Online Appendix

A Merger Gains to Shareholders

Merger gains to the acquirer and the target shareholders in Equation (9) can be solved using the offer price derived in Equation (8). Specifically, acquirer shareholders get the combined firm value and pay the offer price, so their merger gain, $\Delta_{s}^{acq}$, is equal to

$$\Delta_{s}^{acq} = U(z_{c}, \pi_{A}, B_{A} + B_{T}) + sB_{T} - \chi \left( \frac{B_{T}}{B_{A}} \right)^{2} (B_{A} + B_{T}) - P(z_{A}, \pi_{A}, B_{A}; z_{T}, \pi_{T}, B_{T}; s),$$

where $U(z_{c}, \pi_{A}, B_{A} + B_{T})$ and $sB_{T} - \chi \left( \frac{B_{T}}{B_{A}} \right)^{2} (B_{A} + B_{T})$ capture the combined firm value (taking into account the additional synergies and integration costs generated in the merger), and $P(z_{A}, \pi_{A}, B_{A}; z_{T}, \pi_{T}, B_{T}; s)$ is the offer price they pay the target.

Target shareholders get the offer price and tender their firm to the acquirer. Their merger gain, $\Delta_{s}^{tar}$, is equal to

$$\Delta_{s}^{tar} = P(z_{A}, \pi_{A}, B_{A}; z_{T}, \pi_{T}, B_{T}; s) - E \left[ U(z_{T}', \pi_{T}, B_{T}) \right].$$

B Rescale the Firm’s Problem

In the original problem, managers’ periodical control benefit is $\pi$. The level of entrenchment is denoted by $\kappa$, where $ln(\kappa) \sim N(\mu_{ln(\kappa)}, \sigma_{ln(\kappa)})$. Let $ln(\kappa^{*}) \equiv ln(\kappa) - \mu_{ln(\kappa)}$, so $ln(\kappa^{*}) \sim N(0, \sigma_{ln(\kappa)})$. Taking the exponential of both sides, we get $\kappa^{*} = e^{-\mu_{ln(\kappa)}} \cdot \kappa \equiv (\bar{\kappa})^{-1} \cdot \kappa$.

Recall that our original problem, without the normalization, is defined by

$$M(z, \kappa, B) = \max_{e} \pi \cdot B - \frac{c}{2}e^{2} \cdot B + \frac{1}{1 + r} \cdot \left( E \left[ l_{sa} \cdot l_{cont} \cdot M(z', \kappa, B) \right] + E \left[ l_{acq} \cdot l_{cont} \cdot M(z_{c}', \kappa, B_{c}) \right] \right),$$

(B.1)
\begin{align*}
U(z, \kappa, B) &= \max_{i \in \{\text{cont, cls}\}} \left\{ z \cdot B^\alpha - \omega B + \frac{1}{1+r} \cdot E \left[ U \left( z', \kappa, B \right) \right] \\
&\quad + \frac{1}{1+r} \cdot \left( E \left[ 1_{\text{acq}} \cdot \Delta^\text{acq} \right] + E \left[ 1_{\text{tar}} \cdot \Delta^\text{tar} \right] \right), \delta \cdot B \right\}, \\
V(z, \kappa, B) &= U(z, \kappa, B) + \kappa M(z, \kappa, B),
\end{align*}

\begin{align*}
\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{align*}

\begin{align*}
\ell_{i,j} = \arg\max_{\{\text{acq, tar, sa}\}} \{ \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 \},
\end{align*}

\begin{align*}
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.
\end{align*}

Now, let's define a new problem as the following:

\begin{align*}
M^*(z, \kappa^*, B) \equiv \bar{\kappa} M(z, \kappa, B) &= \max_e \bar{\kappa} \pi \cdot B - \frac{\bar{\kappa}_c}{2} \cdot e^2 \cdot B + \frac{1}{1+r} \cdot E \left[ 1_{\text{sa}} \cdot 1_{\text{cont}} \cdot \bar{\kappa} M(z', \kappa, B) \right] \\
&\quad + \frac{1}{1+r} \cdot E \left[ 1_{\text{acq}} \cdot 1_{\text{cont}} \cdot \bar{\kappa} M(z'_c, \kappa, B_c) \right] \\
&= \max_e \pi^* \cdot B - \frac{c^*}{2} \cdot e^2 \cdot B + \frac{1}{1+r} \cdot E \left[ 1_{\text{sa}} \cdot 1_{\text{cont}} \cdot M^*(z', \kappa^*, B) \right] \\
&\quad + \frac{1}{1+r} \cdot E \left[ 1_{\text{acq}} \cdot 1_{\text{cont}} \cdot M^*(z'_c, \kappa^*, B_c) \right],
\end{align*}

