The impact of ownership structure and corporate governance on energy intensity: evidence from Indian business groups

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Abstract

Purpose – Energy ef ciency is critical for global sustainability (International Energy Agency, 2019). The purpose of this paper is to examine how agency con icts arising from pyramidal ownership structures impact the energy intensity (EI) of group-af liated Indian rms. Group-af liated rms face unique governance challenges. For instance, parent owners (promoters) may transfer pro ts from one group-af liated rm to another rm in which they have greater ownership. The authors hypothesize that such governance issues will lead to underinvestment in energy-saving projects among group rms in which promoters have a low ownership stake, resulting in their greater EI.

Design/methodology/approach – The authors measure EI as the ratio of total energy expense to total sales revenue (EI) and as the industry-adjusted version of this ratio. Group listed Indian rms are divided into high- and low-stake rms based on the sample's median promoter ownership.

Findings – Results support the authors' prediction: group rms in which promoters have low ownership are more energy intensive, consistent with these rms being exposed to greater governance challenges and agency con

area of energy economics nd that the energy consumption of a rm depends on its investments in energy-saving projects (DeCanio, 1998; De Groot et al, 2001; Song and Oh, 2015) and its innovativeness in nding solutions to energy challenges (Margolis and Kammen, 1999; Costa-Campi et al, 2015). Additionally, extant literature in corporate governance indicates that agency co icts can affect both a rm's investments and its level of innovation (Cho, 1998; Hoskisson et al, 2002; Lee and O'Neill, 2003; Sapra et al, 2014). These two streams of literature lead us to hypothesize that an association exists between a company's governance (speciy4.627..2(To.627..96.6(su33ods)b9 0 TD (ly)543ds)9(lea)127..96

The results align with this prediction: using energy expenditure per rupee of revenue, we nd that low-stake rms are more energy-intensive than high-stake rms, consistent with low-stake

Energy Agency [IEA], 2021). Academics and governments alike have recognized energy efficiency as a key aspect in combatting environmental degradation and climate change [5]. Indian Government, in particular, has repeatedly made energy efficiency and environmental policies a priority (Mukherjee, 2010; Haider et al, 2019). For further details, Sahoo et al. (2016) provide a detailed discussion of the Indian Government's plans and initiatives, highlighting the achievements and challenges of the country's energy-related programs. Similarly, Haider et al. (2019) provide an insightful, brief review of four major policies that were recently implemented by the Indian Government, focusing on EI and conservation efforts.

Despite the government's efforts, researchers have found evidence that Indian firms are very energy-intensive relative to their potential efficiency. For example, the Indian paper industry is estimated to have a feasible energy savings potential of 40% (Haider et al, 2019), and Indian iron and steel firms could reportedly reduce their energy consumption by half, according to Haider and Mishra (2021). Clearly, given the recent "code red for humanity" report of the Intergovernmental Panel on Climate Change (2021), understanding what factors may be contributing to the EI of Indian firms is critical not only for India's future but also for addressing global climate change.

Several studies have examined a particular sector's EI and its drivers. Kumar (2003) and Sahu and Narayanan (2009) examine Indian industrial firms; Goldar (2011) studies the Indian manufacturing sector; Dasgupta and Roy (2017) analyze seven energy-intensive Indian manufacturing industries; Haider et al. (2019) examine the Indian paper industry; and Haider and Mishra (2021) focus upon Indian iron and steel firms. However, according to Haider and Mishra (2021), "there is a substantial research gap in conducting an energy efficiency analysis at micro-level in the context of India." The present study helps to fill that gap by examining how promoter ownership affects the EI of business group-affiliated firms in India.

prf(er)12.u6d9(387(Mi-220.915.7wa18.288-1'aos4(e)12it2.4(s5.4(l provides a different, nuanced view of the effect that ownership structure can have on rms' energy intensities – building upon the foundation laid by Haider et al. and others.

