Review of Quantitative Finance and Accounting
https://doi.org/10.1007/s11156-024-01365-2

ORIGINAL RESEARCH

Corporate board reform and capital structure dynamics: evidence from UK

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Accepted: 15 October 2024

Abstract
Theoretical arguments suggest that corporate board reform will influence firms' capital structure choices. Consistent with this argument, we examine the impact of corporate board reform on the capital structure dynamics of UK firms. Using 12,384 firm-year observations between 2006 and 2020, we provide evidence of a higher speed of adjustment after board reform. Using an additional analysis, we find that firms with higher agency costs (in the pre-reform phase) are more likely to implement the monitoring effect of debt. Also, our decomposition analysis shows that firms increased both short-term and long-term debt after the board reform, suggesting that improved board monitoring positively impacts firm leverage.Query Our results are robust to alternative leverage proxies and batteries of robustness tests.

Keywords Capital structure · Corporate board reform · Corporate governance · Speed of adjustment

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Published online: 15 November 2024

1 Introduction

Over the past decades, many countries have experienced numerous corporate board reforms to enhance the board's fiduciary duties and monitoring abilities. These reforms, exogenous to firms' internal policies, are of immense help to economic researchers when dealing with potential endogeneity issues that have plagued corporate finance studies. Therefore, the UK provides an ideal setting to examine the impact of board reform on firms' capital structure dynamics.

A growing body of literature has examined the impact of corporate board reform on various organisational outcomes, such as cash holding (Chen et al. 2020), stock price crash risks (Hu et al. 2020), dividend policy (Bae et al. 2021), debt choice (Ben-Nasr et al. 2021) and firm value (Fauver et al. 2017) among others. One important question that needs to be addressed is whether board reforms influence firms' capital structure and UK firms' leverage adjustment speed.

Although there is still ambiguity regarding the impact of board reforms on firms' capital structure choices, two competing views can be identified in the literature. First, anecdotal evidence suggests that enhanced board oversight will increase firm leverage. Hu et al. (2020) also suggest that the improved board monitoring resulting from the board reform increases the likelihood of disciplined insiders subjecting themselves to debt monitoring. The intuition is that enhanced board monitoring that stems from board reform increases firms' reliance on debt. In contrast, it can be argued that board reforms may be inversely related to leverage. The rationale behind this view is that a reformed board facilitates access to alternative sources of finance (Ben-Nasr et al. 2021), thereby reducing firms' leverage. Fauver et al. (2017) argue that board reforms reduce agency conflict, enhance the board's fiduciary duties and improve the transparency in the financial reporting process. The improved monitoring after major board reform will likely reduce asymmetric information, thereby increasing the likelihood of equity issuance. Therefore, one would expect that board reforms signal a good corporate governance environment that appeals to investors.

Our motive for examining board reform's impact on firms' capital structure dynamics is as follows. First, classical agency literature suggests that firm insiders are incentivised to maximise private benefits and are unwilling to be subject to external monitoring. Since the capital structure choice of self-interested agents is unlikely to advance the interest of firms' shareholders (Morellec et al. 2012; Liao et al. 2015), the role of a reformed board is crucial in protecting shareholders' interests. The increased board effectiveness following reforms (Fauver et al. 2017) will likely reduce rent-seeking behaviour and result in insiders accepting the disciplinary effect of debt.

Secondly, studies have emphasised the importance of board reforms in strengthening the fiduciary duties of the corporate boards (Fauver et al. 2017; Ben-Nasr et al. 2021), which increases the credibility of financial reports. The decrease in the information gap between firms and investors due to good corporate governance will protect lenders and shareholders from self-serving agents (Mande et al. 2012). These studies suggest increased agency issues and less debt issuance before board reform.

Third, recent studies suggest that agency costs influence the speed of adjustment (Morellec et al. 2012; Chang et al. 2014; Liao et al. 2015). Morellec et al. (2012) argue that costs emanating from the disciplinary effect of debt are included in the total cost of debt considered by managers. Chang et al. (2014) suggest a slower adjustment in firms with weak governance. Thus, examining the impact of board reform on the speed of leverage adjustment will significantly contribute to the literature.

Therefore, we examine the impact of board reform on the capital structure and SOA of UK firms. We show an inverse relationship between BRefP, RefP and leverage. Interestingly, we find a positive relationship between ARefP and leverage, implying that the board reform reinforces the disciplinary effect of debt, thereby aligning the interests of managers and owners. We also show that the leverage adjustment speed is highest after board reform and lowest during the pre-reform phase. Our result implies that firms are closer to their leverage targets after board reform. We find that board reform results in higher leverage and increased speed of leverage adjustment. Following Kieschnick and Moussawi (2018) and Chang et al. (2014), we performed an additional analysis by excluding zero-debt firms and found that our main result remains unchanged. Overall, our results indicate that board reform enhances the disciplinary effect of debt.

We further examine whether agency conflict in the pre-reform stage influences firms' leverage in the post-reform stage. We show a strong positive relationship between ARefP and leverage, implying that firms with higher agency cost pre-reform are keener to implement the monitoring effect of debt.

We extend our analysis by decomposing the dependent variable (leverage) into short-term and long-term debt following Bevan and Danbolt (2002). We find a positive relationship between BRefP and short-term leverage and a negative relationship with long-term leverage. This result suggests that UK firms rely on short-term debt before board reform. However, we find that firms use both long-term and short-term debt post-board reform, highlighting the role of board reform in increasing firms' leverage. We ensure the robustness of our results using propensity score matching, Heckman tests, weighted least squares, and quantile regression.

We contribute to previous literature in the following ways. First, we add to recent studies that examines the impact of exogenous corporate governance reform on various organisational outcomes (Chen et al. 2020; Hu et al. 2020; Fauver et al. 2017; Bae et al. 2021; Ben-Nasr et al. 2021). The existing studies have mainly focused on the effect of corporate board reform on firm performance. One notable exception is the work of Ben-Nasr et al. (2021), which examined the effect of corporate governance reforms on the choice between public and bank debt. To the best of our knowledge, this study is the first to examine the impact of such exogenous shock on firms' capital structure choice. We document novel evidence that board reform enhances the monitoring effect of debt.

Secondly, previous studies have examined the impact of corporate governance in speed of leverage adjustment (Chang et al. 2014; Liao et al. 2015; Ezeani et al. 2022). Our study goes a step further by examining leverage adjustment speed in the pre-reform, re-form and post-reform phases. We also show that effective board monitoring following board reforms increases the speed of leverage adjustment.

Finally, our study complement broader literature on the role of debt in mitigating agency conflict (Jensen 1986). Particularly, we document evidence that firms increase their leverage in the post-reform phase. We also contribute to previous literature by showing that firms with higher agency cost pre-reform are more likley to implement the monitoring effect of debt.

This study proceeds as follows: Sect. 2 reviews relevant literature on board reform and corporate governance. Section 3 discusses the methodology and approach to empirical design. Section 4 presents the study's findings, robustness and additional tests. Section 5 concludes the study.

2 Literature review and hypothesis development

2.1 Relevant theories

Following the seminal study of Modigliani and Miller (1958), studies have debated factors that influence firms' capital structure. Earlier studies followed the static trade-off theory and highlighted the relevance of bankruptcy cost, refinancing cost and taxes in firms' capital structure decisions (Scott, 1977, Castanias, 1983, Haugen and Senbet 1988). A large body of literature examined the impact of firm-level (Titman and Wessels 1988; Rajan and Zingales 1995), macroeconomic (Cook and Tang 2010; Hackbarth et al. 2006), institutional factors (Öztekin and Flannery 2012) on firms' capital structure decisions. More recent studies have focused on the role of agency conflict in capital structure decisions (Morellec et al. 2012; Kieschnick and Moussawi 2018; Ezeani et al. 2021, 2022).

Agency issues arise since owners and managers have varying interests (Jensen and Meckling 1976, Jensen, 1986). Schleifer and Treisman (1998) and Stulz (1988) argue that shareholders' efforts to rest control from entrenched managers are relatively costly and affect both debt holders and shareholders. However, Myers and Majluf (1984) and Chava et al. (2010) argue that the adverse effect of agency conflict is more pronounced for equity holders. Jensen (1986) argues that agency conflict can be resolved through the disciplinary effect of debt.

