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The joint effects of economic policy uncertainty and firm characteristics on capital structure: Evidence from US firms

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ABSTRACT

This study explores empirically how economic policy uncertainty (EPU) and firm characteristics jointly affect the capital structure decisions of US firms. Using the most comprehensive measure of EPU available, we conceive a research framework by allowing EPU to interact with firm characteristics in dynamic panel regression models, and control for general economic uncertainties and financial crises. Our results reveal that EPU and firm characteristics are jointly important in shaping companies' debt-financing decisions. The marginal effects of a firm's characteristics on debt ratios are not constant but change with EPU even in their signs. The marginal effect of EPU on debt ratios is not uniform in the cross-section due to firms having different characteristics and can be positive for some firms while negative for others. However, on average, a rise in EPU would cause economically significant declines in the debt ratios of firms.

1. Introduction

Is economic policy uncertainty (EPU) important for capital structure decisions? Are the effects of firm characteristics on leverage constant with theoretically predicted signs? How might EPU work jointly, not independently, with firm characteristics in shaping corporate debt-financing decisions? The present study attempts to probe into these questions, motivated by the theoretical and empirical considerations detailed below.

Theoretical work has demonstrated that firms' financing decisions, such as capital structure choice, will change as macroeconomic conditions shift over time. In some models (e.g., Hackbarth et al., 2006), the values of corporate debt and equity and the default thresholds selected by shareholders will vary as the business cycle phase differs, so will capital structure which depends on these values and thresholds. In some others (e.g., Chen, 2010), business cycle variation drives changes in expected growth rates, economic uncertainty and risk premiums, thereby making capital structure decisions dynamic and state-dependent. Further, the growing empirical literature on EPU has suggested that policy uncertainty shocks foreshadow deteriorations in macroeconomic conditions (e.g., Brogaard and Detzel, 2015; Klossner and Sekkle, 2014). All these findings naturally imply that a link between EPU and capital structure choice is not simply a statistical correlation. In fact, a recent study by Cao et al. (2013) develops a theoretical model to formally predict the causal relation from political uncertainty to capital structure choices. The model suggests that high political uncertainty increases corporate borrowing costs, thereby

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leading firms to lower leverage in order to maintain financial stability. Empirical evidence offered by the authors supports the prediction.

Therefore, whether theoretically or empirically, there is little doubt that EPU does impact firms' capital structure decisions. However, conventional corporate finance theories pay attention only to the relation between leverage and firm characteristics, without allowing for EPU at all. An interesting question arises: How do we reconcile the EPU-leverage nexus recently suggested by Cao et al. (2013) and the well-established characteristics-leverage nexus without prejudice to either one of the two? This amounts to asking whether EPU as a systematic factor interacts with idiosyncratic firm characteristics in affecting leverage decisions.

The importance of EPU for capital structure decisions is way under-researched. Until very recently, researchers and theories of capital structure had ignored EPU. Recent empirical studies have started to explore the responses of corporate investment, rather than capital structure decisions, to government policy uncertainty. For instance, a multi-country study of Julio and Yook (2012) show that firms reduce investment expenditures when political uncertainty is high during election years. Further, Gulen and Ion (2016) document that US corporations reduce capital expenditure on investments when EPU is high.

Regarding the effect of EPU on capital structure, the study by Cao et al. (2013) is most closely related to ours. While developing a theoretical model as noted above, that study empirically looks at the effect of EPU on the time length of a stable leverage ratio regime (not leverage *per se*) for US firms. As such, the study does not provide any empirical evidence on how the capital structure choices of US firms vary as a function of EPU. Besides, Cao et al. (2013) does not explore the possibility that a firm's target level of financial leverage may depend on both EPU and characteristics, towards which the firm adjusts partially. In addition, as far as the measure of EPU is concerned, that study employs the overall EPU index consisting only of three components, while the newly updated overall EPU index now comprising four components is available for our study.

Many capital structure studies have focused on whether the relations between firm characteristics and debt ratios are positive or negative, to test the predictions of conventional theories such as the trade-off, pecking order and market timing models. See, for example, Fama and French (2002) and Frank and Goyal (2009), to just name a few. Prior work fails to allow for the above-articulated possibility that firms' debt financing behaviour may well be affected by EPU. This possibility suggests that the leverage-characteristic relation may not be constantly positive or negative, and so merits exploring.

The limitations of existing studies identified above comprise a void for us to fill, and we do so by focusing on US firms. To our knowledge, we are the first to examine the *joint* impact of EPU and firm characteristics on leverage. To better serve our purposes of scrutinizing the joint impact, we conceive a research framework by allowing EPU to interact with firm characteristics in dynamic panel regression models. This framework proves successful in making our analyses richer to provide a broader and deeper insight not seen in the existing corporate finance literature.

One may presume that EPU is a subset of macroeconomic conditions or general economic uncertainty (GEU),[2] so the detected effects of the former likely mirror those of the latter. However, it has been widely recognized that EPU differs from GEU: the former refers to the difficulty with which to forecast the future course of economic policy, while the latter captures the unpredictable future course of an economy caused by changes in some supply-side and/or demand-side factors (Krol, 2018). Some impactful studies involving EPU acknowledge the differences between EPU and GEU – i.e., the former is not simply part of the latter, and thus control for GEU (See, e.g., Brogaard and Detzel, 2015; and Gulen and Ion, 2016). Therefore, we posit that EPU and GEU embrace mutually excluded information, justifying a study of the effect of EPU *per se* on capital structure.

The rest of this paper is organized as follows. Section 2 develops the hypotheses to test. Section 3 describes data and carries out some preliminary analyses of the data. Section 4 outlines the dynamic panel regression model as our econometric tool. Section 5 presents empirical results. Section 6 conducts graphical analyses of the estimation results to draw the implications of EPU for corporate leverage. The analyses use three years, 2008, 2009 and 2010, for illustration purposes. Section 7 offers summary and conclusion.

2. Hypothesis development

Using data of US firms, Byoun (2008) documents the evidence supporting the prediction that the firms adjust their capital structures toward targets determined by firm and industry characteristics.

Further, the author uncovers that most adjustments occur when firms have above-target (below-target) debt with a financial surplus (deficit). These findings convey two messages. First, it is justifiable for our study to apply a partial adjustment model to US firms. Second, it is the deviation of the past actual leverage ($Lev_{i,t-1}$) from the current target ($Lev^{*}_{i,t}$) - i.e., above- or below-target - that causes adjustments; and since $Lev_{i,t-1}$ is already given, the deviation in the current period varies with $Lev^{*}_{i,t}$: If $Lev^{*}_{i,t} - Lev_{i,t-1} < 0$, it is "above target"; and if $Lev^{*}_{i,t} - Lev_{i,t-1} > 0$, it is "below target". This second message motivates us to consider the possibility that EPU makes firms alter $Lev^{*}_{i,t}$ hence the deviation and then adjust their current leverage $Lev_{i,t}$ to close the resultant deviation.[3]

[2] Throughout this paper, GEU conceptually refers to macroeconomic uncertainty and/or financial market uncertainty, as opposed to EPU.

[3] In empirical tests, we also explored the possibility that EPU interacts with lagged leverage to make the speed of adjustment depend on EPU, but obtained utterly insignificant coefficient estimates. The results are available from us upon requests.

A further question is: In what way does EPU affect $Lev^{*}_{i,t}$? The trade-off theory reasons that firms with more volatile cash flows face higher expected costs of financial distresses and should use less debt (Frank and Goyal, 2009). Meanwhile, the growing empirical literature on EPU indicates that EPU shocks foreshadow a deterioration of macroeconomic conditions including investment opportunity set (e.g., Brogaard and Detzel, 2015; Colombo, 2013; Klossner and Sekkle, 2014; Nodari, 2014). In other words, EPU can be taken to represent economy-wide systematic risk. A rise in the risk in turn would lead firms to anticipate that future cash flows will become more volatile and so to reduce debts. Thus, we hypothesize:

Hypothesis 1. On average, EPU has a negative effect on the leverage target.

Hypothesis 1 applies to the aggregate and is derived from the trade-off theory. When coming to econometric work, one needs to allow for variation across individual firms – which is an empirical issue. While testing the dividend predictions of trade-off and pecking order models in the context of Lintner's (1956) model, Fama and French (2002) assume that *empirically* the responses of dividends to common stock earnings vary across firms as a linear function of firm characteristics. Since there is no theory available about exactly how EPU would make firms have different target leverages, we follow Fama and French's (2002) empirical approach. Specifically, we conjecture that the responses of the target leverage to EPU vary across firms also as a linear function of firm characteristics. That is,

Hypothesis 2. The marginal effect of EPU on the leverage target (and actual leverage) varies across firms depending on their characteristics given at t.

Though without a theoretical underpinning, Hypothesis 2 enables us to move away from the widely-maintained assumption that the leverage effects of firm characteristics as well as of macroeconomic conditions are constant across firms and over time.[4] Since EPU and firm characteristics change over time, Hypothesis 2 naturally implies:

Hypothesis 3. The marginal effects of firm characteristics on the leverage target (and actual leverage) vary over time as a function of EPU

Testing Hypotheses 2 and 3 enables us to reap new results in both the cross-sectional (with time t given) and the time dimension (with time t varying). The tests serve the purpose of our study to focus on the joint effects of EPU and firm characteristics on capital structure.

3. Data

Our sample includes all active, dead and suspended firms traded on NYSE, NYSE MKT (formerly known as AMEX) or NASDAQ over the period 1985 to 2015. We exclude all firms in financial, utilities and real estate sectors; and firms that do not have at least five consecutive years of data for total assets, total debt, stock price or number of common stocks. The final sample includes 5,360 firms (64,385 firm-years) from eight industrial sectors, namely industrials, energy, materials, consumer discretionary, consumer staples, health care, information technology, and telecommunication services. A brief summary of the sample composition is presented in Table A1 in Appendix A.