2.2 Business groups in India

Any investigation of the impact of ownership structure in India on rm-level energy ef ciency has to acknowledge the dominant role that business groups play in the country's economy. Basu and Sen (2015) nd that about 35% of the rms listed on the Bombay Stock Exchange (BSE) in 2011 were af liated with a business group. Furthermore, these group-af liated companies held 60% of the total assets of BSE-listed rms (Basu and Sen, 2015). Prior studies have investigated the reasons for the existence and dominance of business groups in emerging markets in general and in India in particular. The dominant view is that the business group structure is a response to imperfections in the capital, labor and product markets (Khanna and Palepu, 2000). A business group has a key advantage in that information ows freely among its constituent rms, which aids the group in overcoming market imperfections through information and resource sharing (Gopalan et al, 2007; Singla et al, 2014). According to this perspective, business group formation is bene cial to constituent rms. This is supported by empirical evidence suggesting that groups inThi5316.7(oup)]TJ /F5 1 stake firms suffer from underinvestment and less innovativeness when compared to high-stake firms. Low investment in assets and R&D is likely to have a negative impact on the energy efficiency of these firms [9] (Costa-Campi et al., 2015), given prior research has suggested that energy savings are closely linked to the innovativeness of firms (Bala Subrahmanya and Kumar, 2011).

Additionally, group promoters may lack the incentive to adequately monitor the managers of low-stake firms, since promoters do not receive a meaningful share of the benefit from the successes of such firms. Less active monitoring could result in missed investment opportunities and self-serving behavior by managers (e.g. "perks" or other traditional agency costs), which might adversely affect the energy efficiency of such firms.

Finally, due to the tunneling of profits and less monitoring by promoters, low-stake firms may find it difficult to finance energy-saving investments. Profit expropriation and managerial "perks" may not only result in poorer bottom-line numbers being reported by low-stake firms to the capital markets, but these are also symptoms of poor corporate governance, which may be recognized by investors and creditors. Lower reported profits and potential recognition of poor governance can make it more difficult to obtain external financing, resulting in a higher cost of capital. A higher cost of financing, in turn, makes energy-saving investments less attractive, and fewer projects will meet low-stake firms' capital budgeting criteria.

In summary, because promoters have incentives to tunnel the wealth of low-stake expense. The first measure used is the ratio of total energy expense to total sales revenue, which we refer to as "energy intensity" or EI. EI indicates how much energy is required, in monetary terms, to produce one rupee of sales revenue. EI is similar to the measures used by Reddy and Kumar Ray (2011), Elliott et al. (2013), Sahu and Sharma (2016) and Oak (2017) and can be assumed to vary inversely with energy efficiency (i.e. higher values of EI indicate less energy efficiency) [11]. One advantage of this EI measure over unscaled (raw total rupees) energy consumption is that it reflects the effects of energy-related investments such as adopting more energy-efficient production methods or installing solar panels to generate power that is off the utility grid and, therefore, lowers energy costs per unit of production. To adjust our measure for inter-industry differences, we construct an industry-adjusted energy intensity proxy (IAEI) by subtracting the industry-average EI ratio from the EI ratio of a given firm within that industry [12]. Thus, IAEI indicates the energy expenditure used to produce sales revenue for each firm relative to the average EI of the corresponding industry for each year in our sample period. A positive IAEI value indicates the firm spent more on energy to support its revenues than the industry average, thus implying the firm was less energy-efficient.

3.1.2 Independent variables. To test the hypothesis, we consider promoter ownership in each group-affiliated firm, defined as the percentage of firm-level ownership held by the controlling person or entity of the business group at the financial year-end. We use this percentage to categorize group firms into low- and high-stake firms as follows. First, we calculate each firm's average promoter ownership percentage across the entire sample period. Then, we take the median value of these firm-specific averages to arrive at the median value of promoter ownership across all years and all group-affiliated firms in our sample. If a company's average promoter ownership across the sample period is below this sample median value (54%) of promoter ownership, then the variable Low-Stake-Firm is assigned a value of one (zero otherwise) for that company [13], [14]. Since low-stake firms are hypothesized to be more energy-intensive than high-stake firms, we expect a positive coefficient for Low-Stake-Firm.