Another way to effectively resolve agency conflict is through corporate governance (Bertrand and Mullainathan 2003; Harford et al. 2008; Liao et al. 2015; Morellec et al. 2012). From the agency theory perspective, the corporate board reform will help align the interest of managers and shareholders by increasing the board's monitoring role (Fauver et al. 2017; Hu et al. 2020). Fauver et al. (2017) argue that corporate board reform is designed to mitigate agency conflict by avoiding the dual role of CEOs and the chairman through the independence of the board, audit committee and firms' auditors.

The signalling theory presents an alternative explanation of the relationship between board reform and leverage. Using a signalling model, Ross (1977) argues that asymmetric information between investors and firms' management plays a key role in reconciling differential prospects. The improvement in the information environment following board reform will make it more difficult for managers to hoard negative information (Hu et al. 2020), thereby attracting the attention of investors. The signalling effect implies that corporate governance reform will increase the attractiveness of other sources of finance, thereby reducing firms' leverage.

2.2 Corporate board reform and speed of leverage adjustment

The dynamic capital structure literature supports a target debt ratio and argues that firms that deviate from this target will adjust their optimal capital structure (Flannery and Rangan 2006; Hovakimian et al. 2001). When the restrictive assumptions of Modigliani and Miller (1958) are relaxed, every firm is expected to maintain its target leverage ratio. However, firms deviate from their leverage target in the face of high adjustment costs (Devos et al. 2017). Chang et al. (2014) suggest that the cost of leverage adjustment is directly proportional to the severity of agency conflict.

Although few studies suggest constant leverage adjustment speed (Flannery and Rangan 2006; Hovakimian et al. 2001), most studies document evidence of non-uniform

adjustment behaviour (Cook and Tang 2010; Öztekin and Flannery 2012; Zhou et al. 2016). The previous explanation of the reported variation in the adjustment speed relates to the impact of transaction costs (Dang et al. 2014, Strebulaev 2007) and security issuance costs (Zhou et al. 2016; Huang and Ritter 2009). Recently, studies have highlighted the impact of agency costs on the speed of adjustment (Morellec et al. 2012; Chang et al. 2014; Liao et al. 2015; Ezeani et al. 2021, 2022). These studies argue that agency costs are higher in firms with poor corporate governance and restrictions on shareholder rights. Chang et al. (2014) argue that managers of firms with lower shareholders' rights limit firms' debt to avoid its disciplinary effect. Morellec et al. (2012) argue that costs emanating from the disciplinary effect of debt are included in managers' total cost of debt when they make financial decisions. They suggest that the adjustment behaviour of firms with weak governance is slower.

2.3 Hypothesis development

2.3.1 Corporate board reforms and leverage

The signalling theory suggests a negative effect of corporate board reform on leverage. The idea is that a reformed board facilitates access to alternative sources of finance, thereby reducing firms' leverage. After implementing corporate board reform, the increased transparency will send positive signals to investors about the company's prospects. Fauver et al. (2017) argue that board reform will result in the willingness of outsiders to provide external finance, which reduces the cost of capital. Therefore, it is likely that the good corporate governance environment following board reform will reduce the cost of equity by signalling firms' prospects to investors. Consistent with this view, we formulate the following hypothesis.

In contrast, agency theory suggest that corporate board reform will increase firm leverage (Jensen and Meckling 1976, Jensen 1986). Particularly, the agency theory of free cash flow (Jensen 1986) argue that opportunistic managers are likely to advance their interest by lowering firms' leverage and suggests using leverage to limit the free cash flow available to self-interested managers. Consistent with the agency theory, a huge body of literature suggests that corporate governance reform improves board oversight, fiduciary duty and monitoring function (Bae et al. 2021; Fauver et al. 2017; Hu et al. 2020; Chen et al. 2020; DeBoskey et al. 2021; Kuzey et al. 2024), thereby preventing firms' insiders from overconsumption of perks. Previous studies suggest that improved board monitoring after board reform increases the likelihood of disciplined insiders subjecting themselves to debt monitoring (Hu et al. 2020; Ben-Nasr et al. 2021). Morellec et al. (2012) suggest that self-interested managers consider the disciplinary effect of debt in their financing decisions. Agency literature supports a positive relationship between board reform and leverage (Hossain et al. 2024) since a high debt ratio helps in aligning the interest of owners and agents (Hermalin and Weisbach 1998, 2001). Consistent with the agency theory, we expect that managers will subject to the monitoring effect of debt after corporate governance reform and formulate the following hypothesis.

H1 Board reform is positively related to leverage.

2.3.2 Corporate board reforms and leverage speed adjustments

Regarding the impact of corporate governance on the speed of adjustment, Morellec et al. (2012) argue that self-interested managers use less than optimal leverage and engage in less restructuring to avoid the disciplining effect of debt. Similarly, Liao et al. (2015) find that severe agency conflict will reduce the speed of adjustment and firms' leverage. They argue that good corporate governance environment will ensure that managers employ debt level that aligns with shareholders' interest and a timely leverage rebalancing. We argue that corporate governance reform will adjust their leverage upward towards target. Therefore, compared with pre-reform phase, the agency cost is likely to be lower after the implantation of board reform.

In line with this view, board reform is expected to encourage managers to be subject to the disciplinary effect of debt and to rebalance firms' capital structure. Thus, we expect a speedier leverage adjustment in the post-reform phase compared to the pre-reform era. ratio.

H2 Board reform increases leverage adjustment speed.

3 Methodology

3.1 Sample and data collection

We collect relevant firm-level data from non-financial firms from Refinitiv database. We chose 2006–2020[1] as our sample period to account for the implementation of major board reforms in the UK. We begin our analyses by collecting information on major board reforms from 2006 to 2020. As in Fauver et al. (2017), our primary souces of corporate board reforms are reports from European Corporate Governance Institute (ECGI), prior studies such as Kim and Lu (2013) and local stock exchange regulations. Next we identify the major board reforms and the year in which they were adopted. Following data scrutiny by removing the companies whose data is not avaialble our final sample, reported in Table 1, consists of 774 firms with a total of 12,384 firms-years observation that have implemented major corporate governance reform. We reduce the effect of outliers by winsorising firm-level data (using the 1st and 99th percentile).

3.2 Measurement of variable

3.2.1 Dependent variables

We use two capital structure proxies to reduce the sensitivity of our explanatory variables to a particular measure of leverage. Following previous studies (Morellec et al. 2012; Liao et al. 2015), we measure capital structure (Lev) using the market debt-to-capital ratio.

[1] *Our initial sample comprised of 924 non-financial firms. We excluded 150 firms which had no data for the entire period of investigation. We intended to collect data from 1990 to 2020 to cover all major reforms, however we noticed that there were no corporate governance data for the period between 1990 and 2005. Thus, our final sample covers a period of 16 years starting from 2006 to 2020.*

Table 1 Descriptive statistics (full sample)

	Observation	Mean	Sd	Min	Max
MLev	12,384	23.68	4.68	0.000	83.380
BLev	12,384	17.64	18.380	0.000	60.910
BRefP	12,384	0.313	0.464	0.000	1.000
RefP	12,384	0.283	0.464	0.000	1.000
ARefP	12,384	0.375	0.484	0.000	1.000
PROF	12,384	−0.021	0.189	−0.538	0.222
TAN	12,384	0.215	0.239	0.000	0.834
FSZ	12,384	11.338	2.391	7.545	16.091
MTB	12,384	2.948	3.204	0.150	13.020
NDTS	12,384	0.037	0.032	0.000	0.116
TAX	12,384	0.122	0.227	−0.415	0.704
LIQ	12,384	2.568	2.631	0.460	10.920
BIND	3,803	65.34	12.823	4.000	100.000
BSZ	3,821	8.234	2.274	3.000	17.000
BGD	3,820	16.847	13.377	0.000	62.500

This table report the descriptive statistics for main variables used in this study. MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, asigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

$$\text{MLevit} = \frac{FIND_{it}}{FIND_{it} + S_{it}P_{it}} \tag{1}$$

where, $FIND_{it}$ is the individual firm's financial debt at time t, which includes their current liabilities and long-term debt. S_{it} represents the number of each firm's outstanding common stock, while P_{it} represents individual firm's price per share at time t.