For each firm in our sample, we retrieve from DataStream the end-of-year unadjusted stock price and Worldscope accounting data. The latter include total assets (WC02999), total debt (WC03255) (which represents all interest bearing and capitalized lease obligations and is the sum of long and short term debt), common shares outstanding (WC03501), net property, plant and equipment (WC02501), EBIT & Depreciation (WC18198) (earnings before interest, tax and depreciation), capital expenditure (WC04601), and total cash dividends paid (WC04551). All data series for financial ratios and for size are trimmed at the 1% level in both the left and right tails of distribution to reduce outliers. Table 1 reports the summary statistics of the variables used in our dynamic regression analyses.

We measure firm size (Size) by the natural logarithm of total assets. Asset tangibility (Tang) is the ratio of net property, plant and equipment to total assets. Firm profitability (Prof) is EBIT & depreciation divided by total assets, following Lemmon et al. (2008). The market-to-book ratio (MTB) is a proxy for a firm's long-term growth prospect, calculated as the ratio of market assets to book assets (Fama and French, 2002; and Frank and Goyal, 2009), with market assets being the sum of total debt and unadjusted stock price times the number of common shares outstanding. In addition, we use the ratio of capital expenditure to total assets (Capex) to capture the effect of a firm's short-term investment opportunity. Dividend (Div) is a dummy variable equal to one if a firm paid a cash dividend in a given year, and zero otherwise.

We employ two measures of EPU, EPU_{ovr} and EPU_{news}. The former is the most comprehensive while the latter is the most widely-used. The annual time series data for EPU_{ovr} and EPU_{news} are constructed using the corresponding monthly data published on the website maintained by Baker, Bloom and Davis.[5] For each year, we take the arithmetic average of twelve monthly EPU index data in that year. Although there are five EPU indexes, the present study is focused on two of them: the overall EPU index (EPU_{ovr}; $LEPU_{ovr} \equiv \log EPU_{ovr}$), and its largest component the news-based EPU index denoted by EPU_{news} ($LEPU_{news} \equiv \log EPU_{news}$). The EPU_{ovr} index represents the most comprehensive measure of economic policy uncertainty, and so is relevant

[4] See, for example, Kayhan and Titman (2007); Huang and Ritter (2009); and Cook and Tang (2010). In particular, Cook and Tang (2010) specify a dynamic panel regression model where the coefficients on firm characteristic variables and on macroeconomic variables are uniform across firms and over time.

[5] All the EPU data used are downloaded from http://www.policyuncertainty.com, and are available from 1985.

Table 1
Summary statistics.

Variables	No. of obs.	Mean	Median	St. Dev.	Min.	Max.
$LEPU_{ovr}$	31	4.6496	4.6770	0.2452	4.2673	5.1489
$LEPU_{news}$	31	4.6544	4.6513	0.2446	4.2067	5.0624
LBCI	31	4.9463	4.9610	0.2088	4.5791	5.2830
LVOL	31	1.3811	1.3274	0.3802	2.2854	0.7589
LVXO	31	2.9832	2.9457	0.3126	2.4739	3.5093
Lev (DTB)	69,753	0.2520	0.2220	0.2009	0.0000	1.1250
Lev (DTM)	65,780	0.2277	0.1478	0.2343	0.0000	0.9745
Size	85,026	19.5127	19.4427	2.0987	6.9078	27.4051
Tang	82,404	0.2682	0.2047	0.2277	0.0010	0.9085
MTB	78,271	2.6137	1.4171	3.6246	0.0713	32.7113
Prof	79,605	0.0782	0.1212	0.2143	−1.4612	0.4898
Capex	79,965	0.0580	0.0403	0.0568	0.0000	0.3567
Div	84,616	0.3890	–	–	–	–

Note. This table provides summary statistics of the variables used in regression analysis. $LEPU_{ovr}$ is the natural logarithm of the EPU_{ovr} index. $LEPU_{news}$ is the natural logarithm of the EPU_{news} index. LBCI is the natural logarithm of the BCI index. LVOL is the natural logarithm of the VOL index. LVXO is the natural logarithm of the VXO index. DTB and DTM stand for the book and the market debt ratio, respectively. Size is the natural logarithm of the book value of total assets in US$. Tang measures asset tangibility which is the ratio of net property, plant, and equipment to total assets. Prof is profitability calculated as EBIT & depreciation divided by total assets. MTB is calculated as the ratio of market value of total assets to the book value of total assets. Capex is the ratio of capital expenditure to total assets. Financial, real estate and utility firms are excluded. Size (in natural logarithm) and all financial ratios are trimmed at the 1% level in both tails of the distribution.

to studying how firms' capital structure decisions respond to changes in overall uncertainty of government economic policies. The EPU_{news} index is constructed based on 10 large newspapers' articles that contain such terms as 'uncertainty' or 'uncertain', 'economic' or 'economy', 'congress', 'legislation', 'white house', 'regulation', 'federal reserve', or 'deficit'. EUP_{news} takes the largest weight (½) in EPU_{ovr}, and has been the most widely used index by researchers (See http://www.policyuncertainty.com/research.html). Out of these considerations and to conserve space, we decide to report our empirical results associated with EPU_{ovr} and EPU_{news} in this study. To our knowledge, we are the first to use EPU_{ovr} the broadest measure of economic policy uncertainty and intend to compare its results with the results of EPU_{news}.[6]

To control for GEU, we use three proxies. The first is the business cycle index (BCI; LBCI ≡ logBCI) of the US,[7] which is designed to provide good and reliable recession forecasting characteristics. We take it to represent uncertainty about how likely and when the US economy is heading for recession. For example, a falling BCI indicates that the certainty (uncertainty) about the economy heading for recession is rising (falling). The second and third proxy variables are, respectively, realized stock market volatility (VOL; LVOL ≡ logVOL) and the Chicago Board Options Exchange Index of Implied Volatility on Standard & Poor's 100 Index (VXO; LVXO ≡ logVXO),[8] following Brogaard and Detzel (2015). Also following the two authors, we create VOL by estimating the standard deviation of daily CRSP value-weighted total return index within a month,[9] computing a monthly variance index as square of the standard deviation and converting the monthly variance index into an annual index. VOL and VXO are taken to proxy for financial market uncertainties, and VXO may also contain information about macroeconomic uncertainty. Fig. 1 presents the time-series plots of the three GEU indexes in panels (f) through (h).

Before formal econometric estimation, it is useful to conduct some preliminary analysis of data with a focus on two issues. One is whether the relations between EPU and leverage decisions, if detected, are not simply correlations but causal relations. Appendix B reports and discusses our Granger causality test results. The results provide preliminary evidence that there exists, to a certain degree, a causal relation from EPU and leverage, which encourages us to further explore a specific way in which the causality runs as suggested by the title of the present article.

The other issue is how the two EPU indexes are correlated with the three proxies for GEU representing macroeconomic/financial market conditions or uncertainties. As matter of fact, an underlying question is: Would the detected effect of EPU on leverage, if any, simply reflect those of GEU on leverage? Table 2 reports the correlation coefficients for the five indexes plotted in Fig. 1, which offer initial answers to the question.

From the table, the two EPU measures in log, $LEPU_{ovr}$ and $LEPU_{news}$, show negative correlations with LBCI: −0.5130 and −0.3340. This confirms that EPU is countercyclical as noted by Brogaard and Detzel (2015) and contains information not captured by LBCI. Thus, it is groundless to view EPU simply as a different measure of macroeconomic conditions, which was noted in Introduction. In addition, the two EPU measures also comove positively with LVOL and LVXO (0.3772, 0.3561,

[6] We also tried the other three components of EPU_{ovr}, including the tax-code-based EPU index (EPU_{tax}), the government-spending based EPU index (EPU_{spd}) and the inflation-forecast-based EPU index (EPU_{cpi}). The three components each take a 1/6 wt in EPU_{ovr}. Their regression results are presented in Section 1 of "Supplemental File".

[7] The BCI data are downloaded from the website of iMarketSDignals at https://imarketsignals.com/bci-download, and is converted from monthly to annual frequency. See also https://imarketsignals.com/bci-explained/ for a detailed description of BCI.

[8] The data on the Chicago Board Options Exchange Index of implied volatility on Standard & Poor's 100 index comes from http://www.cboe.com/products/vix-index-volatility/volatility-on-stock-indexes/cboe-s-p-100-volatility-index-vxo.

[9] The daily data on the index comes from CRSP. We use the index as a measure of overall US stock market performance.

