Revisiting the puzzle of capital structure determinants: an empirical study based on UK firms

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Abstract

Purpose – This study aims to measure impact of several firm-specific factors on alternative measures of leverage. The authors also aim to study impact of the subprime crisis on such associations.

Design/methodology/approach – The authors utilized an unbalanced panel data of 973 firm-year observations on 47 UK listed non-financial firms for the years 1990–2019. Book-based and market-based long-term and total leverage measures have been used as explained variables. The explanatory variables are profitability, size, two measures of growth, asset tangibility, non-debt tax shields, firm age and product uniqueness. Fixed effect and random effect models with clustered robust standard errors have been utilized for data analysis. To find the effect of subprime crisis, original dataset was split to create pre-crisis and post-crisis datasets.

Findings – The authors find that profitability significantly reduces leverage while firms having more tangible assets use significantly more debt in capital structure. Firm size and non-debt tax shield have statistically insignificant positive impact on leverage. Having more unique products reduces use of external debt, albeit insignificantly. Growth, when measured as market-to-book ratio, has inconsistent impact, whereas capital expenditure insignificantly reduces leverage. Age is found to be an insignificant predictor of leverage. After the subprime crisis, firms started relying more on internal fund instead of external debt, more particularly short-term debt. Having more collateral is gradually becoming more important for availing external debt.

Research limitations/implications – Data limitations restrict generalization of the findings.

Originality/value – This is one of the pioneering attempts to show how subprime crisis altered the theoretical domain of capital structure research in the UK.

Keywords Capital structure, Leverage, UK, Trade-off theory, Pecking order theory

Paper type Research paper

1. Introduction

Though capital structure choice is considered as one of the most strategic corporate decisions (Alipour, Mohammadi, & Derakhshan, 2015), the influences of different firm characteristics on leverage remain ambiguous both theoretically and empirically (Kumar, Colombage, & Rao, 2017). Capital structure research started with the ground-breaking work of Modigliani and Miller (1963). They stated that firms set target capital structure to ensure a balance between tax savings from interest payment and potential cost of financial distress. This claim

JEL Classification — G20, G32

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was later formally introduced by Kraus and Litzenberger (1973) as trade-off theory. Several theories of capital structure have been proposed afterward: agency theory (Jensen & Meckling, 1976), pecking order theory (Myers, 1984), and market timing theory (Baker & Wurgler, 2002) to name a few. Each of the prominent theories predict specific impact of different firm attributes on firm leverage. However, though there are empirical supports in favor of all the theories, none of the theories has been unanimously accepted. Several factors contributed towards ambiguity regarding impact of different firm-specific determinants on leverage. Application of wide range of leverage measures (Rajan & Zingales, 1995), lack of uniform measure of firm attributes (Titman & Wessels, 1988), uniform expectation of multiple theories regarding impact of some firm-specific factors on leverage (Myers, 2001), and difference in socio-economic context of different countries (Kumar *et al.*, 2017) etc. made findings consistent with a single theory nearly impossible. Moreover, several financial crises also altered the relationship between many firm attributes and leverage (Danso, Fosu, Owusu-Agyei, Ntim, & Adegbite, 2021; Harrison & Widjaja, 2014). Findings of the papers in the UK context is also perplexing.

This study aims to investigate impacts of several firm specific factors; namely, profitability, size, growth, asset tangibility, non-debt tax shield, age, product uniqueness on leverage of UK firms. Considering the sources of capital structure puzzle, we introduced multiple measures of some of the firm specific determinants to see how measurement of firm attributes may affect the conclusion. We also attempted to see the impact of 2008 financial crisis on capital structure determinants in the UK. 973 firm-year observations for the period 1990-2019 for 47 firms listed in LSE have been analyzed using fixed effect and random effect models with clustered robust standard errors. Market and book measures of total (TDM, TDB) and long-term debts (LTDM, LTDB) have been used as measures of leverage.

We find that both economic and statistical significance of most of the variables fluctuate significantly depending on measure of leverage used as explained variable. We report that profitable firms rely less on all form of external debt, but the coefficient is statistically insignificant in explaining book value of long-term debt. Firm size has significant positive impact on two measures of long-term debt, but the impact is insignificant for both measures of total debt. Asset tangibility is the only variable found to have statistically significant positive impact across all the models. Quite interestingly, non-debt tax shield measured using depreciation generally has positive coefficients. We suppose that the conventional measure of non-debt tax shield rather indirectly represents asset tangibility at least the UK. Firms having more unique products rely less on external debt possibly due to low collateral value. Growth, when measured by market to book ratio (M/B) of asset, shows positive coefficients in book-leverage models but significant negative coefficients in TDM and LTDM models. However, capital expenditure, another measure of growth has consistent negative coefficient. Firm age remains insignificant across all the models. The heterogeneity of coefficients of the variables representing growth and to some extent collateral indicate that lack of uniform definition of firm attributes, along with wide range of leverage measures, make capital structure determinants ambiguous.

The subprime financial crisis substantially altered the capital structure determinants in the UK. We find that the market-based models became more relevant in the UK since the subprime crises. Firms started relying more on internally generated funds since the beginning of the crisis. Having unique product started affecting leverage significantly negatively while coefficient of scaled depreciation became highly significant and positive after the crisis started. These findings suggest that the crisis increased the significance of having more collateral in the process of availing external debt. The direct measures of collateral, i.e. firm size and asset tangibility slightly lost significance since the crisis. Both showed more significant positive impact on leverage before crisis. Growth firms increased

reliance on external debt since crisis. Both before and after the crisis, older firms relied less on external long-term debt. Additional analysis shows that the coefficients of the determinants on leverage differed significantly during and after the crisis. For example, market-to-book ratio had significant negative association with leverage during the crisis while the impact of the variables became mostly insignificant and positive post-crisis. Profitability became economically and statistically more significant after the crisis than the during the crisis period. Non-debt tax shield, an indirect indicator of collateral, became highly significant after the crisis whereas the variable was insignificant both before and during subprime crisis. Having unique products also started significantly reducing leverage post-crisis though the variable was insignificant in other two timespans. Majority of the changes in determinants of capital structure indicate that the pecking order story became more reliable since the sub-prime financial crisis, more pronouncedly after the end of the crisis.

Rest of the paper is structured as follow: section two reviews the empirical literature and dominant theories of capital structure; section three presents the data and methodology; section four discusses the findings. Section five concludes the paper.

2. Theoretical background and prior literature

2.1 Theories of capital structure

2.1.1 Trade-off theory (TOT). Though the first indication of trade-off between potential benefits and costs of using leverage was suggested by Modigliani and Miller (1963), Kraus and Litzenberger (1973), by formally introducing bankruptcy cost as the cost of financial distress, concluded that while setting optimal capital structure, firms try to reach an equilibrium of tax benefit of debts and cost of potential embarrassment due to default. According to TOT, firms will use debt over equity until value of tax shield is less than potential cost of financial distress. According to Myers (1984), under *static trade-off model* with assumption of no cost of adjustment, firm's set-up a target debt ratio and rebalance equity or debt to maximize firm value. But due to existence of adjustment costs in real life, firms may prefer adjusting debt ratio gradually rather than immediately. Debt-ratio stays within a range under such *dynamic trade-off model*. Though TOT is one of the most dominant theories of capital structure, it is criticized on several grounds like failure to reject target adjustment even if it does not happen (Shyam-Sunders & Myers, 1999), and divergence of firms from target (Myers, 1984) etc.