Consistent with Öztekin and Flannery (2012), we measure book leverage as long-term debt plus short-term debt scaled by total assets.

$$\frac{LTD_{it} + STD_{it}}{TA_{it}} \tag{2}$$

3.2.2 Independent variables

To account for the impact of corporate board reform on firms' capital structure, we employed three variables that reflect the period before the reform (*BRefP*), the period the reform is implemented (*ReFP*) and the period after the major board reform (*ARefP*). To be considered as a corpoarte reforms period we consider the reforms which cover key components of board practices: board independence, audit committee and auditor independence, and separation of the chairperson and CEO position. Thus, our reform period is the year in which the major reforms were adopted. For *BRefP,* we used a dummy variable assigned a value of one for the period before major board reform and zero if otherwise. *ReFP* is also a dummy variable with a value of one if in the actual period in which the major corporate board reform were adopted and zero otherwise. Finally, *ARefP* is a dummy variable with a value of one in the post-reform period, and zero is otherwise.

3.2.3 Control variables

We isolated the effect of firm-level and corporate governance. Previous studies documented the impact of profitability, firm size, asset tangibility, market-to-book ratio, non-debt tax shield liquidity and tax on firms' capital structure (Rajan and Zingales 1995, Titman and Wessels 1988, Öztekin 2015, Ezeani et al. 2021, Ezeani et al. 2022). Consistent with the pecking order assumption, studies argue that profitable firms are less interested in debt (Ezeani et al. 2023; Komal et al. 2023; Usman et al. 2023, 2022). Titman and Wessels (1988) and Owusu et al. (2022) show that asset tangibility increases firms' leverage since it mitigates moral hazard and default risk. Baker and Wurgler (2002) argue that firm size increases leverage. Myers and Majluf (1984) suggest that a firm will likely increase borrowing in the face of growth opportunities. Also, it has been argued that liquid assets reduce firms' reliance on debt (Lipson and Mortal 2009). Although Booth et al. (2001) reported no direct impact of tax on a firm's debt policy, previous studies found that tax shield benefits positively impact leverage (Lin and Flannery 2013; Faccio and Xu 2015). In contrast, DeAngelo and Masulis (1980) argue that investment tax credits and depreciation will substitute for tax shield benefits, implying an inverse relationship with leverage.

A large body of literature documents the impact of corporate governance on firms' capital structure (Morellec et al. 2012; Liao et al. 2015; Chang et al. 2014; Ezeani et al. 2021, 2022). These studies shows that large boards with high level of independent non-executive directors are strong in monitoring and thus influences how firms decide on their capital structure. Fulgence et al. (2023) argue that female are risk averse and thus prefers firms with less level of leverage. Similarly, Ezeani et al. (2021) argue that firms with gender-diverse and large boards will use less debt. In the same vein, Liao et al. (2015) show that board independence (outside director) influences leverage adjustment behaviour. Informed by these literature, we therefore control for the effect of board independence, board siae and gender diversity in our inferences. We present the measurement of all study variables in Table 11.

3.3 Empirical model

To examine the impact of board reform on the dynamics of firms' capital structure, we estimate a partial adjustment model in our study sample. This is basically specified as

$$\mathrm{MLev}_{\mathrm{i,t}} - \mathrm{MLev}_{\mathrm{i,t-1}} = \lambda(M\mathrm{Lev}^{*}_{i,t} - \mathrm{MLev}_{\mathrm{i,t-1}}) + \delta_{i,t} \tag{3}$$

where $\mathrm{MLev}^{*}_{i,t}$ is the optimal leverage of each firm in year t. $\mathrm{MLev}_{\mathrm{i,t}}$ is the leverage ratio of each firm in time t. We ensured the variation of a firm's optimal leverage and use λ to measure yearly proportional adjustment for each firm in our sample. Our specification ensures the variation of optimal leverage over time. The speed of adjustment is calculated as $(1 - \lambda)$ since firms partly achieve its yearly leverage target. We expect the SOA to range between 0 and 1. In our model, the optimal leverage ($\mathrm{MLev}_{\mathrm{it}}$) is a function of the corporate governance and firm-level characteristics. Following Öztekin and Flannery (2012) controlled for unobserved heterogeneity by including firm fixed effects.

$$\mathrm{MLev}^{*}_{ij,t} = \beta X_{i,t-1} + F_{i} \tag{4}$$

where, β and $F_{i,}$ represents the vectors of coefficients. We use $X_{i,t-1}$ to account for firm-level and corporate governance characteristics that are likely to affect the optimal leverage of each firm.

Our estimable equation (Eq. 5) is achieved by substituting Eq. 4 into the partial adjustment model.

$$\mathrm{MLev}_{\mathrm{i,t}} = \lambda\beta X_{i,t-1} + (1 - \lambda)\mathrm{MLev}_{\mathrm{i,t}} + \lambda F_{i,} + \delta_{i,t} \tag{5}$$

It is not uncommon for studies that examine the impact of corporate governance characteristics on a firm's capital structure to measure capital structure using a proportional measure of fractional variable (Elsas and Florysiak 2015; Kieschnick and Moussawi 2018). However, statisticians have argued for non-linearity in their conditional mean (Cox 1996, Papke and Wooldridge 1996). Therefore, we used the Blundell and Bond (1998) two-step system generalised method of moments (GMM) and the Bruno (2005) corrected least squares dummy variable (LSDVC) to examine the impact of board reform and capital structure dynamics. Bruno (2005) corrected least squares dummy variable (LSDVC) reduces the bias of the higher order term and is more effective in unbalanced panels. Also, Blundell and Bond (1998) two-step system GMM explores the orthogonality between the lagged explanatory variables and the disturbances during the estimation process (Arellano and Bond 1991). Specifically, we estimated our main equation in first differences and used the second lag of the independent variables as instruments. We checked for serial correlations using Sargan test.

4 Results and discussion

4.1 Descriptive statistics

The descriptive statistics of all the variables employed in our empirical analysis are presented in Table 1. Table 1 reports the overall statistics for the full sample. Table 1 presents the statistics in association with the changes in reforms. As can be observed in Table 1,

the level of UK firms' indebtedness depends on the measure of leverage considered. On average, the market debt-to-capital ratio (MLev) accounts for 23.68% of total assets, with a standard deviation of 4.68. The summary statistics show that some firms have zero market leverage while the maximum leverage value is approximately 83.4% of the total asset. The level of gearing is lower (17.68%) when we used book leverage (BLev) as capital structure proxy. Similar to the market leverage proxy, some of the firms in our sample have zero book leverage. However, the highest value of BLEV is smaller (60.9%) compared to the market leverage. These indicate that for our dependent variables, MLev has a higher value on average when scaled against total assets. Regarding our key independent variables (BRefP, RefP & ARefP), we reported mean values of 0.31, 0.273, and 0.375, respectively.

Furthermore, the results of the control variables used are all as expected. The operating profit (PROF) has a minimum value of −0.54 and a maximum value of 0.222. The negative value suggests that some firms recorded during the period investigated. For the remaining control variables used in our study, the statistical values show variability among the variables and are consistent with extant studies (Fauver et al. 2017; Hu et al. 2020).

The T-test result in Table 2 shows statistically significant mean differences between MLEV and BLev, the market and book leverage proxies used in this study. Also, we find differences in the mean of underleveraged and overleveraged firms. The reported mean values show that the firms in our sample used more debt after board reform compared to the pre-reform phase.

Table 3 presents the correlation matrix of the variables used in our study. The correlation matrix shows that the variables' correlations are below the 80% threshold. Also, the Variance Inflation Factor (VIF) result is within the expected range (less than 10%). Overall, the results suggest that multicollinearity is not a concern in our analysis.

4.2 Regression analysis

4.2.1 Corporate board reforms and leverage

Table 4 reports our main results. We employed three independent variables that reflect the period before the reform (BRefP), the period the reform was implemented (ReFP), and the period after the major board reform (ARefP).

Models 1–6 show the result of market leverage, while models 7–12 report the findings obtained using book leverage. In models 1, 4,7 and 10, we report the relationship between our leverage proxies (MLev, BLev) with BRefP. In models 2, 5, 8, and 11, we show the association between MLEV, BLev and RefP, the reform phase proxy used in this study. In the other models (3, 6, 9 and 12), we reported the same relationship for ARefP.