\begin{align*}
U^*(z, \kappa^*, B) \equiv U(z, \kappa, B) &= \max_{i \in \{\text{cont, cls}\}} \left\{ z \cdot B^\alpha - \omega B + \frac{1}{1+r} \cdot E \left[ U^* \left( z', \kappa^*, B \right) \right] \\
&\quad + \frac{1}{1+r} \cdot \left( E \left[ 1_{\text{acq}} \cdot \Delta^\text{acq} \right] + E \left[ 1_{\text{tar}} \cdot \Delta^\text{tar} \right] \right), \delta \cdot B \right\}
\end{align*}
\[ V^*(z, \kappa^*, B) \equiv V(z, \kappa, B) = U(z, \kappa, B) + \kappa \cdot M(z, \kappa, B) \]
\[ = U(z, \kappa, B) + \frac{\kappa}{\bar{\kappa}} M(z, \kappa, B) \]
\[ = U^*(z, \kappa^*, B) + \kappa^* M^*(z, \kappa^*, B), \quad (B.9) \]

\[ \Sigma^*_b(z_A, \kappa^*_A, B_A; z_T, \kappa^*_T, B_T; s) \equiv \Sigma_b(z_A, \kappa_A, B_A; z_T, \kappa_T, B_T; s) \]
\[ = V(z_c, \kappa_A, B_A + B_T) + s B_T - \chi \left( \frac{B_T}{B_A} \right)^2 (B_A + B_T) \]
\[ - \mathbb{E} \left[ V(z'_A, \kappa_A, B_A) \right] - \mathbb{E} \left[ V(z'_T, \kappa_T, B_T) \right] \]
\[ = V^*(z_c, \kappa_A^*, B_A + B_T) + s B_T - \chi \left( \frac{B_T}{B_A} \right)^2 (B_A + B_T) \]
\[ - \mathbb{E}^* \left[ V(z'_A, \kappa_A^*, B_A) \right] - \mathbb{E}^* \left[ V(z'_T, \kappa_T^*, B_T) \right], \quad (B.10) \]

\[ \ell_{i,j} \equiv \underset{\{acq, lar, sa\}}{\arg \max} \left\{ \Sigma_b(z_i, \kappa_i, B_i; z_j, \kappa_j, B_j; s), \Sigma_b(z_j, \kappa_j, B_j; z_i, \kappa_i, B_i; s), 0 \right\} \]
\[ = \underset{\{acq, lar, sa\}}{\arg \max} \left\{ \Sigma^*_b(z_i, \kappa_i^*, B_i; z_j, \kappa_j^*, B_j; s), \Sigma^*_b(z_j, \kappa_j^*, B_j; z_i, \kappa_i^*, B_i; s), 0 \right\}, \quad (B.11) \]

\[ P^*(z_A, \kappa_A^*, B_A; z_T, \kappa_T^*, B_T; s) \equiv P(z_A, \kappa_A, B_A; z_T, \kappa_T, B_T; s) \]
\[ = \mathbb{E} \left[ V(z'_T, \kappa_T, B_T) \right] + (1 - \theta) \cdot \Sigma_b \]
\[ = \mathbb{E} \left[ V^*(z'_T, \kappa_T^*, B_T) \right] + (1 - \theta) \cdot \Sigma^*_b, \quad (B.12) \]

where \( c^* = \bar{\kappa} \cdot c \) and \( \pi^* = \bar{\kappa} \cdot \pi \).