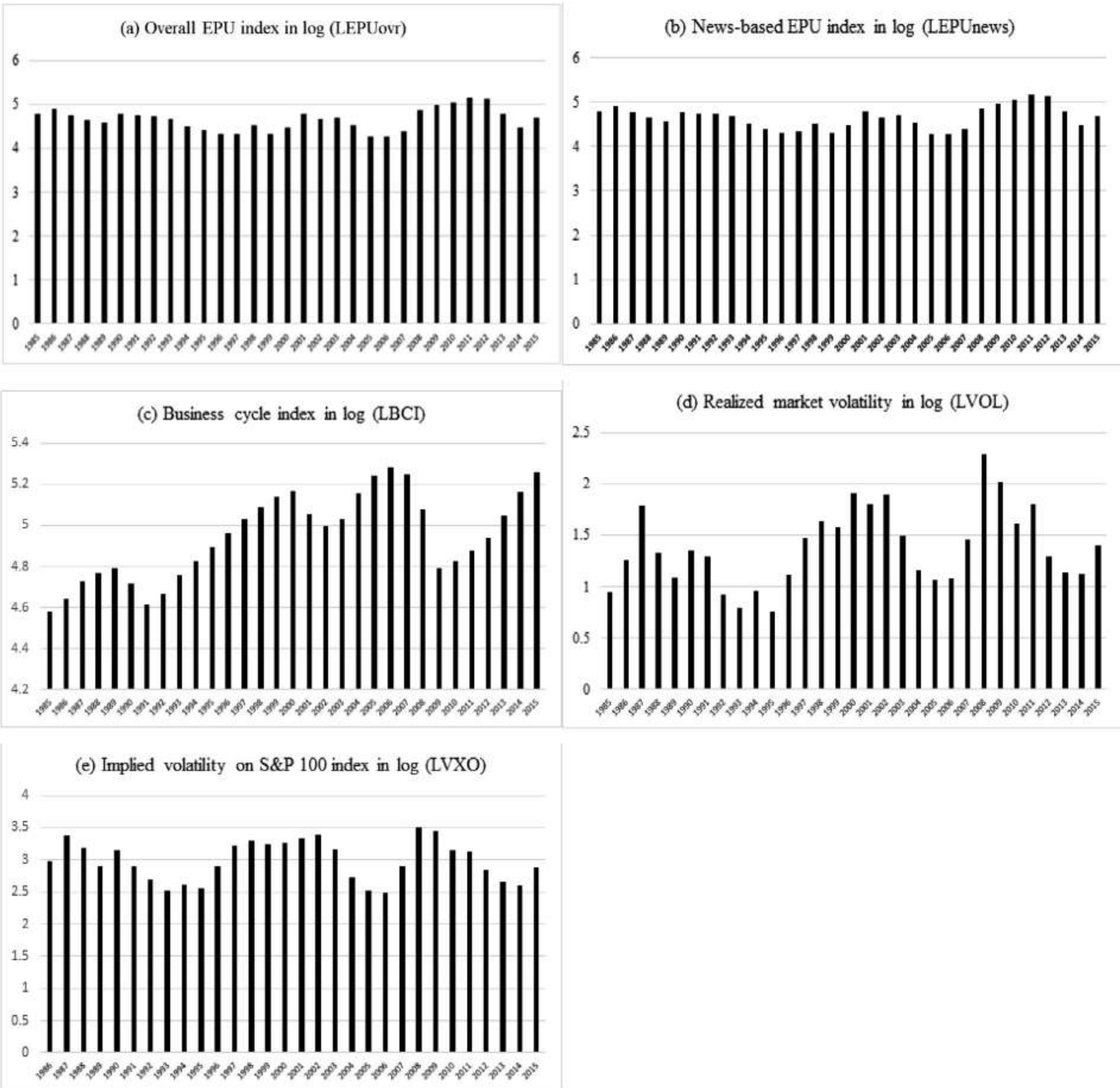

Fig. 1. Time series plots of various uncertainty variables.

Table 2
Pearson correlation coefficients among uncertainty variables.

	$LEUP_{news}$	LBCI	LVOL	LVXO
$LEPU_{ovr}$	0.9192	−0.5130	0.3772	0.3561
$LEPU_{news}$		−0.3340	0.4797	0.4440
LBCI			0.1372	−0.1191
LVOL				0.9042

Note. This table presents Pearson correlation coefficients. $LEPU_{ovr}$ is the natural logarithm of the EPU_{ovr} index. $LEPU_{news}$ is the natural logarithm of the EPU_{news} index. LBCI is the natural logarithm of the BCI index. LVOL is the natural logarithm of the VOL index. LVXO is the natural logarithm of the VXO index.

0.4797 and 0.4440), the two proxies for financial market uncertainty. These suggest that EPU may contain a certain amount, albeit no >52%, of information about general economic conditions (GEU). Accordingly, to isolate the leverage effect of EPU from those of GEU, one way to do so is to include LBCI, LVOL and LVXO as control variables in regression models. This way, which has been proved successful by previous studies such as Brogaard and Detzel (2015), the detected leverage effects of EPU should, to the maximum degree, describe how firm managers respond to EPU only, conditioning on GEU, when setting their target debt ratios.

Table 2 also presents the estimated correlation between EPU_{ovr} and EPU_{news}: 0.9192. Such a high correlation coefficient confirms that the latter is the most important component of the former, and indicates that the results based on, respectively, EPU_{ovr} and EPU_{news} may not be vastly different.

4. Model specification

Section 2 has noted two results of Byoun (2008), one of which motivates us to apply a partial adjustment model to US firms in testing the hypotheses proposed in Section 2. Let us begin with the partial adjustment model proposed by Fama and French (2002) and Kayhan and Titman (2007):

$$Lev_{i,t} - Lev_{i,t-1} = \delta\left(Lev^*_{i,t} - Lev_{i,t-1}\right) + v_{it} \Rightarrow Lev_{i,t} = \gamma Lev_{i,t-1} + \delta Lev^*_{i,t} + v_{i,t} \tag{1}$$

where $\gamma \equiv 1-\delta$, Lev_{it} and Lev^*_{it} denote the actual and the target leverage ratio respectively for firm i at time t, and v_{it} is the idiosyncratic error term which follows an AR(p) process possibly with $p > 1$. We let $Lev_{i,t}$ be either the ratio of debt to book assets (DTB) or the ratio of debt to market assets (DTM). Eq. (1) posits that a firm adjusts partially toward its target leverage ratio due to the presence of positive adjustment costs, in a linear form. The speed of adjustment, δ, should lie between 0 and 1.

Another result of Byoun (2008) as noted in Section 2 suggests that EPU is more likely to affect $Lev^*_{i,t}$. Thus, modelling Lev^*_{it} to test Hypotheses 2 and 3, we take into account two considerations from previous studies. First, in relating Lev^*_{it} to EPU, we use for reference Lintner's (1956) model which assumes that the target dividend of a firm is proportionately related to its common stock earnings. In the spirit of this *proportionality*, we assume that the target leverage ratio of a firm depends proportionally on (lagged) EPU. As the other consideration, prior work has suggested that Lev^*_{it} depends on (lagged) firm characteristics. Incorporating the two considerations into a model, we have

$$\begin{aligned} Lev^*_{i,t} = {} & R^*_{i,t}LEPU_{t-1} + \beta_2 Size_{i,t-1} + \beta_3 Tang_{i,t-1} + \beta_4 Prof_{i,t-1} + \beta_5 MTB_{i,t-1} \\ & + \beta_6 Capex_{i,t-1} + \beta_7 Div_{i,t-1} + \eta_i \end{aligned} \tag{2}$$

where $R^*_{i,t}$ is assumed to measure the proportionality desired by firm i in period t, and it can be viewed as capturing the responses of i's the leverage target to EPU (LEPU ≡ the logarithm of an EPU index).[10] We choose six characteristics variables because they have been widely used in the literature to test some capital structure theories: Size ≡ the logarithm of firm size; Tang ≡ tangibility; Prof ≡ profitability; MTB ≡ the market-to-book ratio; Capex ≡ capital expenditure; and Div ≡ a dummy variable which takes the value of one if a firm paid a cash dividend in a given year, and zero otherwise. η_i denotes the time-invariant fixed effect.

Substituting (2) into (1) for Lev^*_{it} and rearranging yield:

$$\begin{aligned} Lev_{i,t} = {} & \gamma Lev_{i,t-1} + R^*_{i,t}LEPU_{t-1} + \beta_1 Size_{i,t-1} + \beta_2 Tang_{i,t-1} + \beta_3 Prof_{i,t-1} + \beta_4 MTB_{i,t-1} \\ & + \beta_5 Capex_{i,t-1} + \beta_6 Div_{i,t-1} + \delta\eta_i + v_{i,t} \end{aligned} \tag{3}$$

where $0 < \delta < 1$ implies $0 < \gamma < 1$.

In light of Fama and French's (2002) study, if one did not allow $R^*_{i,t}$ to vary across firms, Eq. (3) would be mis-specified. To avoid this problem, we borrow Fama and French's (2002) empirical approach. The two authors assume that the responses of dividends to common stock earnings vary across firms as a *linear* function of firm characteristics (See Eq. (4) in Fama and French, 2002). In our study here, we examine how the responses of the leverage target and, ultimately, of actual leverage to EPU vary across firms also as a linear function of firm characteristics. Thus, in a similar spirit to Fama and French's, we let $R^*_{i,t}$ be a linear combination of firm characteristics, to obtain:

$$\begin{aligned} Lev_{i,t} = {} & \gamma Lev_{i,t-1} + \left(a_1 + a_2 Size_{i,t-1} + a_3 Tang_{i,t-1} + a_4 Prof_{i,t-1} + a_5 MTB_{i,t-1} + a_6 Capex_{i,t-1} + a_7 Div_{i,t-1}\right) \\ & * LEPU_{t-1} + \beta_1 Size_{i,t-1} + \beta_2 Tang_{i,t-1} + \beta_3 Prof_{i,t-1} + \beta_4 MTB_{i,t-1} + \beta_5 Capex_{i,t-1} + \beta_6 Div_{i,t-1} \\ & + \delta\eta_i + v_{i,t} \end{aligned} \tag{4}$$

where $R^*_{i,t} \equiv a_1 + a_2 Size_{i,t-1} + a_3 Tang_{i,t-1} + a_4 Prof_{i,t-1} + a_5 MTB_{i,t-1} + a_6 Capex_{i,t-1} + a_7 Div_{i,t-1}$ can be taken to measure $\partial Lev_{i,t}/\partial LEPU_{t-1}$, the marginal effect of (logarithmic) EPU in a given year t-1 on firm i's subsequent leverage, $\partial Lev_{i,t}/\partial LEPU_{t-1}$.