Table 2 Difference in mean

Variables	BRefP mean (1)	RefP mean (2)	*P*-value	ARefP mean (3)	P-value	Over-levered mean	Under-levered mean	*P*-value
MLev	24.27	25.42	0.003***	29.35	0.050**	50.16	2.33	0.001***
BLev	17.19	17.92	0.027**	23.27	0.035***	35.76	1.72	0.004**

Diff (1) is the mean difference between *BRefP* and *RefP*. Diff (2) is the mean difference between *RefP* and *ARefP*. Diff (3) is the mean difference between Over-levered and Under-levered firms

Table 3 Descriptive statistics: correlation matrix

Variables	1	2	3	4	5	6	7	8
MLev (1)	1.000							
BLev (2)	0.400***	1.000						
BRefP (3)	−0.015	−0.029*	1.000					
RefP (4)	−0.027	−0.026	−0.380***	1.000				
ARefP (5)	0.038**	0.049***	−0.497***	−0.614***	1.000			
PROF (6)	−0.080***	−0.137***	0.054***	0.036**	−0.080***	1.000		
TAN (7)	0.214***	0.319***	−0.015	−0.007	0.019	0.024	1.000	
FSZ (8)	0.341***	0.301***	0.073***	−0.008	−0.054***	0.181***	0.019	1.000
MTB (9)	0.114***	0.013	0.059***	−0.032*	−0.021	0.218***	−0.140***	−0.099***
NDTS (10)	0.062***	0.059***	−0.085***	−0.027*	0.098***	−0.053***	0.222***	−0.377***
TAX (11)	−0.130***	−0.168***	0.062***	0.017	−0.069***	0.233***	−0.082***	0.013
LIQ (12)	−0.363***	−0.304***	−0.018	−0.010	0.025	−0.076***	−0.117***	−0.196***
BIND (13)	0.147***	0.115***	−0.010	−0.035**	0.042**	0.002	−0.059***	0.428***
BSZ (14)	0.196***	0.162***	0.074***	0.010	−0.073***	0.081***	−0.016	0.666***
BGD (15)	0.130***	0.103***	−0.100***	−0.085***	0.165***	0.061***	−0.051***	0.325***

Variables	9	10	11	12	13	14	15	VIF
MLev (1)								
BLev (2)								1.57
BRefP (3)								4.28
RefP (4)								4.03
ARefP (5)								1.36
PROF (6)								1.63
TAN (7)								3.14
FSZ (8)								1.30
MTB (9)	1.000							1.88
NDTS (10)	0.122***	1.000						1.14
TAX (11)	0.125***	−0.018	1.000					1.28
LIQ (12)	−0.034**	−0.171***	0.006	1.000				1.40
BIND (13)	0.027*	−0.126***	−0.019	−0.039**	1.000			2.02
BSZ (14)	0.043***	−0.294***	−0.002	−0.092***	0.256***	1.000		1.71
BGD (15)	0.136***	−0.047***	−0.041**	−0.130***	0.317***	0.199***	1.000	1.57

This table provide the correclation matrics for all main variables used in this study. The significant level is indicated by stars, *$p<0.10$, **$p<0.05$, ***$p<0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, asigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

Table 4 also summarises the result of the dynamic panel data and the speed of adjustment (SOA). The adjustment speed estimates columns report annual adjustment speeds (percent) obtained from the Blundell and Bond (1998) two-step system generalised method of moments (GMM) and the Bruno (2005) corrected least squares dummy variable (LSDVC). The estimated SOA for the market leverage in the pre-reform period is 21.9%. Interestingly, the SOA increased by 2% (23.9%) during the reform phase and significantly increased after the board reform period. Similarly, the reported SOA for market leverage based on LSDVC show the lowest (21.1%) adjustment speed before the board reform phase and a slightly higher (25.8%) in the reform phase, with the highest Fig. (31.3%) reported in the post-reform phase. We also observed a similar pattern based on using book leverage. We show that the leverage adjustment speed is highest after board reform (33.2%, 34.8%) and lowest during the pre-reform phase (25.6%, 28.3%).

We show that our pre-reform variable (BRefP) is negatively related to market and book leverage. Our result also shows an inverse relationship between leverage and RefP, suggesting less reliance on debt in the actual reform phase. Anderson et al. (2004) indicates that weaker board monitoring increases free rider problems, discouraging debtholders from exerting costly monitoring. Previous studies also suggest that asymmetric information results in adverse selection and moral hazard when contracting debt (Myers and Majluf 1984; Fama 1980). Therefore, the weaker governance environment in the pre-reform and reform phases has a negative relationship with leverage.

More interestingly, we find a positive relationship between ARefP and our leverage proxies, which supports our hypothesis (H_1). This result shows high statistical significance regardless of the econometric procedures (GMM and LSDVC) employed. Our findings suggest that leverage increases after board reform, and managers are more willing to accept debt's disciplinary effect post-reform.[2] This result also implies that the board heightened monitoring post-board reform by increasing leverage. It supports the agency theory of free cash flow, which suggests that debt mitigates managerial opportunism. Hu et al. (2020) suggest that the improved board monitoring resulting from the board reform increases the likelihood of disciplined insiders subjecting themselves to debt monitoring.

We further examine whether the severity of agency conflict in the pre-reform phase results in stricter monitoring in the post-reform phase. We expect that board reform will increase leverage among firms with less board gender diversity, less board independence and those with smaller board size pre-reform period. In line with this prediction, we show a strong positive relationship between ARefP and leverage (see Table 5), implying that firms with higher agency cost pre-reform are keener to implement the monitoring effect of debt.

4.2.2 Sensitivity analysis—long-term and short-term debt

Following Bevan and Danbolt (2002), we also examined the impact of long-term and short-term debt on our board reform proxies and reported the result in Table 6. This decompositional analysis provides a better understanding of leverage components and their relationship with our independent variables.

[2] As noted from Table 1, the board independence (BIND), board size (BSZ), and percentage of women (BGD) variables have significantly fewer observations. Thus, the significant observations are not included in our results. As such, we further excluded BIND, BSZ and BGD from our control variables and re-run our main regression. Untabulated results are quantitively simila to the results reported in Table 4.

Table 4 Regression result (board reform and capital structure dynamics)

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
L.MLev	0.781***	0.761***	0.691***	0.789***	0.742***	0.687***						
	(0.060)	(0.055)	(0.066)	(0.009)	(0.009)	(0.009)						
L.BLev							−0.744**	−0.726*	−0.668*	0.717***	0.692***	0.652***
							(0.048)	(0.048)	(0.048)	(0.015)	(0.015)	(0.015)
BRefP	−0.470***			−0.661***			−0.193***			−0.126***		
	(0.146)			(0.110)			(0.029)			(0.011)		
RefP		−0.515**			−0.651***			−0.252***			−0.281***	
		(0.210)			(0.093)			(0.038)			(0.009)	
ARefP			0.454***			0.388***			0.109***			0.116***
			(0.150)			(0.076)			(0.016)			(0.007)
PROF	−0.899	−0.953	−1.175	−1.682***	−1.682***	−1.682***	−0.340**	−0.340**	−0.340**	−0.174***	−0.174***	−0.174***
	(0.916)	(0.776)	(1.080)	(0.211)	(0.211)	(0.211)	(0.166)	(0.166)	(0.166)	(0.020)	(0.020)	(0.020)
TAN	0.524	0.197	0.163	0.660***	0.660***	0.660***	0.142***	0.142***	0.142***	0.091***	0.091***	0.091***
	(0.835)	(0.210)	(0.260)	(0.107)	(0.107)	(0.107)	(0.043)	(0.043)	(0.043)	(0.010)	(0.010)	(0.010)
FSZ	0.118	0.094	0.199	0.185***	0.185***	0.185***	0.013	0.013	0.013	0.017***	0.017***	0.017***
	(0.115)	(0.093)	(0.198)	(0.019)	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)	(0.002)	(0.002)	(0.002)
MTB	−0.002	−0.002	0.052	0.082***	0.082***	0.082***	0.010*	0.010*	0.010*	0.005***	0.005***	0.005***
	(0.033)	(0.029)	(0.045)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.001)	(0.001)	(0.001)
NDTS	0.505	1.058	1.324	3.449***	3.449***	3.449***	0.218	0.218	0.218	0.405***	0.405***	0.405***
	(2.404)	(1.442)	(1.602)	(0.937)	(0.937)	(0.937)	(0.395)	(0.395)	(0.395)	(0.090)	(0.090)	(0.090)
TAX	−0.469	−0.474	−0.877	−0.209**	−0.209**	−0.209**	−0.180	−0.180	−0.180	−0.026***	−0.026***	−0.026***
	(1.201)	(0.964)	(0.797)	(0.094)	(0.094)	(0.094)	(0.134)	(0.134)	(0.134)	(0.009)	(0.009)	(0.009)
LIQ	−0.068	−0.108**	−0.206***	−0.110***	−0.110***	−0.110***	−0.022**	−0.022**	−0.022**	−0.011***	−0.011***	−0.011***
	(0.045)	(0.045)	(0.035)	(0.014)	(0.014)	(0.014)	(0.009)	(0.009)	(0.009)	(0.001)	(0.001)	(0.001)
BSZ	−0.028	0.006	0.074	−0.024**	−0.024**	−0.024**	0.021	0.021	0.021	−0.001	−0.001	−0.001