Apart from this test variable, we control for firm-specific factors that can affect the EI of a firm, following prior literature (Sahu and Narayanan, 2009; Costa-Campi, 2015; Oak, 2017). Specifically, we control for firm size, tangibility, leverage, firm performance (proxied by return on assets), relative investment in research and development, foreign trade intensity (FTI), growth opportunities (proxied by the market-to-book ratio) and firm age. In Table 1, we define each of the control variables and indicate the predicted sign as well as a brief rationale for these expectations.

3.2 Data

The data for our analysis are obtained from Prowess, a database maintained by the CenteTJ /F520BT 9.5 0

Table 1.
Definitions and predicted signs for control variables

Variable	Definition	Expected sign and rationale
Size	Log of total assets	Negative: Economies of scale should reduce energy spending per unit of sale
Tangibility	Ratio of net fixed assets to total assets	Positive: Greater investment in physical assets should correspond to greater EI
ROA	Firm performance proxy, calculated as the ratio of earnings before interest and taxes to total assets	Negative: Greater access to funds for energy-efficient investments
Leverage	Ratio of total debt to total assets	Negative or positive: Greater access to debt financing can facilitate energy-saving investments; alternatively, for firms with high leverage, the need to repay debt could constrain the company's ability to fund energy investments and such firms may be hesitant to borrow more funds to finance energy-saving projects
R&D_Ratio	Ratio of research and development expenditure to total assets	Negative: Investing in innovations should help reduce EI
FTI	FTI, measured as the ratio of the sum of foreign exports and imports to total sales	Negative: Firms that compete in foreign markets are expected to have competitive cost structures (more energy-saving investments)
MB	Firm growth proxy, calculated as the market-to-book ratio of equity	Negative: Firms that are growing are likely to be investing in more energy efficient projects, such as modern equipment that is less energy intensive
Age	Difference between current year and year of incorporation	Negative or positive: Mature firms are likely better positioned to engage in greater energy-efficient investments; alternatively, mature firms may be less innovative or more entrenched in their current practices, leading to less energy-saving projects being undertaken

Table 2.
Sample selection

Criteria	No. of firm-year observations
BSE-listed firms in Prowess for the sample period (2010–2017)	33,019
Less: Financial firms (NIC codes 64920, 64191, 64192, 64920, 66190, 66301, 64990, 64300, iiiiiiiiii 65110, 64300, 66120)	(6,685)
Less: Firms with missing data for the model's control variables and/or promoter ownership in iiiiiiiiii a given year	(12,082)
Less: Firms in industries that have fewer than five firms in a given year	(981)
Less: Standalone firms (i.e. firms not affiliated with a business group)	(8,251)
Sample of group-affiliated firms	5,020
Less: Firms with negative market-to-book, leverage or R&D ratios in a given year	(53)
Final sample of group-affiliated firms used in regression analysis	4,967

The summary statistics for the variables used in our study are presented in Table 3 for high-stake and low-stake group-affiliated firms, which are divided according to a median split of the sample based on the firm-specific averages of promoter ownership stakes. The summary statistics presented in Table 3 reveal that the EI of low-stake firms – which are expected to have inferior corporate governance and to suffer from pro tunneling and other agency problems related to promoter ownership –

Table 4.
Correlation matrix

Variables	EI	Size	Tangibility	ROA	Leverage	R&D_Ratio	FTI	MB	Age
EI	1								
Size	−0.0356	1							
Tangibility	0.3911***	−0.0418	1						
ROA	−0.0880**	0.1539***	0.1138***	1					
Leverage	0.1976***	0.0934**	0.3597***	−0.1834***	1				
RD_Ratio	−0.0895**	0.0860**	0.0221	0.1593***	−0.0935***	1			
FTI	−0.0352	0.1601***	−0.0619**	0.1149***	−0.0189	0.1750**	1		
MB	−0.0872***	0.049	−0.0533**	0.2879***	−0.0803**	0.1212***	0.0336	1	
Age	0.0471	−0.0311	−0.0174	−0.0319	−0.1696***	−0.0614**	−0.0557**	−0.0019	1