Further, on the empirical level, two more considerations are relevant. First, it is well known that global financial crises affect the stability of financial markets, and hence corporate finance decisions. Pástor and Veronesi (2013) suggest that EPU tends to be higher in weaker economic conditions, while Baker, Bloom and Davis (2016) report that EPU index value increased by >50% during the Great Recession of 2007 to 2009. Iqbal and Kume (2014) document that financial leverage

[10] Because the relationship between a variable and its logarithm is monotonic, throughout this paper we refer to the marginal effect of LEPU (≡ logEPU) simply as the marginal effect of EPU, for ease of exposition. This also applies to firm size.

ratios of European firms increase during the financial crisis of 2008 and 2009. All these prompt us to control for the possible joint effects of global financial crises and EPU on the capital structure decisions of US firms.

The second consideration is that EPU could be simply correlated with macroeconomic conditions and so the detected leverage impact of EPU may ultimately reflect the relation between macroeconomic conditions and leverage. As noted earlier, we address this concern by employing LBCI, LVOL and LVXO as control variables which proxy for macroeconomic and/or financial market uncertainties.

The above discussions lead to our final empirical setup as:

$$\begin{aligned} Lev_{i,t} = {} & \gamma Lev_{i,t-1} + (a_1 + a_2 Size_{i,t-1} + a_3 Tang_{i,t-1} + a_4 \mathrm{Prof}_{i,t-1} + a_5 MTB_{i,t-1} + a_6 Capex_{i,t-1} + a_7 Div_{i,t-1} \\ & + \sum_{j=1}^{7} d_j Z_{j,t-1}) * LEPU_{t-1} + c_1 LBCI_{t-1} + c_2 LVOL_{t-1} + c_3 LVXO_{t-1} + \beta_2 Size_{i,t-1} + \beta_3 Tang_{i,t-1} \\ & + \beta_4 \mathrm{Prof}_{i,t-1} + \beta_5 MTB_{i,t-1} + \beta_6 Capex_{i,t-1} + \beta_7 Div_{i,t-1} + \sum_{j=1}^{7} g_j Z_{j,t-1} + \delta \eta_i + v_{i,t} \end{aligned} \tag{5}$$

where the seven dummy variables Z_j's correspond to seven global financial crises, and $Z_{j,t} = 1$ when its corresponding financial crisis occurs in year t, and $Z_{j,t} = 0$ otherwise (i.e., in tranquil years). We use the dummy variables to capture and so *remove* the possible effects of global financial crises on both the intercept and $R^*_{i,t}$, since there are no reasons to believe that the crises have affected only either of the two. Without removing such effects, if any, the estimates of the intercept and the coefficients (a_i, i = 1,. . .,7) in the parenthesised term would be biased due to them bearing such effects whereas they should not according to Eqs. (1) through (4).

Eq. (5) allows us to define $\partial Lev^*_{i,t}/\partial LEPU_{t-1}$ (= $\partial Lev_{i,t}/\partial LEPU_{t-1}$) as the total marginal effect (TME) of last year's (logarithmic) EPU on a firm i's leverage target and hence actual leverage in t (Hypothesis 2). The TME is relevant to examining issues in the cross-sectional dimension with t given (e.g., t = 2008). It also indicates that the relation of EPU with leverage cannot be described simply by the concept of correlation. Since theoretical predictions about the characteristic-debt relations suggest causalities from characteristics to leverage, the TME as a linear combination of characteristics can be viewed as capturing the characteristic-dependent causality from EPU to leverage.

Eq. (5) also enables one to test Hypothesis 3 regarding the marginal effect of a characteristic variable on leverage (target and actual). This marginal effect is defined as the partial derivative of the leverage ratio with respect to that variable. For example, $\partial Lev_{i,t}/\partial Size_{i,t-1} = a_2 LEPU_{t-1} + \beta_2$ measures the marginal effect of firm i's size on the leverage ratio. This marginal effect is relevant to examining issues in the dimension of time with i given (e.g., i = Company No. 109, or Microsoft). Suppose $\Delta Size_{i,t} \equiv Size_{i,t} - Size_{i,t-1} > 0$, i.e., firm i grows larger from t-1 to t. For each percentage point increase in size, the firm would change the debt ratio by $\Delta Lev_{i,t} = a_2 LEPU_{t-1} + \beta_2$ percentage points. If $a_2 > 0$ (<0), then the higher is $LEPU_{t-1}$, the greater will be the rise (fall) in the debt ratio. Generally speaking, if $a_2 \neq 0$, then the relation between firm i's characteristics and debt ratios is not constant but depends on economic policy uncertainty at t-1. The above discussions also apply to the target leverage since $\partial Lev^*_{i,t}/\partial Size_{i,t-1} = \partial Lev_{i,t}/\partial Size_{i,t-1}$.

Regarding the choices of global financial crises, Fry-McKibbin et al. (2014) identify six "true" episodes. Although some of these originated in the United States while others elsewhere, they all had exerted profound contagion effects on the stability of equity markets in many countries around the world. The six global financial crisis episodes include the Asian Financial Crisis (Z_{asia} = 1 for 1997–1998, and 0 otherwise); the Brazilian Currency Crisis (Z_{brazil} = 1 for 1999, and 0 otherwise); the Argentine Crisis (Z_{argtn} = 1 for 2001–2002, and 0 otherwise); the Subprime Mortgage Crisis ($Z_{subprime}$ = 1 for 2007–2008, and 0 otherwise); the Great Recession ($Z_{recession}$ = 1 for 2008–2009, and 0 otherwise); and the European Debt Crisis (Z_{edc} = 1 for 2010–2013, and 0 otherwise). For the crisis periods, we follow the start and the end date as determined by Fry-McKibbin, Hsiao and Tang (2014). Since our sample dates back to 1985, we further add the 1987 US Stock Market Crash as one more crisis episode to the above six, and the resultant dummy is $Z_{smc1987}$ (=1 for 1987, and 0 otherwise).

As far as empirical investigations are concerned, Eq. (5) is a general, unrestricted model, with the upside of minimizing the bias of omitting relevant variables. On the other hand, the model also has the downside that it is likely overparameterized, causing high multicollinearity and the bias of including irrelevant variables. This is so even if a theory suggests that a variable is relevant whereas it is not by econometric tests. In the economics/econometrics literature, the Hendry/LSE approach of modelling from "general to specific" (GTS). The GTS approach has been proposed as a prescriptive way to select a parsimonious final model from a large set of real-world variables: It helps researchers to avoid *ad hoc* decisions on variable inclusion/exclusion (see, e.g., Campos et al., 2005; and the references therein).[11]

The dependent variable, the book debt ratio or the market debt ratio, possesses high persistence. This problem renders inappropriate the use of the AB technique (Arellano and Bond, 1991) and the BB technique (Blundell and Bond, 1998), since we find $v_{i,t}$ in Eq. (5) follows an AR process of order 2 or even higher. In view of this, we estimate (5) by employing the Long Differencing (LD) estimator first proposed by Hahn et al. (2007) for balanced panel. However, following Huang and Ritter (2009) and Dang et al. (2015), we implement the four-period differencing estimator (LD4) for the following reasons: Our

[11] The basic idea of the GTS approach is this: Start with a general model, such as (5), carry out a data-based simplification mainly through Wald and/or t-tests, and arrive at the final, parsimonious model with estimated coefficients significant at the 10% level or higher.

panel is unbalanced, the LD4 estimator excludes fewest firms, and our results can be compared to those produced using the LD4 estimator and US data (in, e.g., Huang and Ritter, 2009).[12] When estimating (5) with LD4, we treat as endogenous the lagged dependent variable, EPU and all interactions between EPU and characteristics, as guided by the evidence from Table 2 of a bi-directional causality between an EPU index and a book or a market debt ratio. We use at least three iterations to ensure that the parameters are estimated efficiently (Hahn et al., 2007).

5. Empirical results

5.1. Results for the overall EPU index

In Panel A of Table 3, Models 1 and 3 are the general models. Though not reported with respect to the estimated coefficients on regressors involving crisis dummies (grouped in CONTROL 1 and CONTROL 2), there seems to be certain multicollinearity among explanatory variables. The issue arises because we use all possible EPU-characteristic and EPU-crisis interactions to capture cross-section variations in the responses of firms' financing decisions to EPU over respectively the turbulent and tranquil years. As a result, some estimated coefficients are statistically insignificant. However, this does not necessarily indicate that the associated variables are unimportant. To preserve the upside while minimizing the downside as noted earlier, we adopt the GTS approach. Note also that implementing the LD4 technique eliminates a constant term and the year dummies; See Eq. (A3) in Appendix C. In addition, the Sargan test statistics in Pane A of Table 3 indicate that the instruments used in regressions are valid.

Models 1 and 2 in Table 3, Panel A are related to the book debt ratio, while Models 3 and 4 to the market debt ratio. The first observation to make is that the γ estimates, which determine the speed of adjustment $\delta \equiv 1\text{-}\gamma$, are comparable with those reported in previous studies (e.g., Dang, Kim and Shin, 2015): 0.7307 (t = 50.4), 0.7135 (t = 47.6), 0.7329 (t = 50.4) and 0.7357 (t = 48.0). That is, the adjustment speed ranges within the [26%, 29%] domain.

Regarding book leverage (DTB), one can see that different firms respond differently to EPU. In Model 2, the coefficient estimates of respectively $LEPU_{ovr,t-1}$, $Size_{i,t-1}*LEPU_{ovr,t-1}$, $Tang_{i,t-1}*LEPU_{ovr,t-1}$, $Prof_{i,t-1}*LEPU_{ovr,t-1}$, $MTB_{i,t-1}*LEPU_{ovr,t-1}$ and $Capex_{i,t-1}*LEPU_{ovr,t-1}$ are significant economically and statistically (−1.6808 with t = −6.50, 0.0881 with t = 6.53, −0.6149 with t = −6.75, −1.0292 with t = −4.14, 0.0322 with t = 3.72, and 0.0440 with t = 4.53). So, the marginal effect of the EPU_{ovr} measure on firms' book leverage (target and actual) depends on all the five characteristics. This result provides evidence in support of Hypothesis 2 for the DTB measure of leverage. Note, although the coefficients of $Div_{i,t-1}*LEPU_{ovr,t-1}$ and $Div_{i,t-1}$ are statistically significant in Model 1, the GTS approach suggests omitting each of the two regressors at different steps when their coefficients become statistically insignificant.