Table 4 (continued)

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
	(0.046)	(0.095)	(0.186)	(0.012)	(0.012)	(0.012)	(0.023)	(0.023)	(0.023)	(0.001)	(0.001)	(0.001)
GBD	0.003	−0.001	−0.036	−0.006***	−0.006***	−0.006***	0.001	0.001	0.001	−0.000**	−0.000**	−0.000**
	(0.005)	(0.010)	(0.024)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
BIND	0.000	0.003	−0.002	−0.001	−0.001	−0.001	−0.004	−0.004	−0.004	0.000	0.000	0.000
	(0.006)	(0.015)	(0.027)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.000)	(0.000)	(0.000)
Constant	−1.247	2.428**	0.045	−1.468***	−1.791***	−2.244***	−0.980***	0.482***	−0.455***	0.046	−0.094**	−0.120***
	(1.283)	(0.966)	(1.359)	(0.467)	(0.463)	(0.469)	(0.200)	(0.185)	(0.164)	(0.045)	(0.045)	(0.045)
SOA (%)	0.219	0.239	0.309	0.211	0.258	0.313	0.256	0.274	0.332	0.283	0.308	0.348
AR1(*p*-value)	0.02	0.04	0.01				0.05	0.00	0.02			
AR2(*p*-value)	0.12	0.27	0.13				0.36	0.20	0.36			
Adjusted R^2				0.78	0.74	0.72				0.63	0.65	0.59
Observation	3372	3372	3372	3802	3802	3802	3727	3727	3727	3727	3727	3727

This table reports the baseline results using the two-stage system GMM and LSDVC results. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board. Informed with Table 1, we exclude BIND, BSZ and GBD and re-run the regress, where untabulated results are quantitatively unchanged

Table 5 Panel A: regression result (high monitoring effect of debt)

Variables	(GMM MLEV)	(LSDVC MLEV)	(GMM BLEV)	(LSDVC BLEV)
ARefP	0.242***	0.483***	0.136***	0.150***
	(0.143)	(0.174)	(0.021)	(0.017)
PROF	−4.506	−2.307***	−0.527	−0.163**
	(4.457)	(0.799)	(0.429)	(0.076)
TAN	1.490	0.518*	0.095*	0.068**
	(1.737)	(0.304)	(0.056)	(0.029)
FSZ	0.030	0.094*	0.012	0.014***
	(0.147)	(0.051)	(0.025)	(0.005)
MTB	0.072	0.095***	0.013*	0.005***
	(0.103)	(0.015)	(0.008)	(0.001)
NDTS	−1.631	8.406***	0.523	0.718***
	(4.401)	(2.647)	(0.657)	(0.253)
TAX	0.822	−0.045	−0.155	−0.006
	(1.421)	(0.193)	(0.173)	(0.018)
LIQ	−0.130	−0.134***	−0.008	−0.008**
	(0.107)	(0.040)	(0.012)	(0.004)
BSZ	0.045	0.051*	0.020	0.005**
	(0.065)	(0.027)	(0.022)	(0.003)
GBD	0.004	−0.007	0.000	−0.000
	(0.011)	(0.005)	(0.002)	(0.001)
BIND	−0.003	−0.000	−0.003	−0.000
	(0.019)	(0.008)	(0.005)	(0.001)
Constant	0.406	−0.496	−0.694	0.033
	(0.189)	(0.062)	(0.009)	(0.092)
SOA (%)	0.309	0.282	0.298	0.271
AR1(*p*-value)	0.003		0.000	
AR2(*p*-value)	0.14		0.25	
Adjusted R^2		0.804		0.678
Observation	743	743	754	754

This table reports the results for further sensitivity analysis under the high monitoring effect of debt. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BrefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ArefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and mortization scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

We find a positive relationship between BRefP and short-term leverage and a negative relationship with long-term leverage. Our results suggest that before the board reform period (BRefP), firms evade monitoring by decreasing their long-term debt and increasing their short-term debt instead. Our result is consistent with Fan et al. (2012), who suggest

Table 6 Regression result (board reform and capital structure dynamics)—long-term and short-term debt

Variables	GMM long− Term debt			LSDVC long− Term debt			GMM short− Term debt			LSDVC short− Term debt		
	1	2	3	4	5	6	7	8	9	10	11	12
BrefP	−0.039***			−0.045***			0.022***			0.016***		
	(0.010)			(0.007)			(0.005)			(0.003)		
RefP		0.048***			0.023***			0.029***			0.009***	
		(0.015)			(0.006)			(0.007)			(0.003)	
ArefP			0.021***			0.019***			0.012***			0.014***
			(0.006)			(0.005)			(0.003)			(0.002)
PROF	−0.110**	−0.098*	−0.098*	−0.092***	−0.092***	−0.092***	−0.014	−0.014	−0.014	−0.028***	−0.028***	−0.028***
	(0.049)	(0.051)	(0.051)	(0.014)	(0.014)	(0.014)	(0.028)	(0.028)	(0.028)	(0.006)	(0.006)	(0.006)
TAN	0.091**	0.050***	0.050***	0.054***	0.054***	0.054***	0.000	0.000	0.000	0.002	0.002	0.002
	(0.042)	(0.016)	(0.016)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
FSZ	0.007	0.010*	0.010*	0.011***	0.011***	0.011***	−0.002	−0.002	−0.002	−0.000	−0.000	−0.000
	(0.007)	(0.006)	(0.006)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
MTB	0.003**	0.003*	0.003*	0.003***	0.003***	0.003***	0.000	0.000	0.000	0.001***	0.001***	0.001***
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
NDTS	−0.174	−0.071	−0.071	0.279***	0.279***	0.279***	0.044	0.044	0.044	0.030	0.030	0.030
	(0.148)	(0.106)	(0.106)	(0.060)	(0.060)	(0.060)	(0.054)	(0.054)	(0.054)	(0.028)	(0.028)	(0.028)
TAX	−0.105*	−0.093*	−0.093*	−0.018***	−0.018***	−0.018***	−0.013	−0.013	−0.013	−0.003	−0.003	−0.003
	(0.056)	(0.054)	(0.054)	(0.006)	(0.006)	(0.006)	(0.028)	(0.028)	(0.028)	(0.003)	(0.003)	(0.003)
LIQ	−0.007***	−0.007***	−0.007***	−0.002**	−0.002**	−0.002**	−0.003***	−0.003***	−0.003***	−0.004***	−0.004***	−0.004***
	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
BSZ	−0.002	−0.002	−0.002	−0.001*	−0.001*	−0.001*	0.002	0.002	0.002	0.000	0.000	0.000
	(0.003)	(0.005)	(0.005)	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)	(0.000)	(0.000)	(0.000)
GBD	0.000	−0.000	−0.000	−0.000**	−0.000**	−0.000**	0.000	0.000	0.000	−0.000**	−0.000**	−0.000**
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BIND	0.000	0.000	0.000	−0.000	−0.000	−0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6 (continued)

Variables	GMM long− Term debt			LSDVC long− Term debt			GMM short− Term debt			LSDVC short− Term debt		
	1	2	3	4	5	6	7	8	9	10	11	12
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Constant	0.116	−0.172***	0.004	−0.171***	−0.160***	−0.122***	−0.014	0.152***	0.046	0.018	0.014	−0.002
	(0.074)	(0.067)	(0.048)	(0.030)	(0.030)	(0.030)	(0.038)	(0.038)	(0.033)	(0.014)	(0.014)	(0.014)
SOA (%)	0.178	0.145	0.152	0.225	0.205	0.195	0.352	0.283	0.278	0.291	0.301	0.281
AR1(*p*- value)	0.010	0.007	0.031				0.021	0.036	0.005			
AR2(*p*- value)	0.133	0.237	0.125				0.128	0.253	0.163			
Adjusted R^2				0.774	0.652	0.722				0.580	0.574	0.602
Observations	3372	3372	3372	3802	3802	3802	3372	3372	3372	3802	3802	3802