Notes: This table presents the correlations between the study's continuous independent variables, which are defined in Table 1. The full sample of 798 firms (or 4,967 firm-year observations) is used to calculate these correlations. Significant correlations are denoted by *** and **, indicating significance at the 1 and 5% level, respectively

Table 6. Impact of promoter shareholdings on the EI of group firms

	EI (energy intensity)		IAEI (industry adjusted energy intensity)	
	Pooled OLS	Fama–MacBeth	Pooled OLS	Fama–MacBeth
Variables (predicted sign)	1	2	3	4
Low-Stake-Firm (+)	0.009*** (4.882)	0.009*** (4.275)	0.008*** (4.542)	0.008*** (6.932)
Size (−)	−0.005*** (−7.583)	−0.002** (−3.348)	−0.004*** (−6.336)	−0.004*** (−14.460)
Tangibility (+)	0.041*** (5.725)	0.137*** (38.830)	0.042*** (7.873)	0.042*** (12.037)
ROA (−)	−0.104*** (−7.174)	−0.125*** (−11.315)	−0.113*** (−7.614)	−0.115*** (−15.318)
Leverage (+/−)	0.003 (0.464)	0.013** (3.365)	−0.000 (−0.089)	−0.001 (−0.245)
R&D_Ratio (−)	−0.007 (−0.165)	−0.275*** (−8.422)	0.029 (0.856)	0.035 (1.508)
FTI (−)	0.003 (0.846)	−0.004 (−1.113)	−0.008*** (−2.604)	−0.008** (−2.980)
MB (+)	0.000 (0.273)	−0.001 (−1.076)	0.001 (1.220)	0.001* (1.956)
Age (+/−)	0.000 (0.360)	0.000*** (4.989)	−0.000 (−0.560)	−0.000 (−0.478)
Constant	0.412*** (8.565)	0.029*** (6.297)	0.040*** (5.736)	0.038*** (12.948)
Observations	4,967a	4,967	4,967	4,967
R-squared	0.504	0.163	0.066	0.072
Industry FE	Yes	No	No	No
Year FE	Yes	No	Yes	No

Notes: Two dependent variables are used in Table 6: EI, which is the cost of fuel, power and water per rupee of sales revenue, and IAEI (calculated as the difference between the EI of the firm and the average EI for the corresponding industry in a given year). The independent variable of interest is Low-Stake-Firm, which is an indicator variable that equals one if the group-affiliated firm has below-the-median promoter shareholding and zero otherwise. All other independent variables are defined in Table 1. ***, ** and * indicate significance at 1, 5 and 10% levels, respectively. [a] Observations that lacked all the data necessary for the model were excluded from the regression, resulting in a sample size of 4,967 investments (Cagno and Trianni, 2013). Leverage is positive and significant when using the EI measure in the Fama-MacBeth regression. This, combined with the consistently negative and significant coefficient for ROA, provides some limited support for slack resource theory's implication that having greater financial resources will result in greater investment in energy-efficient initiatives, while greater financial constraints (as in higher leverage) will result in less investment in energy-saving projects (Nagesha and Balachandra, 2006; Hochman and Timilsina, 2017; Haider et al, 2019).