One can also take a different perspective by looking at the dependence of the marginal leverage effect of a characteristic on EPU. Panel B of Table 3 helps to serve this purpose. Consider $Size_{i,t-1}$ first. Its marginal effect on book leverage is measured by $\partial DTB_{i,t}/\partial Size_{i,t-1} = 0.0881*LEPU_{ovr,t-1} - 0.3883$. Over the entire panel data sample, the mean, minimum and maximum of the marginal effect equal, respectively, 0.0212 (t = 394), −0.0124 and 0.0653. The mean value of 0.0212 suggests that, averaging across time, book leverage rises with firm size, which is also documented in Frank and Goyal (2009) (albeit for market leverage). In addition, a one-percentage-point change in firm i's size, *ceteris paribus*, would lead to a change in the book debt ratio by $0.0881*LEPU_{ovr,t-1} - 0.3883$ percentage points. The magnitude of the change depends positively on the given level of $LEPU_{over,t-1}$. The interpretation may go as follows. As firm i becomes larger ($\Delta Size_{i,t-1} > 0$) and more diversified, it likely has less volatile earnings/net cash flows but easier accesses to capital markets; and both the trade-off and pecking order models then predict that the firm would have more leverage (Fama and French, 2002). We now show that this prediction is reinforced by EPU: Higher EPU leads to significant increases in stock market volatility (documented by Liu and Zhang, 2015), which in turn would make the firm switch from equity financing to debt financing. As per our results, if $LEPU_{i,t-1}$ is high enough to make $\partial DTB_{i,t}/\partial Size_{i,t-1} > 0$, then a rise in i's size would result in a rise in its book leverage. Conversely, if $LEPU_{i,t-1}$ is low enough such that $\partial DTB_{i,t}/\partial Size_{i,t-1} < 0$, then the opposite would apply. Both cases are consistent with the above reasoning.

Consider, next, tangibility ($Tang_{i,t-1}$). Its marginal effect on book leverage is $\partial DTB_{i,t}/\partial Tang_{i,t-1} = -0.6149*LEPU_{ovr,t-1} + 2.8491$. Panel B of Table 3 shows that, over the entire panel data sample, $\partial DTB_{i,t}/\partial Tang_{i,t-1}$ generates a mean value of −0.0092 (t = −24.37), a minimum value of −0.3170, and a maximum value of 0.2251. The conveyed message is that on average over time the positive relation of tangibility with book leverage (2.8491), showed in Frank and Goyal (2009) albeit for market leverage, is attenuated by higher EPU_{ovr}. Note, since book assets are much less susceptible to EPU shocks, the decline in the marginal effect of tangibility on DTB due to higher EPU_{ovr} ought to lead to a decline in debt *per se*, other things being equal. Moreover, a one-percentage-point change in firm i's tangibility, holding everything else constant, would result in a change in the book debt ratio by $-0.6149*LEPU_{ovr,t-1} + 2.8491$ percentage points. The size of the change depends negatively on $LEPU_{over,t-1}$. Pledgeable assets support more borrowing, which allows for further investment in pledgeable assets (Almeida and Campello, 2007). However, Gulen and Ion (2016) show that high EPU leads significantly to low corporate investment.

[12] In Appendix C of this paper, we show how to transform Eq. (5) to a fourth-differenced model in order to implement the LD4 estimation method. Also see the appendixes in Huang and Ritter (2009) for a description of the LD4 technique. We also try the LD6 and LD8 estimators, and the results do not change qualitatively the final conclusions drawn from the LD4 results.

Table 3
Leverage effect: Overall EPU measure.

Panel A Estimation results				
Variable	Lev = DTB		Lev = DTM	
	Model 1	Model 2	Model 3	Model 4
$Lev_{i,t-1}$	0.7307***	0.7135***	0.7329***	0.7357***
	(50.4)	(47.6)	(50.4)	(48.0)
$LEPU_{ovr,t-1}$	−1.5310***	−1.6808***	−1.6931***	−1.7087***
	(−6.66)	(−6.50)	(−5.80)	(−4.40)
$Size_{i,t-1}$*$LEPU_{ovr,t-1}$	0.0761***	0.0881***	0.0692***	0.0697***
	(6.13)	(6.53)	(4.40)	(3.32)
$Tang_{i,t-1}$*$LEPU_{ovr,t-1}$	−0.2276**	−0.6149***	−0.2199*	−0.2472*
	(−2.00)	(−6.75)	(−1.74)	(−1.69)
$Prof_{i,t-1}$*$LEPU_{ovr,t-1}$	−0.9596***	−1.0292***	−0.3448*	−0.4319*
	(−4.61)	(−4.14)	(−1.71)	(−1.84)
$MTB_{i,t-1}$*$LEPU_{ovr,t-1}$	0.0277***	0.0322***	0.0119*	0.0131**
	(3.42)	(3.72)	(1.84)	(2.38)
$Capex_{i,t-1}$*$LEPU_{ovr,t-1}$	0.0155***	0.0440***	0.0245***	0.0267***
	(2.62)	(4.53)	(3.83)	(4.25)
$Div_{i,t-1}$*$LEPU_{ovr,t-1}$	0.1109**	—	0.2516***	0.3196***
	(2.13)		(6.59)	(8.18)
$LBCI_{t-1}$	−0.0756**	−0.2017***	−0.3173***	−0.2863***
	(−2.51)	(−5.33)	(−8.86)	(−9.07)
$LVOL_{t-1}$	0.0359**	0.0867***	0.0800***	0.0603***
	(2.39)	(6.44)	(4.87)	(9.13)
$LVXO_{t-1}$	−0.0130	−0.0489***	−0.0223	—
	(−0.93)	(−4.04)	(−1.56)	
$Size_{i,t-1}$	−0.3361***	−0.3883***	−0.2744***	−0.2776***
	(−5.86)	(−6.23)	(−3.78)	(−2.86)
$Tang_{i,t-1}$	1.0629**	2.8491***	1.0010*	1.1276*
	(2.01)	(6.77)	(1.70)	(1.65)
$Prof_{i,t-1}$	4.4409***	4.7566***	1.6138*	2.0206*
	(4.58)	(4.10)	(1.72)	(1.86)
$MTB_{i,t-1}$	−0.1270***	−0.1469***	−0.0533*	−0.0590**
	(−3.45)	(−3.72)	(−1.81)	(−2.35)
$Capex_{i,t-1}$	0.0492	—	0.1216***	0.1119**
	(1.29)		(2.65)	(2.35)
$Div_{i,t-1}$	−0.4970**	—	−1.1395***	−1.4540***
	(−2.07)		(−6.46)	(−8.05)
CONTROL 1	Yes	Yes	Yes	Yes
CONTROL 2	Yes	Yes	Yes	Yes
Sargan	0.211	0.043	0.250	0.077
	[0.646]	[0.835]	[0.617]	[0.781]

Panel B Estimated marginal leverage effects of characteristics		
	Lev = DTB	Lev = DTM
$\partial Lev_{i,t}/\partial Size_{i,t-1}$	0.0212***	0.0464***
	[−0.0124,0.0653]	[0.0198, 0.0813]
$\partial Lev_{i,t}/\partial Tang_{i,t-1}$	−0.0092***	−0.0215***
	[−0.3170, 0.2251]	[−0.1452, 0.0727]
$\partial Lev_{i,t}/\partial Prof_{i,t-1}$	−0.0275***	0.0130***
	[−0.5427, 0.3647]	[−0.2032, 0.1776]
$\partial Lev_{i,t}/\partial MTB_{i,t-1}$	0.0028***	0.0019***
	[−0.0095, 0.0189]	[−0.0031, 0.0085]
$\partial Lev_{i,t}/\partial Capex_{i,t-1}$	0.2045***	0.2360***
	[0.1878, 0.2266]	[0.2258, 0.2494]
$\partial Lev_{i,t}/\partial Div_{i,t-1}$	—	0.0316***
		[−0.0902, 0.1916]

Notes. Panel A presents, for the overall EPU measure (EPU_{ovr}), the coefficient estimates in the general models specified by Eq. (5), and in the specific models obtained via implementing the GTS approach. Models 1 and 2 are concerned with book leverage, and Models 3 and 4 with market leverage. CONTROL 1 contains seven interactions between crisis dummies and the EPU_{ovr} index, and CONTROL 2 contains seven crisis dummies only. Sargan is the test statistic for the validity of instruments (over-identifying restrictions). Figures in parentheses are t-values based on robust (heteroscedasticity-adjusted) standard errors. *, ** and *** denote the 10%, 5% and 1% significance levels respectively. Panel B presents the estimated marginal leverage effects of characteristics across firms in terms of mean, minimum and maximum values, with the latter two in brackets. The reported coefficient estimates are identical to those in the original LD4 model (See Appendix C).

This in turns would lead to low pledgeable assets, low borrowings, and hence a decline in the effect of a change in tangibility (a proxy for pledgeability; see Almeida and Campello, 2007) on the change in the book debt ratio. So, the coefficient on $LEPU_{i,t-1}$ in the expression of $\partial DTB_{i,t}/\partial Tang_{i,t-1}$ should be negative (−0.6149).