2.1.2 Pecking order theory (POT). Myers and Majluf (1984) and Myers (1984), based on the assumption of information asymmetry, concluded that issuing new equity might significantly reduce share prices as shareholders believe companies to issue equity when shares are overvalued. According to POT, firms with growth opportunities primarily try to finance investment projects using internal funds. Firms might set target dividend to ensure enough internal fund for investment. As debt is less costly than equity, if there are insufficient retained earnings, firms first rely on debt as source of external funding. But firms prefer to keep debt low to maintain "reserve borrowing power". Equity is considered the desperate remedy and according to Myers and Majluf (1984), firms may forego rewarding ventures if equity is to be issued at a lower price. According to the theory, highly profitable firms will have lower leverage and they would not endeavor to adjust debt ratio. The theory makes a strong assumption that managers work in the best interest of the shareholders. Moreover, the theory assumes that the consequences of information asymmetry cannot be avoided. Some researchers (e.g. Frank & Goyal, 2003) however found that internal funds are rarely sufficient to explore investment opportunities and firms rely heavily on outside funds.

2.2 Empirical works

Existing literature critically analyses different firm specific determinants of leverage like firm size, profitability, asset structure, growth opportunities, firm age, non-debt tax shields,

uniqueness, industry effect etc. Country specific factors like inflation, rule of law etc. have also been widely studied. Moreover, after the sub-prime financial crisis, the issue of structural break in the determinants of capital structure has become an interesting issue for analysis. We have considered seven firm specific determinants of capital structure along with impact of the financial crisis.

Though size of firms is a critical determinant of capital structure form multiple point of views (Vo, 2017), relation between them is ambiguous both theoretically (Chen, 2004) and empirically (Bevan & Danbolt, 2004). According to TOT, larger firms have lower probability of default and more transparency (Rajan & Zingales, 1995), and hence they face lower cost of issuing debt. Size is therefore positively related to leverage according to TOT. According to POT on the other hand, larger firms, due to more transparency, will be able to issue equity at lower cost. So, size is expected to have an inverse relationship with leverage. Empirical findings are also mixed. For example, Rabbani (2020), Li and Islam (2019), Moradi and Paulet (2019), Antoniou, Guney, and Paudyal (2008), Frank and Goyal (2009), Hovakimian, Hovakimian, and Tehranian (2004), Bevan and Danbolt (2004, 2002) found significant positive impact of size while Chen (2004) found negative impact. But Bevan and Danbolt (2002) reported the relationship to depend significantly on how leverage is defined. Li and Islam (2019) reported that though firm size typically affects leverage positively, bigger firms in certain industries (retail food and staples industry in Australia in their specific case) may use substantially less external debt. Rabbani (2020) reported in case of Japan that though firm size has significant positive impact on leverage for publicly listed firms, it is statistically insignificant for private firms. Considering that most of the studies report positive association between firm size and leverage, in line with TOT, we hypothesize:

H1. Size has a positive association with leverage.

POT predicts that firms with higher profits issues less debt as they have more internal resources. TOT on the other hand expects that more profitable firms will try to attain higher debt tax shield and will issue more debt. Empirical findings also contradict. Findings of Rabbani (2020), Saif-Alyousfi *et al.* (2020), Li and Islam (2019), Moradi and Paulet (2019), Titman and Wessels (1988), Rajan and Zingales (1995), Bevan and Danbolt (2002), Chen (2004) and Shyam-Sunders and Myers (1999) etc. are consistent with POT. Dakua (2018), Hovakimian *et al.* (2004) found a positive impact of profit on leverage. Vo (2017) found the relationship to depend on definition of leverage. Li and Islam (2019) reported that highly profitable firms in certain industries like technology, food and staple retailing in Australia may rely more on external debt. Consistent with the POT, we make the following hypothesis:

H2. Profitability affects leverage negatively.

According to TOT, higher amount of tangible assets, due to more predictable value, increases collateral value and helps avail more debt (Alipour *et al.*, 2015). POT predicts that existence of more tangible assets reduces information asymmetry (Frank & Goyal, 2009) and curtails equity issuance costs. However, POT also expects a positive impact of tangibility on debt issue. Rabbani (2020), Moradi and Paulet (2019), Frank and Goyal (2009), and Antoniou *et al.* (2008) found asset tangibility to affect leverage positively while Hovakimian *et al.* (2004) found a negative impact. Some studies, e.g. Vo (2017), Bevan and Danbolt (2002) found that the impact of tangible assets is positive on long term leverage but negative on short term debts. Dakua (2018), Titman and Wessels (1988) found no significant effect of collateral on leverage. Saif-Alyousfi *et al.* (2020), using Malaysian sample and by conducting different types of static and dynamic panel regressions, occasionally found insignificant negative associations. In line with the large body of empirical studies, we hypothesize:

H3. Firms with more tangible assets have significantly higher leverage.

Growth is typically measured by the ratio of market value and book value of assets (Frank & Goyal, 2009). High intangibles in high market to book (M/B) firms make debt issuance costly (Harris & Raviv, 1991) and such firms typically face problems with asset substitution (Vo, 2017). Moreover, according to Rajan and Zingales (1995), if market value of stock is higher than book value, firms tend to issue equity instead of debt. Saif-Alyousfi *et al.* (2020), Moradi and Paulet (2019), Antoniou *et al.* (2008), Hovakimian *et al.* (2004) found negative impact of M/B ratio on leverage. POT on the other hand predicts a positive effect of growth on leverage. Findings of Bevan and Danbolt (2002) are consistent with POT when short-term debt is concerned. Li and Islam (2019) found positive impact of M/B on book leverage but a negative impact on market leverage using a large Australian sample. Some researchers (e.g. Titman and Wessels (1988), Frank and Goyal (2009)) used capital expenditure instead of M/B as measure of growth, but none found the coefficients significant. Rabbani (2020) found positive impact of sales growth on financial leverage of Japanese private firms. Saif-Alyousfi *et al.* (2020) applied three different measures of growth while studying in the Malaysian context and reported M/B to result in the most consistent and most significant coefficients while different types of regression models are executed. We make the following hypothesis regarding the association between growth and leverage:

H4. Firm growth significantly reduces leverage.

It can be assumed that firms can accumulate more collateral, build reputation, and reduce problems of information asymmetry as it ages. These factors might influence leverage positively. On the other hand, it is possible that with age, firms become more profitable which, according to POT, affects leverage negatively. Very few studies tests age as predictor of leverage. Rabbani (2020), using a Japanese sample found firm age to have significant and positive impact on leverage of both private and public firms. Saif-Alyousfi *et al.* (2020) found consistent negative impact of firm age on all forms of book-leverage in Malaysia. They however found the associations slightly ambiguous when three market leverage measures were explained. D'Amato (2019) reported significant negative impact of SME age on total and short-term leverage of Italian SMEs but an insignificant positive impact on long-term leverage. Bhaird and Lucey (2010) too found a negative impact of SME age on leverage of Irish SMEs. We make the following hypothesis:

H5. Firm age has significant impact on leverage.