This table reports the results for long-term and short-term, two-stage system GMM and LSDVC results examining how board reforms influence capital structure dynamics. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BrefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ArefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and mortization scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

Table 7 Regression result (board reform and capital structure dynamics)—omission of zero debt firms

Variables	GMM Mlev			LSDVC Mlev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
BrefP	−0.282*			−0.030**			−0.166***			0.043***		
	(0.170)			(0.119)			(0.044)			(0.011)		
RefP		−0.983*			−0.709***			−0.217***			−0.315***	
		(0.550)			(0.098)			(0.058)			(0.010)	
ArefP			0.311**			0.215***			0.094***			0.119***
			(0.143)			(0.079)			(0.025)			(0.010)
PROF	−3.102*	1.472	−1.371	−2.085***	−2.085***	−2.085***	−0.439**	−0.439**	−0.439**	−0.165***	−0.165***	−0.165***
	(1.788)	(2.589)	(1.359)	(0.265)	(0.265)	(0.265)	(0.186)	(0.186)	(0.186)	(0.023)	(0.023)	(0.023)
TAN	3.571*	0.217	0.383	0.610***	0.610***	0.610***	0.151***	0.151***	0.151***	0.089***	0.089***	0.089***
	(1.922)	(0.353)	(0.311)	(0.109)	(0.109)	(0.109)	(0.044)	(0.044)	(0.044)	(0.010)	(0.010)	(0.010)
FSZ	0.172	−0.270	0.189	0.133***	0.133***	0.133***	0.021	0.021	0.021	0.014***	0.014***	0.014***
	(0.227)	(0.405)	(0.204)	(0.020)	(0.020)	(0.020)	(0.028)	(0.028)	(0.028)	(0.002)	(0.002)	(0.002)
MTB	0.108*	0.008	0.080*	0.093***	0.093***	0.093***	0.013*	0.013*	0.013*	0.006***	0.006***	0.006***
	(0.064)	(0.055)	(0.045)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)
NDTS	−3.213	0.289	1.556	4.867***	4.867***	4.867***	0.258	0.258	0.258	0.501***	0.501***	0.501***
	(5.747)	(2.623)	(2.135)	(0.994)	(0.994)	(0.994)	(0.404)	(0.404)	(0.404)	(0.094)	(0.094)	(0.094)
TAX	−0.520	−1.123	−0.790	−0.210**	−0.210**	−0.210**	−0.152	−0.152	−0.152	−0.023**	−0.023**	−0.023**
	(1.904)	(1.796)	(0.914)	(0.096)	(0.096)	(0.096)	(0.128)	(0.128)	(0.128)	(0.009)	(0.009)	(0.009)
LIQ	−0.101	−0.172**	−0.211***	−0.122***	−0.122***	−0.122***	−0.014	−0.014	−0.014	−0.010***	−0.010***	−0.010***
	(0.079)	(0.084)	(0.043)	(0.016)	(0.016)	(0.016)	(0.013)	(0.013)	(0.013)	(0.002)	(0.002)	(0.002)
BSZ	−0.050	0.174	−0.034	−0.012	−0.012	−0.012	0.016	0.016	0.016	−0.001	−0.001	−0.001
	(0.085)	(0.296)	(0.200)	(0.012)	(0.012)	(0.012)	(0.025)	(0.025)	(0.025)	(0.001)	(0.001)	(0.001)
GBD	0.004	−0.058	−0.035*	−0.005***	−0.005***	−0.005***	0.003	0.003	0.003	−0.000**	−0.000**	−0.000**
	(0.007)	(0.038)	(0.020)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.000)	(0.000)	(0.000)
BIND	0.004	0.093	0.020	0.000	0.000	0.000	−0.007*	−0.007*	−0.007*	0.000	0.000	0.000

Table 7 (continued)

Variables	GMM Mlev			LSDVC Mlev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
	(0.010)	(0.060)	(0.033)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.000)	(0.000)	(0.000)
Constant	−2.037	3.020	−0.682	−1.022**	−1.374***	−1.622***	−0.893***	0.364*	−0.442**	0.118**	−0.038	−0.060
	(2.082)	(1.906)	(1.371)	(0.518)	(0.515)	(0.522)	(0.279)	(0.195)	(0.195)	(0.050)	(0.049)	(0.050)
SOA (%)	0.221	0.247	0.317	0.191	0.259	0.334	0.250	0.288	0.349	0.273	0.315	0.353
AR1(*p*-value)	0.010	0.042	0.021				0.008	0.033	0.050			
AR2(*p*-value)	0.109	0.168	0.132				0.172	0.261	0.273			
Adjusted R^2				0.721	0.754	0.691				0.652	0.697	0.662
Observations	3084	3084	3084	3396	3396	3396	3421	3421	3421	3421	3421	3421

This table reports the results, two-stage system GMM and LSDVC results examining how board reforms influence capital structure dynamics when the firms with zero debt are omitted from our sample. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

Table 8 Regression result (board reform and capital structure dynamics)—under levered firms

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
BRefP	−0.718**			−0.041			−0.031			−0.007		
	(0.311)			(0.030)			(0.033)			(0.007)		
RefP		−0.419			−0.100*			−0.046			−0.059***	
		(0.385)			(0.055)			(0.044)			(0.006)	
ARefP			0.293***			0.202***			0.018***			0.035***
			(0.201)			(0.045)			(0.019)			(0.004)
PROF	0.082	−0.249	−3.556*	−0.278***	−0.278***	−0.278***	−0.043	−0.036	−0.043	−0.043***	−0.043***	−0.043***
	(0.988)	(1.037)	(1.982)	(0.102)	(0.102)	(0.102)	(0.165)	(0.121)	(0.165)	(0.011)	(0.011)	(0.011)
TAN	0.087	0.373	6.177**	−0.093	−0.093	−0.093	0.009	0.038	0.009	0.006	0.006	0.006
	(0.756)	(0.581)	(2.809)	(0.088)	(0.088)	(0.088)	(0.051)	(0.042)	(0.051)	(0.008)	(0.008)	(0.008)
FSZ	−0.433*	0.039	0.206	0.084***	0.084***	0.084***	−0.051*	−0.023	−0.051*	0.008***	0.008***	0.008***
	(0.239)	(0.147)	(0.189)	(0.012)	(0.012)	(0.012)	(0.026)	(0.017)	(0.026)	(0.001)	(0.001)	(0.001)
MTB	−0.043	−0.006	0.111	−0.002	−0.002	−0.002	−0.010**	−0.008*	−0.010**	−0.000	−0.000	−0.000
	(0.051)	(0.058)	(0.073)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.000)	(0.000)	(0.000)
NDTS	1.096	1.045	−19.266	−0.582	−0.582	−0.582	−0.343	−0.299	−0.343	0.061	0.061	0.061
	(5.055)	(5.854)	(12.409)	(0.571)	(0.571)	(0.571)	(0.426)	(0.407)	(0.426)	(0.055)	(0.055)	(0.055)
TAX	0.376	−0.167	−0.409	−0.037	−0.037	−0.037	−0.010	−0.071	−0.010	−0.007	−0.007	−0.007
	(1.556)	(1.718)	(2.073)	(0.064)	(0.064)	(0.064)	(0.094)	(0.091)	(0.094)	(0.005)	(0.005)	(0.005)
LIQ	−0.081	−0.080	−0.068	−0.047***	−0.047***	−0.047***	−0.016*	−0.011	−0.016*	−0.005***	−0.005***	−0.005***
	(0.101)	(0.068)	(0.088)	(0.007)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.001)	(0.001)	(0.001)
BSZ	0.647**	0.040	−0.052	−0.013	−0.013	−0.013	0.024	0.006	0.024	−0.000	−0.000	−0.000
	(0.253)	(0.103)	(0.118)	(0.008)	(0.008)	(0.008)	(0.025)	(0.007)	(0.025)	(0.001)	(0.001)	(0.001)
GBD	0.003	−0.008	−0.005	−0.001	−0.001	−0.001	0.004**	0.005*	0.004**	−0.000	−0.000	−0.000
	(0.009)	(0.014)	(0.019)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)
BIND	0.017	0.058	−0.001	0.000	0.000	0.000	0.006*	0.003	0.006*	−0.000	−0.000	−0.000

Table 8 (continued)