Pertaining to profitability ($Prof_{i,t-1}$), Model 2 indicates that, for a given rise in profitability (i.e., $\Delta Prof_{i,t-1} > 0$), high EPU would cause a firm with increased profitability to decrease the book debt ratio more ($\partial DTB_{i,t}/\partial Prof_{i,t-1} = -1.0292*LEPU_{ovr,t-1} + 4.7566$), all else equal. Fama and French (2002) find that more profitable firms are less levered (i.e., $\partial DTB_{i,t}/\partial Prof_{i,t-1} < 0$), confirming the pecking order model. In our results here, this negative marginal leverage effect of profitability holds only if EPU is so high that $LEPU_{over,t-1} > 4.7566/1.0292 = 4.6216$. The possible explanation is that when firm i becomes more profitable while at the same time facing high EPU, it tends to use more internal financing such as increasingly available retained earnings and less external financing from riskier securities such as debt and/or equity. In addition, since the mean of $\partial DTB_{i,t}/\partial Prof_{i,t-1}$ is −0.0275 (t = −43.65) over our panel data sample (See Panel B of Table 3), there is on average a negative relation between profitability and book leverage, consistent with the result reported by, e.g., Frank and Goyal (2009). However, this negative relation is strengthened by higher EPU, a finding not documented by previous studies.

Turning to the long-term growth prospect (MTB), Model 2 indicates that, for a given rise in the market-to-book ratio (i.e., $\Delta MTB_{i,t-1} > 0$), higher EPU would induce firms with greater MTB to increase debt more, everything else equal: $\partial DTB_{i,t}/\partial MTB_{i,t-1} = 0.0322*LEPU_{ovr,t-1} - 0.1469$. Fama and French (2002) and Frank and Goyal (2009) find a negative relation between (market) leverage and the market-to-book ratio (used as a proxy for growth opportunities), but Titman and Wessels (1998) find no reliable relation between leverage and their measures of growth opportunities. Our result demonstrates that the sign of the relation hinges on EPU: if $LEPU_{ovr,t-1} > (<) 4.5621$ (=0.1469/0.0322), the relation is positive (negative). One possible explanation is that, as noted above, higher EPU predicts greater volatility of stock markets, making the firm switch from equity financing to debt financing – known as pecking order behaviour, while seizing greater growth opportunities. Overall, the mean, minimum and maximum of $\partial DTB_{i,t}/\partial MTB_{i,t-1}$ are estimated to be, respectively, 0.0028 (t = 141), −0.0095 and 0.0189 (See Panel B of Table 3). Thus, averaging over the entire panel data sample, the relation between the market-to-book-asset ratio and book leverage is positive, consistent with the pecking order theory at the aggregate level.

Finally, consider capital expenditure ($Capex_{i,t-1}$). It has a marginal effect on book leverage dependent positively on EPU_{ovr}: $\partial DTB_{i,t}/\partial Capex_{i,t-1} = 0.0440*LEPU_{ovr,t-1}$. Capital expenditures, while also a proxy for growth, represent outflows and should be positively related to debt under the pecking order theory (Frank and Goyal, 2009). However, having increased capital expenditures for growth, firm i tends to be even more levered if EPU is higher. This may be because higher EPU makes equity financing riskier thereby inducing the firm to further switch from equity financing to debt financing if internal financing is constrained. This reasoning is still in agreement with the pecking order theory. Since economic policy is always uncertain albeit to a varying degree (i.e., $LEPU_{ovr,t-1} > 0$), there are no negative values for the minimum of the marginal leverage effect of capital expenditure, let alone its mean and maximum (See Panel B of Table 3: mean = 0.2045, minimum = 0.1878 and maximum = 0.2266).

The above discussions about the dependence of the marginal leverage effect of a characteristic on EPU enables us to conclude that Hypothesis 3 is supported by the data as far as the DTB measure of leverage is concerned.

Model 2 in Panel A of Table 3 also indicates that general economic uncertainties (GEU) do not subsume economic policy uncertainty (EPU), nor vice versa, with respect to their impacts on the book debt ratio. The estimated coefficients of $LBCI_{t-1}$, $LVOL_{t-1}$ and $LVXO_{t-1}$ are all significant: −0.2017 (t = −5.33), 0.0867 (t = 6.44) and −0.0489 (t = −4.04). The coefficients should capture the leverage impacts of GEU. More importantly, even controlling for GEU, EPU still manifests its strong effects on firms' book leverage one way or another as discussed above.

Related to book leverage, the obtained signs of the estimated coefficients on the three proxies for GEU seem to be in line with some theories. Consistent with the pecking order theory, a rise in the business cycle index (LBCI) induces firm managers to predict a rise in internal funds, causing a fall in their incentives to use debt financing and hence in book debt ratios ("–": −0.2017). Regarding realized stock market volatility (LVOL), the literature has documented its countercyclical relation with economic activity (See Chauvet, Senyuz and Yoldas, 2015). A rise in realized market volatility is usually associated with economic downturns which, in turn, reduce internal funds. Anticipating fewer internal funds available, firm managers would likely switch to external financing such as debt financing, causing book debt ratios to rise ("+": 0.0867). This seems to be consistent again with the pecking order theory. Finally, a heightened implied stock market volatility (LVXO) signals that stock market participants generally expect the market to rise in the future. Expecting bull stock markets in the future, firm managers may tend to reduce current equity issuance and, likely, debt issuance too, for increasing future equity issuance. As a result, book debt ratios would decline ("–": −0.0489), given book value being less changeable than market value when hit by macroeconomic shocks. This is consistent with the market timing theory.

Where the debt ratio is calculated using market value (i.e., DTM), Model 4 of Table 3, Panel A shows that $LEPU_{ovr,t-1}$ and its interactions with all the six characteristics considered have significant coefficients. That is, the TME of $LEPU_{ovr}$ on market leverage depends, among other things, six characteristics, not five in the case of book leverage. Thus, Hypothesis 2 is also supported by our empirical evidence from an alternative leverage measure DTM.

A closer inspection across Models 4 and 2 reveals that all the key variables common in the two columns have the same signs. Also, Panel B of Table 3 exhibits that the marginal leverage effects of five characteristics have the same signs of the coefficients with EPU and with the corresponding characteristic variable. Their mean, minimum and maximum values also have the same signs across the "Lev = DTB" and "Lev = DTM" columns except for profitability (Prof). Thus, the analyses of the marginal book-leverage effects of characteristics largely apply to market leverage.

In particular, the coefficient on $Capex_{i,t-1}$ in Model 4 is not zero but 0.1119 (t = 2.35), and hence $\partial DTM_{i,t}/\partial Capex_{i,t-1} = 0.0267*LEPU_{ovr,t-1} + 0.1119$, unlike that from Model 2. Since the coefficient 0.0267 > 0, the underlying economic stories said above about the marginal book-leverage effect of capital expenditures also apply qualitatively to DTM here, despite $\partial DTM_{i,t}/\partial Capex_{i,t\text{-}1}$ now containing a constant 0.1119 > 0.

Note also that there is an interaction term not seen in Model 2: $Div_{i,t\text{-}1}{*}LEPU_{ovr,t\text{-}1}$ in Model 4. So, let us examine the responsiveness of market leverage to a change in dividends expressed as $\partial DTM_{i,t}/\partial Div_{i,t\text{-}1} = 0.3196{*}LEPU_{ovr,t\text{-}1}-1.4540$. The higher is EPU_{ovr}, the less negative/more positive will be the marginal effect. Frank and Goyal (2009) report that dividend-paying firms tend to have lower market leverage. We show that this negative relation (−1.4540) is attenuated by the presence of EPU_{ovr} ($0.3196{*}LEPU_{ovr,t\text{-}1}$). However, one should be cautious when interpreting this result. Higher EPU_{ovr} tends to be subsequently followed by lower stock prices (Sum, 2013) hence lower market value, and so tends to raise DTM. In other words, the positive component of the marginal effect of $Div_{i,t\text{-}1}$ on $DTM_{i,t}$ ($0.3196{*}LEPU_{ovr,t\text{-}1}$) may be attributed to falls in market value. There is another possible explanation. If EPU is getting high, the firm would tend to rely more on debt issuance than on equity issuance, in accordance with the pecking order model. This implies that, even if market assets are given, DTM would rise, and thus the coefficient on $LEPU_{ovr,t\text{-}1}$ should be positive. Furthermore, Panel B of Table 3 provides the mean, minimum and maximum values of $\partial DTM_{i,t}/\partial Div_{i,t\text{-}1}$: 0.0316 (t = 161.8), −0.0902 and 0.1916. From these values one can see that the average impact of a given rise in dividends on the market leverage of dividend-paying firms is positive and tends to be greater when EPU is higher. These results are not seen in the previous studies such as Frank and Goyal (2009) that ignore economic policy uncertainty.

The above discussions about the dependence of the marginal leverage effect of a characteristic on EPU demonstrate that Hypothesis 3 is supported by the results related to the DTM measure of leverage.

In addition, for market leverage, the coefficients on $LBCI_{t\text{-}1}$ and $LVOL_{t\text{-}1}$ have the same signs as for book leverage: −0.2863 (t = −9.07) and 0.0603 (t = 9.13), although the coefficient on $LVXO_{t\text{-}1}$ is statistically indifferent from zero (Note, this coefficient has an expected negative sign in Model 3, albeit statistically insignificant). Thus, the capital structure stories put forward above for book leverage about LBCI and LVOL apply to market leverage. Note, however, stock markets hence market assets are more susceptible to macroeconomic shocks than book assets. So, it should be useful to ponder the signs of the coefficients from the perspective of stock markets, as follows.