TOT forecasts that leverage is used to reduce tax burden. Thus, if there is high Non-Debt Tax Shield (NDTS) through, e.g. depreciation, investment rebate, TOT expects leverage to drop. Findings of Moradi and Paulet (2019), DeAngelo and Masulis (1980), Hovakimian *et al.* (2004), Deesomsak, Paudyal, and Pescetto (2004) conforms to TOT. Antoniou *et al.* (2008) found a positive impact of NDTS in case of France and USA but negative coefficient for Germany, Japan, and UK. Saif-Alyousfi *et al.* (2020), while combining different measures of leverage and several types of regression models, found both positive and negative coefficients of NDTS. They however found only the positive coefficients statistically significant. Dakua (2018), Chen (2004) found NDTS having insignificant impact on leverage. We hypothesize in line with the TOT:

H6. Non-debt tax shield significantly reduces leverage.

According to Titman and Wessels (1988), if a firm has unique products, it has lower collateral value and this increases cost of debt. Hence firms with unique products are expected to use less debt. They used research and development (RND) expenses as one of the indicators of uniqueness and found negative relationships with all forms of leverage. Frank and Goyal (2009) found a negative relation between RND and total debt. Bhaird and Lucey (2010) found insignificant negative impact of product uniqueness in case of Irish SMEs. Moradi and Paulet

(2019) found significant negative impact of research and development spendings on book leverage and debt-equity ratios of European firms. They however reported insignificant positive coefficients in case of transportation and tourism industry. Following majority of the prior literature, we make the following hypothesis:

H7. Firms making higher investment in research and development have lower leverage.

D'Amato (2019), in his study on a sample of Italian SMEs, by defining 2009-2012 a period of subprime crisis, found statistical and economic significance of firm age, asset tangibility, profitability, sales growth, and NDTS to differ significantly among pre-crisis, crisis, and post-crisis periods. He, however, found coefficients of SME size similar over the three periods. Harrison and Widjaja (2014), based on 331 US firms, found that 2008 financial crisis increased the economic significance of having more collateral. Growth prospects measured by M/B started influencing leverage more negatively after the crisis in their study. They found firm size to lose statistical and economic significance while profitability to lose economic significance after the crisis. They concluded that POT became more relevant post-crisis. Deesomsak *et al.* (2004) too found similar impact of East Asian financial crisis of 1997 on coefficient of tangibility in Asia Pacific countries. Deesomsak *et al.* (2004) also found that liquidity became significant predictor of leverage post-crisis. Recently, Vo, Mazur, and Thai (2022) reported that the impact of different firm-specific factors on speed of adjustment towards target leverage has been substantially changed during the Covid-19 period. Based on the prior literature, we make the following hypothesis:

H8. Impact of the independent variables differ significantly before and after subprime crisis.

3. Data and methods

3.1 Data collection

Our initial dataset consists of 1173 firm-year observations. We at the beginning developed an unbalanced panel dataset for the years 1990-2019 for 47 UK non-financial firms listed in the London Stock Exchange (LSE). Considering the possible effects of the Covid-19 on firm leverage, data related to 2020 has been omitted. The selected firms represent 8 different industries including consumer discretion, consumer staple, industrial, real estate, healthcare, technology, basic material, and energy firms.

3.2 Variables

Several measures of leverage have been utilized in prior literature. Bevan and Danbolt (2002) and Titman and Wessels (1988) emphasized that results of analysis are significantly influenced if short-term debt is excluded from leverage measurement. Prior works also differ in using book value and market value of total asset as denominators. We, therefore, have used four dependent variables incorporating both long-term and total debt and standardized using book-value and market-value of total assets. The total debt indicators are TDB and TDM while long-term debt indicators are LTDB and LTDM. Several firm specific factors, namely profitability, firm size, growth opportunity, asset tangibility, non-debt tax shields, firm age, uniqueness on leverage has been used as independent variables. A detailed list of the variables has been provided in Table A1.

3.3 Descriptive statistics and data cleaning

Table 1 draws attention to the significant difference between mean and median values of different variables. Each of the items have significantly higher mean than median. This indicates

Variable	Mean ('000)	Median ('000)	Minimum ('000)	Maximum ('000)
Total debt	770,000	140,000	0.000	16,500,000
Long term debt	613,000	109,000	0.000	12,400,000
Short term debt	156,000	15,700	0.000	4,060,000
Total asset	3,010,000	720,000	7,330	50,800,000
EBITDA	338,000	86,800	−4,420,000	5,610,000
Operating income	259,000	60,800	−222,000	3,890,000
Net sales	2,850,000	750,000	4480	64,800,000
RND	5,560	0.000	0.000	257,000
Market capitalization	3,260,000	724,000	2020	48,700,000
Total capital	1,860,000	475,000	3160	27,700,000
PPE	1,200,000	159,000	13.00	29,500,000
Capital expenditures	150,000	26,400	4.00	4,490,000
Total intangible asset	777,000	23,700	0.000	40,300,000
TDB	21.4	20.5	0.000	99
LTDB	17.0	15.0	0.000	97.2
TDM	15.0	13.1	0.000	75.0
LTDM	12.2	9.56	0.000	68.2

Source(s): Authors' own work

Table 1. Summary statistics using pre-winsorized dataset

that higher mean values are affected by large extreme values. For example, in case of RND expenses, the median value is zero while mean is far higher. Percentile analysis reveals that RND expense is 0 till 67th percentile. It points to the influence of extreme values on mean. Mean value of total debt is arrived at 78th percentile. Existence of extreme values can further be confirmed by comparing mean against maximum and minimum values. Existence of extreme values points to the need for data trimming.

The problem of significant difference between mean and median is lower when ratios are concerned. Still there remains about two percentage difference between mean and median measures of leverage. Among the leverage ratios, it is striking that total debt and long-term debt were 99% and 97.2% of total asset for some firm. As use of market value of total assets reduced the maximum TDM and LTDM, it indicates market value of assets to be higher than book value of assets. TDM and LTDM based models may therefore resolve problems caused by extreme values.

As descriptive statistics portray existence of extreme values, data has been trimmed. Top and bottom 1% observations of all the variables have been removed to get rid of any effect of extreme values. This reduces our dataset to 973 firm-year unbalanced panel data for final analysis. Fifteen missing values of depreciation were found in the dataset and were replaced by zero.

3.4 Analytical procedure

Before getting into finding the determinants of leverage, we have analyzed how mean leverage changed from 1990 to 2019. We focused on trend of both amounts of debts and leverage ratios. This analysis enlightens us about overall leverage scenario in the UK over the last 30 years. A bivariate analysis using Pairwise Correlation Matrix follows. Finally, we have used fixed effect (FE) and random effect (RE) models to estimate determinants of leverage. To eliminate any potential heteroskedasticity or autocorrelation, clustered robust standard error models have been used. Appropriate models have been selected based on Joint-significance test and Hausman test.

Econometric Model: We focus on the basic econometric model presented in equation (1) to estimate determinants of leverage. It is assumed in equation (1) that leverage of a firm of time

T is determined by independent variables of time T. $LEV_{i,t}$ is substituted by four measures of leverage; namely TDB, LTDB, TDM, and LTDM.

$$LEV_{i,t} = \alpha + \sum \beta_j . X_{i,t} \quad (1)$$

$$LEV = f(\text{PROFIT}, \ln\text{ASSET}, \text{M/B}, \text{TANG}, \text{NDTS}, \ln\text{AGE}, \text{RND}, \text{CPX})$$

Financial Crisis and Leverage: Eight different model have further been developed to investigate impact of sub-prime crisis on determinants of four measures of leverage. We split the dataset following Harrison and Widjaja (2014), i.e. a pre-crisis dataset included data till the year 2007 while post-crisis dataset started from the year 2008. Though the The subprime crisis started in mid-2007 and ended in early 2009 (Reserve Bank of Australia, 2023), we have identified years till 2007 as pre-crisis period, and 2009 as a crisis year. Including 2007 as pre-crisis period is probably justified as capital structure decisions are strategic in nature and firms may need some time to adjust capital structure. Besides, considering the possible posterior impact of the crisis on capital structure, including the year 2010 as crisis year may also be justified.