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
	(0.014)	(0.052)	(0.014)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)
Constant	−0.632	−1.426	−0.851	−0.391*	−0.441**	−0.510**	−0.070	0.104	0.014	−0.001	−0.052**	−0.050**
	(1.609)	(3.310)	(1.929)	(0.218)	(0.214)	(0.220)	(0.211)	(0.162)	(0.172)	(0.021)	(0.021)	(0.022)
AR1(*p*-value)	0.004	0.001	0.008				0.020	0.010	0.000			
AR2(*p*-value)	0.182	0.124	0.135				0.119	0.241	0.217			
Adjusted R^2				0.723	0.745	0.693				0.766	0.724	0.785
Observations	784	784	784	887	887	887	1519	1519	1519	1519	1519	1519

This table reports the two-stage system GMM and LSDVC results examining how board reforms influence capital structure dynamics, which considers the undelivered firms. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

Table 9 Regression result (board reform and capital structure dynamics)—over levered firms

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
BRefP	−0.363**			−0.568***			−0.287***			−0.056***		
	(0.178)			(0.121)			(0.037)			(0.011)		
RefP		−0.325			−0.694***			−0.344***			−0.409***	
		(0.208)			(0.103)			(0.049)			(0.011)	
ARefP			0.212**			0.233***			0.163***			0.147***
			(0.093)			(0.085)			(0.021)			(0.008)
PROF	−1.990	−1.873	−3.675*	−2.233***	−2.233***	−2.233***	−0.111	−0.258	−0.111	−0.120***	−0.120***	−0.120***
	(2.289)	(1.452)	(1.947)	(0.302)	(0.302)	(0.302)	(0.205)	(0.225)	(0.205)	(0.025)	(0.025)	(0.025)
TAN	−0.060	0.143	3.928**	0.522***	0.522***	0.522***	0.059	0.103**	0.059	0.061***	0.061***	0.061***
	(0.304)	(0.317)	(1.672)	(0.112)	(0.112)	(0.112)	(0.044)	(0.051)	(0.044)	(0.010)	(0.010)	(0.010)
FSZ	0.028	−0.159	0.054	0.078***	0.078***	0.078***	−0.023	−0.005	−0.023	0.005**	0.005**	0.005**
	(0.401)	(0.154)	(0.091)	(0.022)	(0.022)	(0.022)	(0.026)	(0.015)	(0.026)	(0.002)	(0.002)	(0.002)
MTB	0.059	0.055	0.150**	0.104***	0.104***	0.104***	0.011	0.015**	0.011	0.005***	0.005***	0.005***
	(0.069)	(0.040)	(0.067)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.001)	(0.001)	(0.001)
NDTS	1.763	−0.411	−5.447	3.917***	3.917***	3.917***	0.366	−0.029	0.366	0.325***	0.325***	0.325***
	(2.628)	(2.444)	(5.380)	(1.067)	(1.067)	(1.067)	(0.399)	(0.391)	(0.399)	(0.098)	(0.098)	(0.098)
TAX	−1.554	−0.781	−0.930	−0.284***	−0.284***	−0.284***	−0.144	−0.206*	−0.144	−0.021**	−0.021**	−0.021**
	(1.902)	(1.656)	(2.059)	(0.100)	(0.100)	(0.100)	(0.113)	(0.112)	(0.113)	(0.009)	(0.009)	(0.009)
LIQ	−0.103	−0.125*	−0.195**	−0.075***	−0.075***	−0.075***	−0.006	−0.005	−0.006	−0.003	−0.003	−0.003
	(0.086)	(0.064)	(0.095)	(0.020)	(0.020)	(0.020)	(0.007)	(0.008)	(0.007)	(0.002)	(0.002)	(0.002)
BSZ	−0.017	0.007	−0.029	−0.014	−0.014	−0.014	0.035	0.001	0.035	−0.001	−0.001	−0.001
	(0.353)	(0.042)	(0.050)	(0.013)	(0.013)	(0.013)	(0.024)	(0.006)	(0.024)	(0.001)	(0.001)	(0.001)
GBD	0.006	0.007	0.009*	−0.005**	−0.005**	−0.005**	−0.003	−0.002	−0.003	−0.000*	−0.000*	−0.000*
	(0.006)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)
BIND	−0.000	0.034	0.007	−0.000	−0.000	−0.000	−0.000	0.004	−0.000	0.000	0.000	0.000

Table 9 (continued)

Variables	GMM MLev			LSDVC MLev			GMM BLev			LSDVC BLev		
	1	2	3	4	5	6	7	8	9	10	11	12
	(0.010)	(0.030)	(0.008)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.000)	(0.000)	(0.000)
Constant	0.805	2.963***	0.434	3.181***	2.836***	2.556***	− 1.357***	0.473**	−0.576***	0.538***	0.335***	0.315***
	(2.477)	(1.039)	(1.237)	(0.805)	(0.805)	(0.806)	(0.230)	(0.219)	(0.190)	(0.091)	(0.090)	(0.090)
AR1(*p*- value)	0.028	0.011	0.040				0.037	0.010	0.000			
AR2(*p*- value)	0.113	0.116	0.156				0.13	0.184	0.170			
Adjusted R^2				0.717	0.743	0.697				0.762	0.738	0.785
Observations	2588	2588	2588	2840	2840	2840	2208	2208	2208	2208	2208	2208

This table reports the two-stage system GMM and LSDVC results examining how board reforms influence capital structure dynamics, which considers the over-levered firms. Stars indicate the significant level, *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board

Table 10 Endogeneity

Variables	P. score matching		Two-stage Heckman models				WLS models		Quantile models	
	MLev	BLev	MLevered	MLev	BLevered	BLev	MLev	BLev	MLev	BLev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ARefP	0.111***	0.064***		0.188**		0.193***	0.182***	0.153***	0.106**	0.117***
	(0.000)	(0.002)		(0.092)		(0.006)	(0.039)	(0.002)	(0.044)	(0.003)
PROF	0.037***	0.016**	−0.303**	−2.275***	−0.551***	−0.154***	−1.477***	−0.058***	−0.679***	−0.037***
	(0.000)	(0.006)	(0.133)	(0.318)	(0.135)	(0.019)	(0.112)	(0.005)	(0.125)	(0.007)
TAN	−0.017***	−0.010**	1.247***	2.630***	1.191***	0.187***	1.686***	0.071***	1.476***	0.100***
	(0.000)	(0.005)	(0.125)	(0.235)	(0.127)	(0.014)	(0.081)	(0.004)	(0.090)	(0.005)
FSZ	−0.004***	−0.004***	0.493***	0.659***	0.472***	0.033***	0.349***	0.009***	0.380***	0.014***
	(0.000)	(0.001)	(0.016)	(0.050)	(0.016)	(0.003)	(0.009)	(0.000)	(0.010)	(0.001)
MTB	−0.002***	−0.002***	0.012	0.134***	−0.004	0.003***	0.103***	0.002***	0.049***	0.001***
	(0.000)	(0.000)	(0.008)	(0.016)	(0.008)	(0.001)	(0.006)	(0.000)	(0.007)	(0.000)
NDTS	−0.197***	−0.183***	5.645***	7.962***	5.671***	0.339***	5.198***	0.103***	3.426***	0.146***
	(0.001)	(0.035)	(0.803)	(1.741)	(0.821)	(0.103)	(0.599)	(0.029)	(0.671)	(0.039)
TAX	−0.008***	−0.004	−0.384***	−0.676***	−0.427***	−0.043***	−0.504***	−0.018***	−0.306***	−0.011**
	(0.000)	(0.005)	(0.116)	(0.214)	(0.118)	(0.013)	(0.083)	(0.004)	(0.093)	(0.005)
LIQ	−0.003***	−0.003***	−0.239***	−0.654***	−0.261***	−0.036***	−0.261***	−0.008***	−0.159***	−0.008***
	(0.000)	(0.000)	(0.009)	(0.043)	(0.009)	(0.003)	(0.007)	(0.000)	(0.008)	(0.000)
BSZ	0.007***	0.006***	0.007	−0.020	0.007	−0.001	0.004	0.000	0.005	0.000
	(0.000)	(0.000)	(0.012)	(0.022)	(0.012)	(0.001)	(0.008)	(0.000)	(0.009)	(0.001)
GBD	−0.002***	−0.002***	0.001	0.001	0.000	0.000	0.002	0.000**	0.002	0.000
	(0.000)	(0.000)	(0.002)	(0.004)	(0.002)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)
BIND	−0.001***	−0.001***	−0.002	−0.001	−0.002	−0.000	0.001	−0.000	0.001	0.000
	(0.000)	(0.000)	(0.002)	(0.004)	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)
MyLambda				0.943***		0.048***	0.944***	0.028***	0.787***	0.043***
				(0.019)		(0.001)	(0.019)	(0.001)	(0.021)	(0.001)