Based on the definition of Equations (B.7)-(B.12), suppose \( \{M, U, V, P, \ell_{i,j}\} \) solves the original problem defined by Equations (B.1)-(B.6), then we know that the set \( \{\bar{\kappa}M, U, V, P, \ell_{i,j}\} \) should solve the redefined problem. Note that the redefined problem has the exact same format as a setting where the managers have periodical control benefit of \( \pi^* \), effort cost of \( c^* \), and entrenchment levels \( \kappa^* \sim N(0, \vartheta_{ln}(\kappa)) \). We verify that our setup satisfies the conditions for Theorem 9.6 in Stokey and Lucas (1989), which guarantees a solution. Theorem 9.8 in Stokey
and Lucas (1989) ensures a unique optimal policy function. Therefore, we conclude that after normalizing $\mu_{in(\kappa)}$ to zero and redefining the set of parameters, $\{\pi, c\}$, we can transform the original problem into a new one where the observed takeover market characteristics $\{U, V, P, \ell_{i,j}\}$ remain exactly the same.

Note that the only difference between the two versions of the firm problem lies in the managers’ utility function, $M$, which scales proportionally with our normalization factor, $\bar{\kappa}$. This difference, however, does not cause any issue with our estimation because we are only matching on the observed deal characteristics. We are not targeting any moments directly related to $M$, which measures the managers’ psychological preferences and is unobservable in nature. One caveat is that the estimated parameters in the normalized problem, $\{c^*, \pi^*\}$, should be interpreted as a multiplier of the normalization factors, $\bar{\kappa}$. Their relative magnitudes, however, remain the same as in the original problem. The magnitudes of $\pi$ relative to $c$ determines managers’ effort and, ultimately how fast underperforming firms recover from their bad performance.

C Firm Value Decomposition

To measure $U_{sa}$, we assume that the firm cannot participate in the takeover market, thus it operates as a standalone entity forever. We solve the following Bellman equation using the estimated parameters:\(^{15}\)

$$U_{sa}(z, \pi, B) = zB^\alpha - \omega B + \beta \cdot E[U_{sa}(z', \pi, B)]. \quad (C.1)$$

To solve for $OU_{acq}$ and $OU_{tar}$, we first assume that the firm can only act as an acquirer or a target in the M&A market and solve for its value with the option to be an acquirer or a target

---

\(^{15}\)We fix the manager’s effort as solved in the baseline equilibrium in this exercise. Doing so allows the takeover market to still discipline the manager even if we counterfactually shut down the shareholders’ gains from realized mergers.
only:

\[ U_{acq}(z, \pi, B) = zB^\alpha - \omega B + \beta \cdot E \left[ U_{acq}(z', \pi, B) \right] + \beta E \left[ 1_{acq} \cdot \Delta_{acq}^s \right], \]  
\[ U_{tar}(z, \pi, B) = zB^\alpha - \omega B + \beta \cdot E \left[ U_{tar}(z', \pi, B) \right] + \beta E \left[ 1_{tar} \cdot \Delta_{tar}^s \right]. \]  
\[ (C.2) \]

\[ OU_{acq} \] and \( OU_{tar} \) are then defined as:

\[ OU_{acq} = U_{acq} - U_{sa}, \]  
\[ (C.4) \]
\[ OU_{tar} = U_{tar} - U_{sa}. \]  
\[ (C.5) \]

To solve for \( OU_{cls} \), we assume that the firm can participate in the takeover market as usual, but it will not be closed down. Such a firm has a value function that satisfies the following Bellman equation:

\[ U_{surv}(z, \pi, B) = z \cdot B^\alpha - \omega B + \beta \cdot E \left[ U(z', \pi, B) \right] + \beta \cdot \left( E \left[ 1_{acq} \cdot \Delta_{acq}^s \right] + E \left[ 1_{tar} \cdot \Delta_{tar}^s \right] \right). \]  
\[ (C.6) \]

The option value of closing the firm is, by definition, equal to

\[ OU_{cls} = U - U_{surv}. \]  
\[ (C.7) \]

**D Adjusting Data Moments**

We use the fraction of M&A deals with negative combined firm announcement returns as a data moment to help identify the dispersion of managerial control benefits, \( \sigma_\pi \). Since the combined firm’s announcement return is computed from the abnormal returns of the acquirer and target within the bid announcement period, it contains significant measurement errors. Measurement errors can arise from various factors, such as pricing errors in the benchmark asset pricing model and confounding events that occur in our measurement window. Although measurement errors may not necessarily bias the estimation of average announcement returns for the combined firms,
they significantly inflate the estimated standard deviation. Given that the empirical distribution of combined firm announcement returns is close to a normal distribution with a positive mean, an inflated standard deviation leads to an overestimation of the fraction of M&A deals with negative combined returns.