4. Findings and discussion

4.1 Debt and leverage trends

As can be seen in Figure 1, average long-term debt started rising significantly since 1997 unless there was a slump in 2006. Recovering in 2007, LTD raised to its peak at £687,463 in 2009. Negative effect of sub-prime l crisis on LTD started after 2009 and pushed LTD down to as low as £552,230 in 2012. STD on the other hand dropped sharply from £140,548 in 2008 to £100,358 in 2009, soon after the financial crisis. D'Amato (2019) found in case of Italian SMEs that short-term debt ratio responded to the subprime crisis immediately while long-term debt slowly responded to the crisis. Since 2015, nominal LTD, being around £630,000 on average, is growing smoothly. LTD started to become major part of TD since 2001 and have a correlation of around 0.94.

Total book leverage stayed within 20% and 25% during the period. It was not much volatile even during the financial crisis. But since 2009, with decline in total debt, leverage ratio started to decline. TDM on the other hand was quite volatile during the financial crisis. The sharp rise in total and LTDM ratio in 2008 was possibly caused by significant decline in market value of total asset during financial crisis. But after a period of turmoil, both market and book leverage ratios have been reverted to earlier stage. Our finding extends DeAngelo and Roll (2015), who, based on leverage data till 2008, found Debt/TA ratio to be lower than 20% for majority of the firms. We conclude that, in UK, average total book leverage stayed between 20% and 25% between 1990 and 2019 while TDM remained between 12% and 21%.

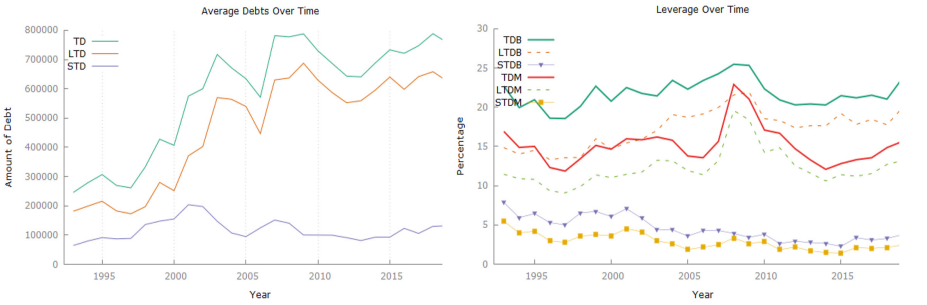

Figure 1.
Debt and leverage ratio trends

Source(s): Author's own work

4.2 Bivariate analysis

The pairwise correlation (Table 2) suggests that profitability, uniqueness measured by RND, and growth denominated by M/B and CPX have significant negative relation with all measures of leverage. Firm size, tangibility of assets, and firm age are positively associated with all measures of leverage. Non-debt tax shield is not statistically significant. Among the independent variables, the highest correlation (0.677) is between M/B and PROFIT. As none of the coefficients among independent variables is more than 0.70, we assume that there is no problem of multicollinearity. VIF test confirms absence of multicollinearity.

4.3 Determinants of leverage

We found support for H1, H2, H3 and H7. The result related to H4 is slightly ambiguous while H5 is rejected. Our findings contradict H6. Our findings are against the claim of Frank and Goyal (2009) that crucial variables are robust to alternative measures of leverage, but in favor of findings of Bevan and Danbolt (2002) that statistical and economic significance of variables differ largely depending on measure of leverage. Moreover, the model fitness data presented in Table 3 also support the findings of prior studies (e.g. Saif-Alyousfi *et al.*, 2020; Li & Islam, 2019; Bevan & Danbolt, 2002; Rajan & Zingales, 1995) that market-based models have better explanatory power.

Coefficients of tangibility is the most consistent in terms of both statistical and economic significance. In line with both TOT and POT, and majority of prior UK based and global studies (e.g. Rabbani, 2020; Moradi & Paulet, 2019; Frank & Goyal, 2009; Antoniou *et al.*, 2008), significant positive relationship between tangibility and all measures of leverage is observed. Thus, high collateral value leads firm to issue more debt. Refuting claims of Vo (2017) and Bevan and Danbolt (2002), the coefficients for tangibility remain effectively unchanged when short-term debt is considered with long-term debt. However, statistical significance of tangibility is higher in market-based models. Profitability, consistent with POT, majority of prior works (e.g. Rabbani, 2020; Saif-Alyousfi *et al.*, 2020; Li & Islam, 2019; Moradi & Paulet, 2019; Titman & Wessels, 1988; Rajan & Zingales, 1995; Bevan & Danbolt, 2002; Chen, 2004; Shyam-Sunders & Myers, 1999), and bivariate analysis, has highly significant negative relationship with leverage. Profitability is statistically insignificant in LTDB model. This finding contradicts with findings of Bevan and Danbolt (2004, 2002) for UK firms, Moradi and Paulet (2019) in case of European Firms, D'Amato (2019) in case of Italian SMEs and claim of Frank and Goyal (2009) that measure of leverage is irrelevant for determining direction and significance of relationship with profitability. Profit becomes

	1	2	3	4	5	6	7	8	9	10	11	12
TDB	1											
LTDB	0.937[a]	1										
TDM	0.833[a]	0.804[a]	1									
LTDM	0.785[a]	0.861[a]	0.948[a]	1								
PROFIT	−0.253[a]	−0.236[a]	−0.446[a]	−0.399[a]	1							
lnASSET	0.250[a]	0.247[a]	0.109[a]	0.131[a]	−0.180[a]	1						
M/B	−0.197[a]	−0.190[a]	−0.494[a]	−0.438[a]	0.677[a]	−0.027	1					
TANG	0.130[a]	0.173[a]	0.287[a]	0.317[a]	0.051	−0.093[a]	−0.183[a]	1				
NDTS	0.011	−0.028	−0.016	−0.039	0.507[a]	−0.205[a]	0.090[a]	0.317[a]	1			
lnAGE	0.086[a]	0.053[c]	0.098[a]	0.067[b]	−0.075[b]	−0.064[b]	−0.128[a]	0.044	−.009	1		
RND	−0.184[a]	−0.161[a]	−0.195[a]	−0.167[a]	0.112[a]	−0.229[a]	0.207[a]	−0.191[a]	0.052	−0.064[b]	1	
CPX	−0.112[a]	−0.126[a]	−0.086[a]	−0.101[a]	0.309[a]	−0.140[a]	0.066[b]	0.573[a]	0.445[a]	−0.042	−0.103[a]	1

Note(s): [a] denotes significance at 1% level; [b] denotes significance at 5%; [c] means significance at 10%
Source(s): Authors' own work

