimates with turnover for performance

| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z | β | The dark-side effect | The bright-side effect |
|-----------------|-------|---------------------------|---------|------------|----------|--------|----------|----------|-------|------------|---------|----------------------|------------------------|
| Estimate | 0.054 | 2.097 | 0.823 | 1.900 | 0.197 | 1.280 | 0.714 | 0.854 | 2.423 | 0.799 | 0.054 | | |
| Standard errors | 0.019 | 0.208 | 0.047 | 0.173 | 0.019 | 0.252 | 0.075 | 0.009 | 0.350 | 0.018 | 0.006 | -1.44% | 1.09% |

Panel D: Parameter estimates with observed executive compensation

| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z | The dark-side effect | The bright-side effect |
|-----------------|-------|---------------------------|---------|------------|----------|--------|----------|----------|-------|------------|----------------------|------------------------|
| Estimate | 0.053 | 1.714 | 0.625 | 1.942 | 0.196 | 1.269 | 0.742 | 0.854 | 2.423 | 0.802 | | |
| Standard errors | 0.005 | 0.085 | 0.175 | 0.124 | 0.032 | 0.262 | 0.169 | 0.009 | 0.213 | 0.017 | -1.51% | 1.12% |

Panel E: Parameter estimates with golden parachute

| | π | $\vartheta_{\ln(\kappa)}$ | μ_s | σ_s | γ | χ | δ | ρ_z | c | σ_z | The dark-side effect | The bright-side effect |
|-----------------|-------|---------------------------|---------|------------|----------|--------|----------|----------|-------|------------|----------------------|------------------------|
| Estimate | 0.095 | 2.564 | 0.452 | 1.906 | 0.196 | 1.243 | 0.417 | 0.844 | 0.735 | 0.791 | | |
| Standard errors | 0.040 | 0.139 | 0.167 | 0.197 | 0.020 | 0.086 | 0.089 | 0.015 | 0.209 | 0.038 | -1.93% | 1.97% |