When rising LBCI induces the expectations that inflation will rise in the future and interest rates tend to rise, this will have a negative effect on current stock prices causing market assets to decline. Since we observe a negative sign of the coefficient on LBCI, this may indicate that debts fall (due to the aforementioned capital structure theories) faster than market assets after LBCI has risen. An increase in realized market volatility (LVOL) also means a heightened risk premium required by investors, which causes past stock prices to fall. As current stock prices tend to rise to recover, market assets rise too. However, since we observe a positive sign of the coefficient on LVOL, this may imply that debts rise (due to the above-mentioned capital structure theories) faster than market assets after LVOL has risen. A heightened implied stock market volatility (LVXO) may also reflect that investors expect future market volatility to rise. So, they would require greater risk premium for them to purchase stocks currently, which in turn depresses current shares prices (Black and McMillan, 2006) leading to falls in market assets. However, since the coefficient on LVXO is found to be insignificantly different from zero, this may suggest that debts fall as fast as market assets after LVXO has risen.

5.2. Results for the news-based EPU index

Table 4 concerns the results using the news-based EPU index (EPU_{news}). Because EPU_{news} only accounts for ½ of EPU_{ovr} albeit highly correlated with EPU_{ovr} (0.9192), but is most widely used in influential studies (see, e.g., Gulen and Ion, 2016), it should be of relevance to examine its results in comparison with those associated with EPU_{ovr}: How different and similar will the results be between using EPU_{ovr} and using EPU_{news}? Addressing this question is the focus of our discussions in this subsection.

Models 1 through 4 in Panel A of Table 4 show that the adjustment speed ranges within the [25%, 27%] domain, similar to the case of EPU_{ovr} discussed above. As per Model 2, four firm characteristics (size, tangibility, profitability and market-to-book ratio), rather than five under EPU_{ovr}, interact with EPU_{news} alongside the index itself in determining the marginal effects of EPU on book leverage. The marginal leverage effects of EPU_{news} depend positively on firm size (0.0763 with t = 4.55), but negatively on tangibility (−0.3284 with t = −2.88), profitability (−0.7804 with t = −2.00) and the market-to-book ratio (−0.1759 with t = −21.0). The first three signs agree with those for EPU_{ovr}, while the last is opposite to that for EPU_{ovr} related to DTB (See Model 2 in Panel A of Table 3). In any event, these results associated with EPU_{news} also support Hypothesis 2.

Turning to the marginal book-leverage effect of a characteristic, one can see from comparing Panel A of Table 4 and of Table 3 the notable qualitative difference with respect to the market-to-book ratio: $\partial DTB_{i,t}/\partial MTB_{i,t\text{-}1} = -0.1759{*}LEPU_{news,t\text{-}1} + 0.8003$. This is in contrast to $\partial DTB_{i,t}/\partial MTB_{i,t-1} = 0.0322{*}LEPU_{ovr,t\text{-}1} - 0.1469$, in that the sign of the coefficient on EPU is negative for $LEPU_{news}$, but positive for $LEPU_{ovr}$. In addition, as far as capital expenditure (Capex) is concerned, there is also a qualitative difference: In the case of EPU_{news}, Capex's marginal book-leverage effect does not depend on EPU, while in the case of EPU_{ovr} it does and positively (See Panel A of Table 3). Clearly, the stories put forward for EPU_{ovr} do not apply to EPU_{news}. One possible reason is that the other three components of EPU_{ovr}, i.e., EPU_{tax}, EPU_{spd} and EPU_{cpi}, are excluded from the regression models in Table 4, so their roles in determining $\partial DTB_{i,t}/\partial MTB_{i,t\text{-}1}$ and $\partial DTB_{i,t}/\partial Capex_{i,t\text{-}1}$ are ignored. The consequence of this ignoring may be large enough to result in the significant differences noted for MTB and Capex, although it may not be so for other characteristics.

Table 4
Leverage effect: News-based EPU.

Panel A Estimation results

Variable	Lev = DTB		Lev = DTM	
	Model 1	Model 2	Model 3	Model 4
$Lev_{i,t-1}$	0.7354***	0.7467***	0.7312***	0.7295***
	(37.1)	(35.9)	(49.1)	(49.8)
$LEPU_{news,t-1}$	−0.8175***	−0.9524***	−1.2040***	−1.1700***
	(−2.98)	(−3.27)	(−4.83)	(−4.91)
$Size_{i,t-1}$*$LEPU_{news,t-1}$	0.0644***	0.0763***	0.0591***	0.0535***
	(4.11)	(4.55)	(4.38)	(4.24)
$Tang_{i,t-1}$*$LEPU_{news,t-1}$	−0.4406***	−0.3284***	−0.2886**	−0.2603**
	(−3.06)	(−2.88)	(−2.28)	(−2.12)
$Prof_{i,t-1}$*$LEPU_{news,t-1}$	−1.0973***	−0.7804**	−0.3418	–
	(−2.76)	(−2.00)	(−1.47)	
$MTB_{i,t-1}$*$LEPU_{news,t-1}$	−0.1272***	−0.1759***	−0.0529***	−0.0395***
	(−22.1)	(−21.0)	(−8.79)	(−19.0)
$Capex_{i,t-1}$*$LEPU_{news,t-1}$	0.0163*	–	0.0264***	0.0257***
	(1.77)		(3.44)	(3.56)
$Div_{i,t-1}$*$LEPU_{news,t-1}$	0.0807	–	0.2177***	0.2081***
	(1.27)		(4.28)	(4.35)
$LBCI_{t-1}$	−0.1557***	−0.1510***	−0.2702***	−0.2573***
	(−5.59)	(−7.72)	(−10.8)	(−10.7)
$LVOL_{t-1}$	0.1593***	0.1897***	0.1196***	0.1032***
	(9.44)	(10.8)	(9.25)	(8.25)
$LVXO_{t-1}$	−0.1503***	−0.1935***	−0.0757***	−0.0572***
	(8.58)	(−9.68)	(−6.07)	(−4.75)
$Size_{i,t-1}$	−0.2798***	−0.3354***	−0.2281***	−0.2033***
	(−3.84)	(−4.30)	(−3.62)	(−3.45)
$Tang_{i,t-1}$	2.0418***	1.5195***	1.3273**	0.2008**
	(3.01)	(2.86)	(2.23)	(2.08)
$Prof_{i,t-1}$	5.1708***	3.6927**	1.6289	0.0197**
	(2.77)	(2.02)	(1.49)	(2.10)
$MTB_{i,t-1}$	0.5780***	0.8003***	0.2418***	0.1808***
	(22.0)	(21.1)	(8.80)	(19.2)
$Capex_{i,t-1}$	0.0264	–	0.1245**	0.1402***
	(0.42)		(2.34)	(2.85)
$Div_{i,t-1}$	−0.3588	–	−0.9880***	−0.9435***
	(−1.22)		(−4.18)	(−4.24)
CONTROL 1	Yes	Yes	Yes	Yes
CONTROL 2	Yes	Yes	Yes	Yes
Sargan	0.000	0.000	0.000	0.000
	[0.998]	[1.000]	[0.998]	[0.995]

Panel B Estimated marginal leverage effects of characteristics

	Lev = DTB	Lev = DTM
$\partial Lev_{i,t}/\partial Size_{i,t-1}$	0.0196***	0.0456***
	[−0.0144, 0.0509]	[0.0218, 0.0675]
$\partial Lev_{i,t}/\partial Tang_{i,t-1}$	−0.0082***	−1.0101***
	[−0.1430, 0.1380]	[−0.1170, −0.8942]
$\partial Lev_{i,t}/\partial Prof_{i,t-1}$	0.0623***	0.0197***
	[−0.2580, 0.4098]	[0.0197, 0.0197]
$\partial Lev_{i,t}/\partial MTB_{i,t-1}$	−0.0180***	−0.0030***
	[−0.0902, 0.0603]	[−0.0192, 0.0146]
$\partial Lev_{i,t}/\partial Capex_{i,t-1}$	–	0.2598***
		[0.2483, 0.2703]
$\partial Lev_{i,t}/\partial Div_{i,t-1}$	–	0.0246***
		[−0.0680, 0.1100]

Notes. Panel A presents, for the news-based EPU measure (EPU_{news}), the coefficient estimates in the general models specified by Eq. (5), and in the specific models obtained via implementing the GTS approach. Models 1 and 2 are concerned with book leverage, and Models 3 and 4 with market leverage. CONTROL 1 contains seven interactions between crisis dummies and the EPU_{news} index, and CONTROL 2 contains seven crisis dummies only. Sargan is the test statistic for the validity of instruments (over-identifying restrictions). Figures in parentheses are t-values based on robust (heteroscedasticity-adjusted) standard errors. *, ** and *** denote the 10%, 5% and 1% significance levels respectively. Panel B presents the estimated marginal leverage effects of characteristics across firms in terms of mean, minimum and maximum values, with the latter two in brackets. The reported coefficient estimates are identical to those in the original LD4 model (See Appendix C).

With regard to the marginal book-leverage effects of firm size, tangibility and profitability, Panel B of Table 4 shows that they are qualitatively similar to those under EPU_{ovr}, in terms of the signs of the coefficients on the EPU index and the signs of the constants. Therefore, the analyses for the relations between the marginal book-leverage effects of the three characteristics and economic policy uncertainty proposed for EPU_{ovr} apply to those for EPU_{news}. As such, we refrain from repeating these analyses. In sum, regarding the dependence of the marginal leverage effect of a characteristic on EPU_{news}, we obtain evidence from DTB in favour of Hypothesis 3.

Pertaining to the three proxies for GEU, $LBCI_{t-1}$, $LVOL_{t-1}$ and $LVXO_{t-1}$, Model 2 in Panel A of Table 4 indicates that they have statistically significant coefficients estimated: −0.1510 with t = −7.72, 0.1897 with t = 10.8 and −0.1935 with t = −9.68. The signs of the three coefficients remain the same as those for DTB under EPU_{ovr}. Thus, the stories said for the overall EPU index apply to the news-based EPU index.