Table 2. Pairwise correlation coefficients

	Dependent variable			
	TDB	LTDB	TDM	LTDM
PROFIT	−0.35568[a]	−0.09094	−0.28421[a]	−0.09044[b]
	(0.000)	(0.188)	(0.003)	(0.049)
lnASSET	0.000217	0.00988[c]	0.00081	0.01169[a]
	(0.968)	(0.052)	(0.955)	(0.001)
M/B	0.01227[b]	0.00312	−0.01704[b]	−0.02067[a]
	(0.020)	(0.533)	(0.012)	(0.000)
lnAGE	−0.005508	0.002158	−0.00779	−0.00881
	(0.652)	(0.852)	(0.774)	(0.254)
TANG	0.05212[c]	0.05591[c]	0.149779[b]	0.14143[a]
	(0.087)	(0.053)	(0.017)	(0.000)
NDTS	0.40198[a]	0.17523	0.085263	−0.01719
	(0.005)	(0.194)	(0.610)	(0.848)
RND	−0.2235	−0.17068	−0.36936[c]	−0.20481
	(0.495)	(0.583)	(0.082)	(0.323)
CPX	−0.03856	−0.14978	−0.126148	−0.18589[a]
	(0.696)	(0.110)	(0.118)	(0.003)
_CONSTANT	0.22325[a]	0.00892	0.177588	0.001268
	(0.001)	(0.892)	(0.418)	(0.977)
Robust std. error	Yes	Yes	Yes	Yes
Model F and $p > F$	3.64	1.89	12.80	23.29
	(0.0004)	(0.0580)	(0.0000)	(0.0000)
Overall R-squared	0.1088	0.1583	0.3193	0.2886
Within R-squared	0.0307	0.0162	0.2692	0.1687
Between R-squared	0.2121	0.2125	0.4584	0.3983

Note(s): [a] = significance at 1% level; [b] = significance at 5%; [c] = significance at 10%
Source(s): Authors' own work

Table 3. Summary of fixed effect regression models on total dataset

economically more significant when short-term debt is included in leverage. This may indicate that firms rely even less on external resources for short-term funding.

Growth, when measured using M/B, provides inconsistent coefficients across the four models. Against the claim of POT, M/B is found to have significant negative impact on the market-based measures of leverages. Antoniou *et al.* (2008) found negative coefficient for growth opportunities across all the G-5 countries for market leverage. The coefficients we found in the book-value models are, on the other hand, consistent with POT. However, M/B is statistically insignificant for LTDB but highly significant for TDB. Our findings are in line with the findings of Li and Islam (2019) who found negative impact of M/B in case of market leverage, but positive coefficients in case of book leverage using Australian sample. Bevan and Danbolt (2002) found significant negative impact of M/B on market leverage and inconsistent impact on book leverage. Inconsistent coefficients of M/B in market and book leverage models contradicts the findings of Saif-Alyousfi *et al.* (2020) in Malaysian case that growth, when measured using M/B has the most consistent negative impact on all measures of leverage irrespective of regression method applied. Impact of growth opportunities has consistent negative impact on all forms of leverage when capital expenditure is used as a proxy. However, the coefficient is significant only in LTDM model. This finding is slightly consistent with Titman and Wessels (1988) who found negative coefficients for capital expenditure in all three market-based models they used. However, they reported positive coefficients in the book models. It is therefore difficult to draw any conclusion on effect of growth on leverage based on our findings. However, three of the four statistically significant coefficients for the two measures of growth are negative which is consistent with TOT.

Findings related to firm size is also generally consistent with the claim of TOT that larger firms rely more on external debt at least when long-term debt is concerned. The coefficient in LTDM model is statistically and economically more significant than the coefficient in the LTDB model. However, inclusion of short-term debt in leverage makes the coefficients for total debt both economically and statistically highly insignificant. This finding contradicts with some prior studies (e.g. D'Amato, 2019; Saif-Alyousfi *et al.*, 2020; Moradi & Paulet, 2019) who found consistent significant positive impact of firm size on different measures of leverage across different industries. We also find that NDTS has positive impact, albeit mostly insignificant except in the TDB model, on leverage. NDTS is found to have significant positive association with TDB. This finding is against the TOT but is partially supported by Antoniou *et al.* (2008). Moradi and Paulet (2019) also found positive impact of NDTS on book leverage measures in European sample, though the finding was not pronounced in all industries. Antoniou *et al.* (2008) found positive coefficient for NDTS in the model with all the G5 countries in the sample and explained the positive coefficient of NDTS, i.e. scaled depreciation, to be rather related to the notion of collateral value. The statistically significant positive coefficient of NDTS in the TDB model may indirectly indicate that tangibility increases use of debt, especially the short-term debt. NDTS is found to affect LTDM negatively, albeit statistically insignificantly. Our findings relate to NDTS take similar pattern of the findings of Saif-Alyousfi *et al.* (2020) who found only few positive coefficients of NDTS statistically significant, and all the negative coefficients statistically insignificant while studying Malaysian firms. Moreover, the consistently negative coefficients of RND may be interpreted with reference to Moradi and Paulet (2019) and Titman and Wessels (1988). They claim that product uniqueness reduces collateral value of firms and in effect, reduces use of debt by increasing cost of debt. However, we found statistical significance of the coefficient only in the TDB model. Though no conclusion could be made regarding impact of growth on leverage due to the ambiguity created by alternative proxies of growth, by observing coefficients of firm size, asset tangibility, product uniqueness, and scaled depreciation that having more collateral may affects leverage positively. The heterogeneity of coefficients of the variables representing growth and to some extent collateral indicate that lack of uniform definition of firm attributes, along with wide range of leverage measures, make capital structure puzzle even more ambiguous. Our findings indicate that age is insignificant predictor of leverage.

4.4 Impact of financial crisis on determinants of capital structure

We find support for H8 that subprime crisis affected determinants of capital structure in the UK. In Table 4, we see that the overall R-squared of the models show that market-based models gained explanatory power during and after the financial crisis while before the crisis, book value models were capable to predict more variations in leverage. Overall R-squared of TDM and LTDM models increased from 0.1191 to 0.3097 and from 0.0826 and to 0.1355 respectively. Overall R-squared of TDB and LTDB models on the other hand declined from 0.1668 to 0.1563 and 0.1689 to .01040 respectively.

Before the financial crisis, there was insignificant impact of profitability on both measures of long-term debt. However, due to high reliance of firms on internally generated fund for short-term loans, profitability showed significant negative impact on both the measures of total debt. Quite interestingly, after the financial crisis, firms increased their reliance on internal fund even for long-term debts. As a result, coefficient of profitability became statistically significant after the crisis for all measures of debt. Moreover, economic significance of the variable also experienced a bump. This result contradicts with the US based findings presented by Harrison and Widjaja (2014) but is consistent with the East Asian financial crisis-based findings of Deesomsak *et al.* (2004). D'Amato (2019) also reported

Table 4.
Capital structure determinants in the UK before (1990-2007) and after the subprime crisis started (2008-2019)