We make the following adjustments to this moment before putting it in the SMM estimation. First, we denote the observed combined firm return as

\[ \tilde{r}_c = r_c + \epsilon, \]  

where \( r_c \) is the true value, and \( \epsilon \) is the measurement error. Taking variance on both sides, we get

\[ Var(\tilde{r}_c) = Var(r_c) + Var(\epsilon). \]  

The covariance \( Cov(r_c, \epsilon) \) equals zero and drops out from Equation (D.2) because, by definition, \( r_c \) and \( \epsilon \) are uncorrelated. \( Var(\tilde{r}_c) \) can be measured from data using the cross-sectional variance of the combined firm returns; therefore, if we are able to measure \( Var(\epsilon) \) in the data, we then can back out \( Var(r_c) \).

To measure \( Var(\epsilon) \) from the data, we first compute the abnormal returns for the combined firm (i.e., the weighted average abnormal returns earned by the acquirer and the target) in a window that has the same length as our measurement window (i.e., 22 trading days) but lies three months before the bid announcement. We use the abnormal returns in this alternative window to approximate \( \hat{\epsilon} \), the estimated measurement error, because no bid announcement is made within this window; therefore, any abnormal returns, if detected, can be attributed to pricing errors in the benchmark asset pricing model or to other confounding events that are likely to happen in our measurement window. We verify that \( \hat{\epsilon} \) has a mean that is very close to zero and a significant standard deviation. We then compute the mean and standard deviation
of the true combined firm returns, $E(r_c)$ and $Std(r_c)$, as follows:

$$E(r_c) = E(\tilde{r}_c) - E(\tilde{\ell}),$$

$$Std(r_c) = \sqrt{Var(\tilde{r}_c) - Var(\tilde{\ell})}.$$

We calculate the point estimate of the fraction of M&A deals with negative combined firm returns as

$$\text{Prob}(r_c < 0) = \Phi(E(r_c), Std(r_c), 0),$$

where $\Phi(\mu, \sigma, x)$ is the cumulative distribution function of a normal distribution with mean $\mu$ and standard deviation $\sigma$, evaluated at point $x$.

The moment constructed above depends on two key parameters, $E(r_c)$ and $Std(r_c)$, and hence it inherits the estimation errors of these two parameters. We use simulation to calculate the standard error of this moment, taking into account the estimation errors in $E(r_c)$ and $Std(r_c)$. Specifically, we first obtain the point estimates and the standard errors for the two parameters (i.e., $E(r_c)$ and $Std(r_c)$) based on $E(\tilde{r}_c)$, $E(\tilde{\ell})$, $Var(\tilde{r}_c)$, and $Var(\tilde{\ell})$ that we measure from the data. We then assume that the true values of $E(r_c)$ and $Std(r_c)$ follow normal distributions, with their means equal to the point estimates and their standard deviations equal to the estimation errors (i.e., standard errors of $E(r_c)$ and $Std(r_c)$). We then run $L$ trials of simulation. In each simulation trial $l \in L$, we first obtain a draw of $E_l(r_c)$ and $Std_l(r_c)$ from the normal distributions (this step takes into account the estimation errors in these parameters), and then we simulate $r_c$ for $N$ deals, assuming that $r_c \sim N(E_l(r_c), Std_l(r_c))$, where $N$ is the sample size of our M&A data (this step takes into account the estimation errors due to limited sample size). Last, we calculate the fraction of deals with negative combined abnormal returns, $\text{Prob}_l(r_c < 0)$, for this simulation trial $l$. The standard error of the moment $\text{Prob}(r_c < 0)$ is equal to the standard deviation of $\text{Prob}_l(r_c < 0)$ across all simulation trials:

$$S.E.\left(\text{Prob}(r_c < 0)\right) = Std\left(\text{Prob}_l(r_c < 0)\right).$$
This figure shows the empirical distribution of the combined firms' announcement returns, the fitted normal distribution, and the normal distribution with adjusted mean and standard deviation parameters. The parameter adjustment is presented in detail in Online Appendix D. The fraction of M&A deals with negative combined firm announcement returns is equal to the cumulative probability on the left side of the cutoff (i.e., the black dashed line).