As suggested by Mandal and Madheswaran (2010) and the findings of Haider and Mishra (2021), a firm's research and development spending can lead to higher energy efficiency. This is consistent with our finding that R&D_Ratio has a negative and significant impact on EI in the Fama-MacBeth regression in Table 6 (column 2). FTI (coand

Table 7. Impact of promoter shareholdings on the EI of group firms, using business group median promoter ownership to classify firms

	EI (energy intensity)		IAEI (industry adjusted energy intensity)	
	Pooled OLS	Fama–MacBeth	Pooled OLS	Fama–MacBeth
Variables (predicted sign)	1	2	3	4
Low-Stake-Group_Median (+)	0.004*** (2.645)	0.004** (2.679)	0.004* (1.939)	0.004*** (3.972)
Size (−)	−0.005*** (−7.490)	−0.002** (−2.843)	−0.004*** (−6.091)	−0.004*** (−13.371)
Tangibility (+)	0.040*** (5.633)	0.137*** (38.539)	0.042*** (7.995)	0.043*** (11.802)
ROA (−)	−0.107*** (−7.343)	−0.129*** (−11.486)	−0.117*** (−7.705)	−0.118*** (−16.119)
Leverage (+/−)	0.003 (0.509)	0.013** (3.069)	−0.001 (−0.143)	−0.001 (−0.283)
R&D_Ratio (−)	−0.016 (−0.410)	−0.281*** (−8.961)	0.025 (0.705)	0.029 (1.384)
FTI (−)	0.003 (0.951)	−0.003 (−0.942)	−0.007** (−2.428)	−0.008** (−2.755)
MB (+)	0.000 (0.205)	−0.001 (−1.148)	0.001 (1.155)	0.001 (1.798)
Age (+−/−)	0.000 (0.736)	0.000*** (5.347)	−0.000 (−0.280)	−0.000 (−0.228)
Constant	0.411*** (8.534)	0.030*** (6.491)	0.041*** (5.815)	0.039*** (12.791)
Observations	4,967a	4,967	4,967	4,967
R-squared	0.502	0.160	0.062	0.068
Industry FE	Yes	No	No	No
Year FE	Yes	No	Yes	No

Notes: Two dependent variables are used in Table 7: EI, which is the cost of fuel, power and water per rupee of sales revenue, and IAEI (calculated as the difference between the EI of the firm and the average EI for the corresponding industry in a given year). The independent variable of interest is Low-Stake-Group_Median, which is an indicator variable that equals one if the group-affiliated firm has promoter ownership less than its affiliated business group median promoter ownership and zero otherwise. All other independent variables are defined in Table 1. ***, ** and * indicate significance at 1, 5 and 10% levels, respectively. [a] Observations that lacked all the data necessary for the model were excluded from the regression, resulting in a sample size of 4,967

MacBeth model (β = 0.004, $p < 0.01$). The

	EI (energy intensity)		IAEI (industry adjusted energy intensity)	
	Pooled OLS	Fama–MacBeth	Pooled OLS	Fama–MacBeth
Variables (predicted sign)	1	2	3	4
Low-Stake-Firm (+)	0.010*** (5.275)	0.009*** (4.904)	0.010*** (5.251)	0.009*** (8.952)
Size (−)	−			

preferences led to high-stake firms being less energy intensive. Still, this is a limitation of our study, and we hope that future research will address this issue when new data become available or a natural experiment arises.

While prior studies examining energy policy often treat corporate governance among sample firms as a constant factor, our study reveals that variation in ownership structure and related governance issues has a significant impact on firms' energy intensities and should be considered in future research. Our results also extend the documented evidence of corporate governance from mostly financial and strategic policy-related effects to its role in the energy policies of firms. By examining our hypothesis in the Indian context and by specifically investigating group-affiliated firms, this study also contributes to the emerging markets–related literature and literature regarding the effects of various ownership structures.