	Before financial crisis				After financial crisis			
	TDB	LTDB	TDM	LTDM	TDB	LTDB	TDM	LTDM
PROFIT	−0.3742[a]	−0.0994	−0.2538[a]	−0.0376	−0.6849[a]	−0.4878[a]	−0.4658[a]	−0.3239[a]
	(0.000)	(0.209)	(0.000)	(0.498)	(0.000)	(0.000)	(0.000)	(0.000)
lnASSET	0.0224[a]	0.0236[a]	0.00002	0.0023	0.0210[b]	0.0135	0.0003	0.0011
	(0.000)	(0.000)	(0.997)	(0.688)	(0.020)	(0.116)	(0.958)	(0.903)
M/B	−0.0149[b]	−0.0263[a]	−0.0396[a]	−0.0379[a]	0.0176[b]	0.0138[b]	−0.0113[b]	−0.0097[b]
	(0.031)	(0.000)	(0.000)	(0.000)	(0.013)	(0.039)	(0.026)	(0.040)
lnAGE	−0.0129	−0.0120	−0.0667[a]	−0.0729[a]	−0.0147	−0.0323[c]	−0.0174	−0.0604[a]
	(0.283)	(0.282)	(0.000)	(0.000)	(0.451)	(0.083)	(0.163)	(0.008)
TANG	0.0566	0.0583	0.1100[a]	0.1052[a]	0.0471	0.0309	0.1335[a]	0.0568
	(0.149)	(0.119)	(0.001)	(0.001)	(0.385)	(0.548)	(0.000)	(0.213)
NDTS	0.5076[a]	0.2363	0.0566	−0.1091	0.8549[a]	0.5193[b]	0.4315[a]	0.2468[c]
	(0.001)	(0.106)	(0.593)	(0.294)	(0.000)	(0.012)	(0.006)	(0.098)
RND	−0.2853	−0.1299	−0.1788	−0.0408	−0.8803[b]	−0.8049[b]	−0.6258[a]	−0.9161[b]
	(0.312)	(0.631)	(0.402)	(0.845)	(0.011)	(0.016)	(0.005)	(0.044)
CPX	0.0099	−0.0399	−0.0571	−0.0417	0.0554	0.0838	0.0271	0.1319
	(0.924)	(0.694)	(0.4400)	(0.565)	(0.761)	(0.623)	(0.833)	(0.280)
_CONSTANT	0.00004	−0.0769	0.4372[a]	0.3557[a]	−0.0017	0.1362	0.2449[a]	0.3808[a]
	(0.993)	(0.357)	(0.000)	(0.000)	(0.990)	(0.298)	(0.008)	(0.001)
Robust std. error	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald chi-square and $p >$ chi-square	57.54	45.16			58.46	34.87	149.79	
	(0.000)	(0.000)			(0.000)	(0.000)	(0.000)	
Model F and $p >$ F			8.50	5.75				10.67
			(0.000)	(0.000)				(0.000)
Overall R-squared	0.1668	0.1689	0.1191	0.0826	0.1563	0.1040	0.3097	0.1355
Within R-squared	0.0855	0.0590	0.3207	0.2421	0.1064	0.0611	0.2218	0.1763
Between R-squared	0.2578	0.2915	0.1658	0.1311	0.1914	0.1595	0.4370	0.2195

Note(s): [a] denotes significance at 1% level; [b] denotes significance at 5%; [c] indicates significance at 10%
Source(s): Authors' own work

economic significance of profitability to increase substantially during subprime crisis. He however found profitability to lose economic significance after 2012.

Coefficients of growth measured by M/B has also experienced significant change. The coefficients in the book leverages models changed from significantly negative to significantly positive. D'Amato (2019) also reported coefficients of growth, though measured as percentage change in sales growth, to alter from significant and negative to positive and significant in case of Italian SMEs. Although the coefficients of M/B in our TDM and LTDM model remained negative and significant, both lost economic and statistical significance. Similar impact was experienced in East Asian market after 1997 financial crisis (Deesomsack *et al.*, 2004). Capital expenditure, another indicator of growth, consistently had statistically insignificant impact on four forms of leverage. However, the economic significance of the variable changed slightly. Coefficient for capital expenditure were mostly negative before financial crisis, while all the four coefficients have been found positive post crisis.

Tangibility slightly lost both economic and statistical significance in models for TDB, LTDB post crisis. In LTDM model, the coefficient was highly significant before crisis but became insignificant post crisis. However, both statistical and economic significance of tangibility increased in the market-based total debt model. Ambiguous change in statistical and economic significance of asset tangibility due to subprime crisis was reported by D'Amato (2019). They reported asset tangibility to gain economic and statistical significance in explaining long term debt but to lose both types of significance in models explaining total debt of Italian SMEs. Moreover, both statistical and economic significance of NDTS, an indirect measure of tangibility, increased dramatically after the financial crisis. NDTS is found to have significant positive impact on all the four measures of leverage after the financial crisis. D'Amato (2019) also reported NDTS to gain both economic and statistical significance in explaining long-term debt ratio during and post subprime crisis. He however reported the variable to lose both the significances while explaining total debt. Based on the coefficients of both measures of tangibility, it may be stated that having more tangible assets became more important in availing all forms of debt after the crisis. Danso *et al.* (2021) also reported higher significance of tangible assets post-crisis in Japan. However, their decision was based on direct measure of tangible assets.

Size represented by lnAsset lost both statistical and economic significance post financial crisis, especially when long-term debt is concerned. Larger firms, after the crisis, could not or did not avail more debt after the financial crisis. Harrison and Widjaja (2014) also found similar impact of crisis on coefficient of firm size in the USA. Moreover, product uniqueness denominated by RND became statistically significant after the financial crisis. The consistent negative coefficient after the crisis indicates that having unique product, or having lower collateral value in other words, became a barrier to getting loan after the financial crisis. Besides, though firm age is found insignificant across all the four models with total data, is has been found to affect TDM and LTDM significantly positively before the crisis. However, after the financial crisis, it showed a statistically significant negative impact on both forms of long-term debt. Older firms in the UK rely less on external debt long-term after the financial crisis.

We show that the sub-prime financial crisis altered impact of almost all the determinants under our study. Majority of the changes in determinants of capital structure, i.e. increased reliance on internal profit, less reliance of large firms and firms with unique products on external debt, high reliance on external fund by firms with more tangible asset indicate that Pecking Order Theory (POT) became more dominant after the sub-prime financial crisis. These findings, based on UK evidence, re-establishes the American firm-based claim of Harrison and Widjaja (2014) that POT became more dominant after the 2007-2008 financial crisis. Kumar *et al.* (2017), a study reviewing literature on determinants of capital structure, also confirmed dominance of POT in recent empirical works.

4.5 Practical implications

Our key findings have vast implications for firms availing and providing external debts and accounting policymakers.

Firms willing to introduce more debt in their capital structure, and those willing to lend to such firms may critically analyze our findings to understand who can avail more debt, both short and long term. Potential borrowers having substantial profits would be aware reading our findings that they may prioritize profits rather than external debt as source of fund, especially when the need is short-term. This may particularly be important to rely less on external debt for short-term purposes post Covid-19 pandemic. Both borrowing and lending firms may also be aware from our findings that having more collateral value of firm is important in availing external debt, and significance collateral is substantially more during and after financial crises. This finding may imply that, now, after the Covid-19 pandemic, significance of having collateral has increased while availing external debt. Both borrowers and lenders would get to know from our findings that lending or borrowing propensity is not typically affected by age or maturity of borrowing firms.

The findings that market-leverage measures have better explanatory power than book-leverage measures, and market-leverage models are getting even stronger after the exogenous shocks have immense implications for accounting practitioners and policymakers. This may indicate that the conventionally practiced historical cost accounting is losing significance while the relevance of fair value accounting is increasing over time. Accounting policymakers may therefore want to further investigate how fair value accounting is gaining significance in explaining different financial and economic phenomena.