Table 10 (continued)

Variables	P. score matching		Two-stage Heckman models				WLS models		Quantile models	
	MLev	BLev	MLevered	MLev	BLevered	BLev	MLev	BLev	MLev	BLev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	0.457***	0.472***	−3.627***	−5.702***	−3.245***	−0.236***	−1.716***	0.069***	−2.472***	−0.047***
	(0.000)	(0.018)	(0.225)	(0.722)	(0.227)	(0.041)	(0.150)	(0.007)	(0.168)	(0.010)
Adjusted. R^2	0.998	0.759		0.395		0.417	0.388	0.445		
Pseudo R^2/ Wald Chi^2			0.264		0.262				0.305	0.236
Observations	3802	3727	2588	3802	2208	3802	3802	3727	3802	3727

For space and brevity, we unpacked the results for BRefP and RefP in all models. MLev = Market debt-to-capital ratio; BLev = Long-term debt and short-term debt scaled by total asset; BRefP = a dummy variable, assigned a value of one for the period before major board reform and zero if otherwise; RefP = a dummy variable, taken as 1 if in the actual period of board reform and zero, otherwise; ARefP = a dummy variable with the value of one in the post-reform period and zero is otherwise; PROF = EBIT divided by total asset; TAN = The ratio of fixed asset to total asset; FSZ = Natural log of the total assets; MTB = The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets; NDTS = Depreciation and amortisation scaled by total asset; TAX = Current income taxes divided by income before income taxes; LIQ = Total current Asset divided total current liability; BIND = Percentage of non-executive directors on the board; BSZ = Number of directors on the board; BGD = Percentage of female directors on the board. MLevered is an indicative variable that equals 1 if the firm has a market leverage greater than 1; otherwise equals zero, while BLevered is an indicative variable that equals 1 if the firm has a book leverage greater than 1, otherwise equals zero

managers prefer short-term debt in a low-governance environment. However, we show a positive relationship between ARefP and both components of leverage, suggesting that managers are more willing to be subject to the monitoring effect of both long-term and short-term debt post-reform phase.

Overall, our result suggests that a reformed board facilitates long-term and short-term debt access. The intuition is that increased transparency following corporate board reform will send positive signals to lenders about the company's prospects, thereby reducing the cost of debt. It also implies that firm insiders are more willing to accept debt' monitoring effect after board reform (Tables 7, 8 and 9).

4.2.3 Senstivity analysis—firms' level of indebtedness

To examine the firm's level of indebtedness, first we eliminated observation with zero-debt firms and re-estimated our partial adjustment model as part of our additional analysis. Following Kieschnick and Moussawi (2018) and Chang et al. (2014), we recognised that including such firms may result in wrong inferences regarding firms' debt usage. Consistent with our main result, we find an inverse relationship between BRefP, RefP and market leverage. Also, BRefP and RefP have a negative relationship with book leverage. Particularly, we show that ARefP is positively related to our leverage proxies. We also find a slightly speedier adjustment speed due to the omission of zero-debt firms.

Second we categorised our sample into two categories—over-leveraged and under-leveraged firms to examine the impact of firms' level of indebtedness on our board reform proxies. We show a significant positive relationship between ARefP and leverage for both overleveraged and underleveraged firms. Our results suggest that managers of both over-leveraged and underleveraged and underleveraged firms are more willing to be subject to the monitoring effect of debt after board reform. Previous studies suggest that board reform reduces the cost of debt (Ben-Nasr et al. 2021; Trinh et al. 2020).

4.2.4 Endogeneity test

We further conducted endogeneity and sensitivity tests to ensure our results were robust. We use propensity score matching (PSM) analysis to control for potential endogeneity bias since a firm may have different features which may also influence their tendency to opt for equity or bank financing. We do this by identifying a control sample of firms-years observations in years with no board reform (i.e., control firms), but with similar features to those in years with board reform (i.e., treated firms).

In line with the existing studies (Ben-Nasr et al. 2021), we start by estimating the probability (i.e., propensity score) of being in a year that had a board reform through a Probit regression that regresses ARefP against the control variables and then match without replacement, each treated firm to a control firm that has the closest propensity score using the nearest neighbor matching approach. The propensity score matching procedure yields 3821 observations, including 1223 treated observations and 2598 control observations. We report the results in models 1 and 2 of Table 10. Consistent with our baseline result, we document a positive relationship between ARefP and our leverage proxies. This particular result is important and confirms that the increased leverage in the post-reform period is driven by board reforms rather than differences in firm features between treated and control firms.

We further control for biasness in sample selection using Heckman model. We first use the first stage (see models 3 & 5) to estimate the mills Lambda, which is further used in the second stage as an additional control for sample selection bias (see models 4 & 6). The ARefP variable is positively related to market and book leverage, confirming our main result.

In line with the existing literature (see Bruno 2005), unbalanced data may suffer from multicollinearity and heteroscedastic concerns, which the corrected least squares dummy variable (LSDVC) may not necessarily mitigate. We, therefore, apply weighted least square (WLS) regression as an alternative estimation technique to LSDVC to mitigate issues related to the use of unbalanced panel data in this model. We also use the Mill Lambda estimated in the Heckman model. The results in models 7 and 8 are quantitatively similar to our baseline results. To further mitigate homoscedasticity concerns, we used quantile regressions alongside the Mills Lambda and reported the results in models 9 and 10 of Table 10. The results continue to support our baseline results.

5 Conclusion

This study examines the impact of board reform on the capital structure and SOA of UK firms. Using 12,384 firm-year observations between 2006 and 2020, we show that firms' market and book leverage increased significantly after board reform. This result implies that board reform reinforces debts' disciplinary effect and aligns the interest of principal and agents.

We also find that the speed of leverage adjustment is lowest in the pre-reform phase and highest after the implementation of board reform. Our findings also shows a slightly higher speed of leverage adjustment after excluding zero-debt firms in from our sample.

Using an additional analysis, we find that firms with higher agency cost pre-reform are more likely to implement the monitoring effect of debt. Also, the result of the decompositional analysis shows a positive relationship between BRefp and short-term debt and an inverse relationship with long-term debt. We also find that firms increased both short-term and long-term debt after the board reform, suggesting that improved board monitoring has a positive impact on firm leverage.

We used several robustness tests to confirm the validity of our results. For instance, we confirmed our main result after employing propensity score matching, Heckman tests, weighted least squares, and quantile regression.

Our study has implications for researchers and helps them understand the implications of corporate governance for firms' leverage. The result of this study will also help the board to reinforce the disciplinary effect of debt in resolving agency conflict.

One limitation of this study is its focus on UK firms. Future studies will benefit from cross-country studies that include developing and developed economies.

Appendix

See Table 11

Table 11 Measurement of variables

Variable type	Definition	Measurement
Dependent variable	MLev (Market leverage)	Market debt-to-capital ratio
	BLev (Book leverage)	Long-term debt and short-term debt scaled by total asset
Independent variables	BRefP (Before Reform Period)	BRefP is a dummy variable, asigned a value of one for the period before major board reform and zero if otherwise
	RefP (Reform Period)	RefP is a dummy variable, taken as 1 if one if in the actual period of board reform and zero, otherwise
	ARefP (After Reform Period)	ARefP is a dummy variable with the value of one in the post-reform period and zero is otherwise
Control variables (firm-level factors)	PROF (Profitability)	EBIT divided by total asset
	TAN (Asset Tangibility)	The ratio of fixed asset to total asset
	FSZ (Firm size)	Natural log of the total assets
	MTB (Market-to-book ratio)	The book value of assets less the book value of equity plus the market value of the equity, scaled by total book value of assets
	NDTS (Non-debt tax shield)	Depreciation and amortisation scaled by total asset
	TAX (Taxes)	Current income taxes divided by income before income taxes
	LIQ (Liquidity)	Total current Asset divided total current liability
Control variables (Corporate governance characteristics	BIND (Board independence)	Percentage of non-executive directors on the board
	BSZ (Board Size)	Number of directors on the board
	BGD (Board gender diversity)	Percentage of female directors on the board

Declarations

Conflict of interest None.

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