These results are timely given the challenge of promoting global sustainability, particularly since India is the world's third leading source of carbon emissions (World Economic Forum, 2019) and energy efficiency will be key in addressing climate change (IEA, 2019). Our findings may help explain the apparent lack of initiative among some firms to invest in energy-saving projects: it is possible that governance problems related to the firms' ownership structures are contributing to their underinvestment. Thus, our study has significant implications for policymakers: any directive or program intended to manage energy-related issues through technological improvements or other corporate initiatives should consider firms' ownership structures and the corresponding governance issues. Additional research is needed to further examine the impact of specific corporate governance characteristics and mechanisms on the energy policies of firms, in both emerging and developed markets. For instance, since there is likely an association between the automation of operations, investment in energy-efficient equipment or technologies and energy efficacy, future studies could examine whether investment in high-tech machines acts as an alternative, more-specific dependent measure capturing the relationship between promoter ownership and EI documented in this study. Another avenue for future research would be to investigate whether the relationship between ownership structure and energy efficiency is similar across different geographic locations in India, as well as in other countries. Such research is only possible if firms disclose information related to their environmental impacts, like energy spending, which may motivate standard setters to further consider the value of such disclosures, particularly as accountants continue to contribute to corporate social responsibility related reporting and assurance (KPMG, 2017).

Notes

1. According to the Prowess database, the Securities and Exchange Board of India defines "promoter" as "the person or persons who are in control of the company, directly or indirectly, whether as shareholder, director or otherwise." In other words, the promoter is the person or entity in de-facto control of a business group, even if the ownership stake in some of the affiliated firms is low. Please refer to Section 2 for a discussion of the pyramidal ownership structure that commonly characterizes business groups in India.
2. Ownership rights depend on the percentage of shareholding in a given firm.
3. There is also a possibility that promoters prefer more energy-efficient firms. In this case, the business group might purposefully acquire a higher stake in firms that are less energy intensive, and firms wishing to attract greater promoter investment could invest more in energy-saving projects. We recognize that this is an alternative explanation for our predicted results; regrettably, data limitations prevent us from testing it. However, this concern is mitigated by the

fact that many business groups in India are family-founded and were established well before our study's period, making it less likely that promoters' investment preferences led to high-stake firms being less energy intensive. Still, we recognize the inability to test this alternative explanation that the results could be a consequence of an endogeneity (Cho, 1998) is an empirical limitation of our study. We also mention this as a limitation and area for future research in the Conclusion section.

4. For additional information regarding the institutional differences between India – which constitutes a large emerging market – and the developed world, readers may refer to Allen et al. (2012), Narayanaswamy et al. (2012) and Jadiyappa et al. (2016).

5. Yang and Li (2017), Moon and Min (2017), Haider and Mishra (2021) and others.

6. Bertrand et al. (2002) provide an excellent example of the pyramid structure and of tunneling for interested readers.

7. The average growth rate of low-stake firms is significantly less than that of high-stake firms ($p < 0.01$).

8. The average R&D expenditure of low-stake firms is also significantly less than that of high-stake firms ($p < 0.01$). Missing R&D ratios have been replaced by zeros throughout all subsequent analyses; however, for this statistic, only positive R&D ratios are included in its computation.

9. Data on energy-specific investments are not available in the Prowess database.

10. Our prediction that low-stake firms will underinvest may at first appear to contrast with the theoretical model presented by Zhang (1998), who posits that firms with highly concentrated ownership will tend to be risk-averse and, therefore, tend to under-invest in risky projects. In Zhang's model, the use of debt can mitigate this problem. Our setting differs in that the pyramidal ownership structure of business groups in India permits the tunneling of profits to the high-stake firms, which leads to under-investment in energy-saving projects by low-stake firms and enables greater investment by high-stake firms.

11. If the cost per kilowatt of power purchased varied among companies, then the EI measure might not be perfectly inversely related to energy efficiency. For instance, if a firm was purchasing its power from more sustainable energy sources that may be more expensive and more efficient, this would increase the firm's EI, but the firm may actually be less energy-intense. This concern is mitigated in large part by the fact that in India all solar and wind power firms must sell their power to state electricity boards, which, in turn, supply power to firms at a fixed rate. Thus, firms do not pay a premium for more sustainable energy purchased in India. Further, in our sample, about 98.7% of firms purchase electricity from the grid, and only 6.8% have solar or wind energy that they produce themselves. Therefore, there is considerable institutional and statistical support for the assumption that EI is inversely related to energy efficiency in the Indian setting of our study.