Though we have used a small sample of 47 firms, they represent eight industries with significant market capitalization. Moreover, as the firms have been selected randomly, we believe, the firms represent at least the eight industries, if not all the listed UK firms. Considering the high market capitalization of the industries of concern, our finding may have immense implication in general. Moreover, while explaining our findings, we have always referred to papers utilizing large samples. For example, our findings related to impact of subprime crisis on impact of capital structure determinants are supported by several studies (e.g. Harrison & Widjaja, 2014; D'Amato, 2019) utilizing large samples. Our findings, though based on a relatively small sample, therefore have a credible implication to the best of our understanding.

4.6 Additional analyses

4.6.1 Using lagged independent variables. While we have used independent variables of time t to explain capital structure of time t, someone may presume that capital structure of current year is rather affected by firm profitability, growth, size etc. of the previous year due to time required by firms to adjust capital structure. Lagged independent variables may also have different impact than independent variables themselves. To check this, we have run eight more models (results not presented). In four models, we used only lagged variables while in the other four, we used both lagged and current values of independent variables. We find that coefficients of the lagged independent variables are fairly consistent with the coefficients of independent variables when only lagged variables are used instead of the independent variables of time t. When independent variables of time t and (t-1) are used together, the coefficients of independent variables of time t also remained mostly consistent with Table 3. The coefficients of lagged independent variables, in some instances (e.g. coefficients of PROFIT, lnASSET, M/B) showed opposite direction to the coefficients of independent variables of time t. For the models using independent variables of both time t and (t-1), we also estimated the summation of coefficients of the independent variables of the two years and their respective statistical significance. The direction of such summed coefficients is largely

consistent with Table 3 presented in section 4.3. However, such coefficients are infrequently statistically significant in book leverage models, more specifically LTDB model. Coefficients in market leverage models are more consistent with Table 3.

4.6.2 Additional test of impact of subprime crisis on the determinants of capital structure. Many prior studies (e.g. Vo *et al.*, 2022; D'Amato, 2019) emphasize that the impact of different predictors of capital structure differ substantially before, during, and after financial crises. Moreover, to ensure econometric accuracy, it is important to incorporate similar timespans in two datasets to make the results comparable. To address how significance of the coefficients changed during and after the subprime crisis, we further split the dataset in three and defined data for the years 1999-2007 as pre-crisis dataset, data for the years 2008-2010 as crisis time dataset, and data for the years 2011-2019 as post-crisis dataset. We conducted 12 additional fixed/random effect models with robust standard errors. The appropriate model was selected after conducting Hausman test.

As Table 5 shows, the variable PROFIT became economically more significant in the crisis period while it was both statistically and economically even more profound after the financial crisis. This indicates that profitable firms started relying more on internal fund since the beginning of subprime crisis and the reliance increased further post-crisis. Higher statistical and economic significance of total debt measures compared to long-term debt measures indicate that firms started relying more on internal fund more specifically for short term funding.

Since the subprime crisis, external debt is availed more by firms with higher collateral value. This trend can be explained with reference to a number of variables. Coefficients of size (lnAsset) were generally negative and statistically insignificant pre-crisis while all the coefficients during and after the crisis are positive. Coefficient of size in TDM model during crisis, TDB and LTDB models after the crisis are statistically highly significant. The coefficients of NDTS are generally positive but statistically insignificant before and during the financial crisis. Three of the coefficients of NDTS are however highly statistically and economically significant post crisis. In fact, post-crisis NDTS has the largest coefficients among all the models. This indirectly indicate that though having more collateral was not very significant during crisis, it became more significant post-crisis. Firms with more unique products (higher RND) started availing significantly less external debt post-crisis. Having unique products however did not significantly affect capital structure during the crisis. The only finding contradictory with our claim of higher relevance of collateral during and post crisis is the trend of coefficients of asset tangibility. Though TANG was positive and generally statistically significant pre-crisis, it lost both statistical and economic significance during and post crisis.

The impact of firm growth on leverage also changed substantially over time. M/B became economically and statistically more significant during the financial crisis. Firms with higher market-to-book ratios relying less on external debt during the subprime crisis. The variable however shows ambiguous, and generally statistically insignificant coefficients post crisis. The coefficients of capital expenditure and firm age generally remained statistically insignificant in almost all the models.

Based on the above additional analysis, we conclude that POT became more dominant since the beginning of subprime crisis. It generally became more profound in the post-crisis period though some findings are more consistent with POT during the crisis period.

4.6.3 Using alternative years as post-crisis periods. While defining crisis period in our original analysis, we also included 2010 as crisis year considering any potential posterior impact of the subprime crisis. But this may affect our findings of section 5.5.2 significantly if no such posterior impact is prevalent. To check validity of our results, we have used alternative post-crisis period (2010-2019) to split data. The statistical and economic significance of all the coefficients remain almost identical when data for alternative post-crisis

Table 5.
Capital structure determinants in the UK before, during and after the subprime crisis

	1999-2007				2008-2010				2011-2019			
	TDB	LTDB	TDM	LTDM	TDB	LTDB	TDM	LTDM	TDB	LTDB	TDM	LTDM
PROFIT	−0.2903[a]	−0.1458	−0.2215[a]	−0.1172[c]	−0.3914[a]	−0.2180	−0.4892[a]	−0.2585[c]	−0.8436[a]	−0.6752[a]	−0.4204[a]	−0.2913[a]
	(0.0023)	(0.0715)	(0.0014)	(0.0934)	(0.0007)	(0.1237)	(0.0075)	(0.0622)	(0.0000)	(0.0000)	(0.0000)	(0.0014)
lnASSET	−0.0196	−0.0032	−0.0037	0.0019	0.0189	0.0128	0.1124[b]	0.0081	0.0310[a]	0.0454 [a]	0.0073	0.0029
	(0.1270)	(0.7425)	(0.6331)	(0.7923)	(0.1709)	(0.3549)	(0.0397)	(0.3840)	(0.0013)	(0.0029)	(0.3654)	(0.6693)
M/B	0.0043	−0.0087	−0.0292[a]	−0.0275[a]	−0.0281[a]	−0.0359[a]	−0.0303[b]	−0.0466[a]	0.0343	0.0283[a]	−0.0042	−0.0060
	(0.5211)	(0.2615)	(0.0000)	(0.0000)	(0.0064)	(0.0050)	(0.0271)	(0.0002)	(0.0007)	(0.0060)	(0.3872)	(0.2698)
lnAGE	−0.0020	−0.0043	−0.0273	−0.0051	−0.0155	−0.0265	−0.3725[a]	−0.0084	−0.0093	−0.0828[b]	0.0098	−0.0230
	(0.9685)	(0.7799)	(0.2643)	(0.5723)	(0.5315)	(0.2755)	(0.0088)	(0.6037)	(0.6694)	(0.0175)	(0.7725)	(0.3660)
TANG	0.1541[b]	0.1021	0.1941[a]	0.1598[a]	0.0508	0.1444	0.0730	0.1574[b]	0.0936	−0.0043	0.1143	0.0740
	(0.0150)	(0.0574)	(0.0010)	(0.0003)	(0.5596)	(0.1248)	(0.6666)	(0.0245)	(0.3477)	(0.9808)	(0.1391)	(0.3340)
NDTS	0.0833	0.0694	−0.0865	−0.1247	0.1730	−0.2733	0.3924	0.0210	1.0901[a]	0.8832[a]	0.4804[a]	0.2903
	(0.5539)	(0.6371)	(0.4686)	(0.3318)	(0.5429)	(0.4308)	(0.2996)	(0.9478)	(0.0000)	(0.0017)	(0.0094)	(0.1342)
RND	−0.3810	−0.6623	−0.0298	−0.1327	−0.4395	−0.0579	0.0687	0.1809	−0.8367[a]	−0.8859	−0.8041[c]	−0.6672
	(0.5299)	(0.0597)	(0.9411)	(0.5476)	(0.5893)	(0.9449)	(0.9774)	(0.7592)	(0.0000)	(0.1266)	(0.0963)	(0.1204)
CPX	−0.0854	−0.2642	−0.0906	−0.2393[b]	0.2946	−0.4308	0.1830	−0.4516	−0.0703	0.2823	0.0764	0.1814
	(0.5036)	(0.0321)	(0.4007)	(0.0263)	(0.2250)	(0.1466)	(0.5946)	(0.1135)	(0.7231)	(0.1694)	(0.5258)	(0.1353)
CONSTANT	0.4682[a]	0.2573	0.3241[a]	0.1463	0.0893	0.1860	0.1257	0.1435	−0.1952	−0.1305	0.0111	0.1826[b]
	(0.0003)	(0.0847)	(0.0012)	(0.1832)	(0.6758)	(0.3894)	(0.8570)	(0.3324)	(0.3236)	(0.3537)	(0.9144)	(0.0315)
Robust std. error	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Model chi-square, P value		25.7395 (0.0012)		118.157 (0.0000)	35.1053 (0.0000)	23.3626 (0.0029)		35.7448 (0.0000)	288.932 (0.0000)			
Overall R-squared		0.1674		0.3986	0.1907	0.2002		0.3627	0.1730			
LSDV R-squared	0.8268		0.8551				0.9381			0.8420	0.8705	0.8779
Within R-squared	0.0809		0.2987				0.3305			0.0852	0.1603	0.1140

Note(s): [a] denotes significance at 1% level; [b] denotes significance at 5%; [c] indicates significance at 10%
Source(s): Authors' own work

period is analyzed. We have also analyzed how to statistical and economic significance of the independent variables varies in Table 5 is alternative crisis periods are used. We have used three alternative crisis periods (2008-2010, 2007-2009, and 2007-2010). The results (not reported) shows that the direction of the coefficients of the statistically significant variables (PROFIT, lnASSET, M/B, lnAGE) across three alternative crisis periods remain consistent. All the coefficients with reversed direction are statistically insignificant.

5. Concluding remarks

This study finds that long-term debt, the most significant component of total debt of UK firms, did not drop immediately when the subprime crisis hit while short-term debt responded swiftly. Average nominal long-term debt reverted to pre-crisis amount much earlier than did short-term debt. Using four measures of leverage as dependent variables in fixed effect and random effect models, we also find that market-based leverage models have more explanatory power. Moreover, we generally find that either statistical or economic significance of all the variables vary largely if short-term debt is included in the leverage, or market-based leverage is used instead of book leverage measures. Only tangibility showed significant impact on all forms of leverage. Quite interestingly, we found that the measure of non-debt tax shield used by prior researchers is rather indirect representation of asset tangibility. Subsequent analysis shows that the subprime crisis had a dramatic impact on determinants of leverage in the UK. Market-based leverage models became more reliable since the financial crisis while book leverage models had more explanatory power before the crisis. Firms started relying more on internally generated funds and larger firms reduced their dependence on external debt. But it cannot be obviously concluded based on our findings whether firms need more collateral to avail external debt in the UK since the subprime crisis. Having unique product started affecting leverage significantly negatively while coefficient of scaled depreciation became highly significant and positive since the crisis. These findings suggest that having higher collateral became more important due to the crisis. The direct measures of collateral, i.e. firm size and asset tangibility slightly lost significance since the crisis. Both showed more significant positive impact on leverage before crisis. We conducted additional analysis to check whether impacts of the independent variables were different during and after the crisis period. In line with prior literature (e.g. D'Amato, 2019), we found that the coefficients of the independent variables differ dramatically in the two periods. We conclude based on the observed changes in coefficients of profitability, firm size, product uniqueness, asset tangibility, and NDTS that POT is becoming more relevant in the UK over time since the subprime crisis. Some limitations of our study may be utilized as future research avenue. For example, as our study relies on a small sample from a few industries, future studies maybe conducted using a larger panel data of UK firms. Future studies may also investigate impact of the subprime crisis by differentiating between crisis years and post-crisis years. Moreover, as we have omitted data from the year 2020 to keep the analysis of the post-crisis determinants of leverage unaffected by the pandemic year, studies may also be conducted to see whether the determinants of leverage during the subprime crisis and during the Covid-19 pandemic were similar. This may help reach a decision whether leverage dependence of firms is affected similarly by different forms of financial crises.

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(The Appendix follows overleaf)

Appendix

Variable	Definition	Relevant literature
Dependent variables		
TDB	Total Debt* scaled by book value of total asset (BVTA)	Saif-Alyousfi *et al.* (2020), Antoniou *et al.* (2008), Korajczyk and Levy (2003)
LTDB	Long-term debt scaled by BVTA	Saif-Alyousfi *et al.* (2020), Titman and Wessels (1988)
TDM	Total debt scaled by market value of total asset (MVTA)**	Deesomsak *et al.* (2004), Korajczyk and Levy (2003), Frank and Goyal (2009), Antoniou *et al.* (2008)
LTDM	Long-term debt scaled by MVTA	Korajczyk and Levy (2003), Titman and Wessels (1988)
Independent variables		
PROFIT	EBITDA divided by BVTA	Vo *et al.* (2022), D'Amato (2019), Dakua (2018), Bevan and Danbolt (2004), Rajan and Zingales (1995)
lnASSET	Natural logarithm of Sales representing firm size	D'Amato (2019), Saif-Alyousfi *et al.* (2020), Dakua (2018), Rajan and Zingales (1995), Titman and Wessels (1988), Antoniou *et al.* (2008)
M/B	MVTA/BVTA	Vo *et al.* (2022), Li and Islam (2019), Deesomsak *et al.* (2004), Rajan and Zingales (1995)
TANG	Property, plant, and equipment scaled by BVTA	Following Shyam-Sunders and Myers (1999), PPE is used as proxy for fixed asset. Also used by Vo *et al.* (2022), Saif-Alyousfi *et al.* (2020), D'Amato (2019), Li and Islam (2019)
NDTS	Depreciation*** scaled by BVTA	Vo *et al.* (2022), D'Amato (2019), Dakua (2018), Antoniou *et al.* (2008), Deesomsak *et al.* (2004), Chen (2004)
lnAGE	Natural logarithm of firm age	D'Amato (2019), Saif-Alyousfi *et al.* (2020), Bhaird and Lucey (2010)
RND	Research and development expense scaled by sales revenue	Titman and Wessels (1988) Frank and Goyal (2009)
CPX	Capital expenditure scaled by BVTA	Titman and Wessels (1988), Frank and Goyal (2009)

Note(s): * Due to data limitations, book value instead of market value of debt has been used
** Following Bevan and Danbolt (2002), Market Value of Total Asset has been calculated as follows
MVTA = BVTA -BVE + MVE
*** Depreciation = EBITDA – Operating Income
Source(s): Authors' own work

Table A1.
List of variables

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