12. We use the industrial classification system of the Prowess database which follows the National Industrial Classification (NIC) system of the Government of India. This system is very similar to the SIC classification system followed in the USA. For better accuracy on the reference point for calculation of relative energy intensity, we use a four-digit classification. We retain only those industries which have at least five firms in a given year. In total, our sample consists of firms belonging to 87 different industries.

13. The rationale for this classification is that promoter ownership is quite stable over time. In an untabulated analysis regressing promoter ownership against a time trend (considering only those firms that have observations for all the years in the study period), the time trend coefficient is insignificant ($p = 0.454$), demonstrating that promoter ownership is fairly stable over the study period. Further, as an untabulated robustness test, we use promoter ownership as a continuous variable (rather than using the *Low-Stake-Firm* indicator variable) and find consistent results: promoter ownership is significantly and negatively related to EI, meaning our conclusions would

not change if a continuous measure of promoter ownership were used instead. Finally, we also classify firms relative to their business group's median ownership, and the results remain robust (please see the Supplemental Analysis Section).

14. For low-stake firms, the average promoter ownership across our sample period is 38.73% (median = 42.59%), while for high-stake firms, the average promoter ownership is 66.02% (median = 65.67%).

15. These 798 group firms represent about 53% of the total number (1,495) of non-financial, BSE-listed group firms.

16. A supplemental table presenting industry-related summary statistics for our sample is available upon request.

17. As described in footnote 13, in an untabulated analysis regressing promoter ownership against a time trend, the time trend coefficient is insignificant (p = 0.454), demonstrating that promoter ownership is fairly stable over the study period. Hence, we use a firm's average promoter ownership and the entire sample period's median promoter ownership value to classify firms as high or low stake firms, making this variable time-invariant.

18. When each of the columns reporting mean EI from Table 5 (i.e., columns 2, 4 and 6) is regressed against a time trend, the time trend coefficient is insignificant, implying that there is not much variation in the dependent measure (EI) across the study period.

19. The results are qualitatively and quantitatively similar, and the conclusions drawn are not changed when using two or three lags.

20. We also observe from Table 5 that the average energy intensity of low- and high-stake group-affiliated firms is fairly stable across time. As mentioned in the Estimation Section, stability in the EI values contributed to the choice of the Fama-MacBeth methodology for our regression analyses.

21. Although the present study focuses on the influence of promoter ownership on the energy intensity of group-affiliated firms, it is natural to ask whether the energy intensity of group firms overall differs from that of standalone firms. To explore this question, we create a new indicator variable, which equals one if the firm is affiliated with a business group, and zero for all standalone firm observations. Regression results (untabulated) reveal that group-affiliated firms are more energy intensive than standalone firms. This finding is consistent with the logic underlying our main hypothesis – namely, that group firms suffer from unique agency issues that arise from their pyramidal promoter ownership structure, such as tunneling.

22. We recognize that not all group firms are included in the Prowess database, so the calculated group median ownership may be distorted as a result.

23. Since the Prowess database only captures data for a limited number of group-affiliated unlisted firms, we have only included listed group companies in our sample; this is one limitation of our study.

24. We considered examining the annual reports of our sample firms to see if we could gather more direct evidence of variation in firms' energy policies. However, we were concerned that annual reports may not divulge such information in a consistent or reliable manner. Some firms may report a focus on energy efficiency or specify that new investments are energy-saving projects, while other firms may not report whether the investments are more energy efficient than alternative projects. Interpreting such voluntary disclosures could lead to misguided conclusions because the decision to make voluntary, detailed disclosure differs from the decision to invest in the firm's energy efficiency; hence, a lack of disclosure does not necessarily mean a lack of energy-efficient initiatives/investments within a given firm. Thus, our concern that analyzing voluntary disclosures in annual reports could lead to misleading conclusions about energy policies deterred us from conducting such an examination.

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