Model 4 in Panel A of Table 4 is concerned with the market debt ratio (DTM). The model shows that the marginal effect of $LEPU_{news,t-1}$ on market leverage varies positively with size, capital expenditure and dividends (0.0535 with t = 4.24, 0.0257 with t = 3.56, and 0.2081 with t = 4.35), and negatively with tangibility and the market-to-book ratio (−0.2603 with t = −2.12, and −0.0395 with t = -19.0). As suggested by Panel B of Table 4 and of Table 3, the signs of the EPU-leverage-effect relations agree with those under EPU_{ovr} for Size, Tang, Capex and Div, but the signs disagree for MTB. Such similarities and differences between EPU_{news} and EPU_{ovr} in terms of the marginal effects of characteristics on market leverage indicate the importance of using EPU_{ovr} as the most comprehensive index. Nevertheless, all these results associated with EPU_{news} and DTM support Hypotheses 2 and 3.

According to Panel A of Table 4, $LBCI_{t-1,}$ $LVOL_{t-1}$ and $LVXO_{t-1}$ are shown to be statistically significant economy-wide factors (−0.2573 with t = −10.7, 0.1032 with t = 8.25 and −0.0572 with t = −4.75). The signs of these coefficients are consistent with those for DTB under EPU_{ovr} (and EPU_{news} *per se* too), so the possible explanations given there apply here.

To conclude this section, some remarks are in order. Using the overall index of EPU (EPU_{ovr}) and incorporating it into a dynamic panel regression model, we find that the marginal effects of firm characteristics on leverage vary with EPU over time. The documented evidence supportive of a joint role of EPU and characteristics can be explained by conventional capital structure theories, though not directly predicted by the theories. Nevertheless, our findings challenge the conventional wisdom that the leverage effects of detected firm characteristics, whether positive or negative, are constant over time. Using the news-based index of EPU (EPU_{news}) in the model, the above conclusions drawn under EPU_{ovr} remain qualitatively unchanged, although a few of characteristics change the relation of their marginal leverage effects with EPU away from that using EPU_{ovr}. The changes would lead to contradiction in applying theories to explain the results between EPU_{ovr} and its component EPU_{news}. These precisely highlight the importance of using the most comprehensive, overall index of EPU, rather than using one of its components, in reaching less biased conclusions.

6. Implications of EPU for corporate leverage

Presenting the estimation results of the dynamic panel data models, the preceding section has devoted discussions mainly to the marginal effects of characteristics on leverage, defined generically as $\partial Lev_{i,t}/\partial X_{i,t-1}$ with $X_{i,t-1}$ denoting a particular characteristic of firm i, if they are found to interact with EPU. In this section, we carry out the analysis of the implications of EPU for corporate leverage, with a focus on the total marginal effect (TME) of EPU on debt ratios for 2008, 2009 and 2010. During these three years, the US economy was heading toward recession. As Fig. 1 illustrates, relative to 2007, all the two EPU indexes rose, while the BCI index declined, in 2008 and 2009. These suggest rising economic policy uncertainty but falling uncertainty (or rising certainty) about the Great Recession, although the VOL and VXO indexes rose in 2008 and fell in 2009. Thus, we pick these three years to gauge how firms' different characteristics play a role in the responsiveness of their debt-financing decisions to EPU innovations, during this turbulent period. Another reason is that using the representative three years, instead of 31 years (including other high/low EPU periods), greatly saves space while still serving our illustration purpose to make economic sense of the results.

We take the cross-section perspective by holding each individual firm's characteristics as given, while allowing for EPU innovations, in t-1. The interesting findings from Tables 3 and 4 are that there are cross-sectional variations in the TME defined generically as $\partial Lev_{i,t}/\partial LEPU_{t-1}$ (Recall Eq. (5)). The variations arise from different firms having different values of a given characteristic – e.g., $Size_{i,t}$ varies as i differs given t. Based on these findings, we now examine the implications of the TME within a given year. As argued at the end of the preceding section, using the overall index of EPU (EPU_{ovr}) would better avoid the omitted-variable bias, thereby making the results more reliable, than using any one of its components such as EPU_{news}. Therefore, we report the analysis results associated with EPU_{ovr} only. [13]Note, although any coefficient estimates inevitably possess statistical errors, they can still be used to yield at least suggestive insights into the issues under investigations.

To facilitate discussions, we appeal to graphical analyses and use the definition of TME ($\partial Lev_{i,t}/\partial LEPU_{t-1}$) to compute its mean value (denoted by $\overline{TME}$). Note, however, that the mean values of several TMEs ought to be viewed from a relative, rather than absolute, perspective, to mitigate the consequences of the statistical errors and the possible biases involved in model estimations by LD4 and model simplifications via GTS. To this end, our discussions below will also attend to the changing pattern of $\overline{TMEs}$ by taking several (given) years to compare them. This way, one can tell whether/how firms on

[13] The graphical analysis results for EPU_{news} are presented in section 2 of "Supplemental File". The main conclusions drawn from the results confirm qualitatively those drawn from EPU_{ovr}, although, not surprisingly, some differences do exist.

average become more/less conservative (i.e., $\overline{TME}$ is relatively more/less negative) or less/more aggressive (i.e., $\overline{TME}$ is relatively less/more positive) via the comparisons.

Fig. 2 depicts the TMEs of the overall EPU measure (EPU_{ovr}) on, respectively, the book debt ratio and the market debt ratio for 2008 (Panels (a) and (b)), 2009 (Panels (c) and (d)) and 2010 (Panels (e) and (f)). The equations used to calculate $TME_{i,t}^{DTB}$ and $TME_{i,t}^{DTM}$ are presented in the footnote of the figure, and they use relevant coefficient estimates from Models 2 and 4 in Table 3. Several observations can be made from the figure. The first is that the TME of EPU_{ovr} is not constant, but varies across firms, in any given year (2008 or 2009 or 2010), and for both measures of leverage. This is not surprising, as the $TME_{i,t}^{DTB}$ and $TME_{i,t}^{DTM}$ equations indicate that the $TME_{i,t}$ at t depends on the characteristics of individual firms in t-1 and changes as i changes.

Second, Panels (a), (c) and (e) of Fig. 2 demonstrate that, whether in 2008, 2009 or 2010, some firms had negative, while others positive, TMEs - that is, some book debt ratios tended to rise, while others tended to fall, in responses to a rise in EPU_{ovr}. However, a closer inspection of Panels (a), (c) and (e) uncovers that, on average across all firms, the estimated TMEs ($\overline{TME}^{DTB}$) are, respectively, −0.0786 (for 2008), −0.0869 (for 2009) and −0.0825 (for 2010), all negative and statistically significant. Note, the number of companies with positive $TME_{i,t}$ is smaller than that with negative $TME_{i,t}$, in each of the three years considered (942 < 1721 in 2008, 844 < 1771 in 2009, and 882 < 1731 in 2010). These largely contribute to $\overline{TME}^{DTB}$ being negative for the three years.

Third, Panels (b), (d) and (f) reveal that for the three years, the average TME on the market leverage ($\overline{TME}^{DTM}$) is constantly negative (−0.5423, −0.5381 and −0.2645) and statistically significant. And, the number of companies with a positive TME is also smaller than that with a negative TME in each of the three years (4 < 2659 in 2008, 13 < 2594 in 2009, and 388 < 2210 in 2010). These also contribute to $\overline{TME}^{DTM}$ being negative for the three years.

Fourth, the number of firms with a positive (negative) TME^{DTB} changed only slightly, and $\overline{TME}^{DTB}$ also changed slightly, over the three years. So, as far as the book debt ratio is concerned, firms on average changed from less conservative to more so between 2008 and 2009, and then tended to become less conservative between 2009 and 2010, facing higher EPU_{ovr}. On the other hand, however, the number of firms with a positive (negative) TME^{DTM} rose (fell) relatively sharply, and $\overline{TME}^{DTM}$ also rose relatively sharply (from −0.5381 to −0.2645), between 2009 and 2010. Thus, in terms of the market debt ratio, firms on average changed from more conservative to less so between 2009 and 2010, facing higher EPU_{ovr}.

To sum up, the TMEs of EPU_{ovr} on book and market leverages are not constant but vary across firms due to their different characteristics, in any given year. This result is not seen in studies that ignore the effect of EPU on leverage or studies that fail to allow for the *joint* effects of EPU and firm characteristics on leverage. Aggregating across all the firms over these three years, a rise in EPU_{ovr} would lead to a decline in leverage on average. This result offers a support for Hypothesis 1.

It is useful to illustrate the economic significance of our results for the US economy as a whole, and we do so by using the value of $\overline{TME}^{DTB}$ of $LEPU_{ovr}$. Taking 2009 as an example, $\overline{TME}^{DTB} = -0.0869$. Suppose $LEPU_{ovr}$ rose by one standard deviation of 0.245 (i.e., $\Delta LEPU_{ovr} = 0.245$ or $\Delta EPU_{ovr} = 39.96$) in 2009. Holding all else constant, the average decline in the book debt ratio in 2009 would be approximately $\overline{\Delta DTB} = \overline{TME}^{DTB} * \Delta LEPU_{ovr} = -0.0869*0.245 = -0.0213$. If multiplied by the median value of the book assets of all firms in our sample, i.e., US$ 277,880,021, the "median" firm would, *ceteris paribus*, reduce its debt by some US$ −5,918,844 in 2009. If using the mean value (US$ 298,028,596), the "mean" firm would reduce its debt by US$ −6,348,009 in 2009. Therefore, the implications of EPU for corporate leverage are so economically significant that the important role of EPU in affecting capital structure decisions cannot be overlooked.

Next, let us have an overall picture of TMEs for the entire sample period. Because EPU_{ovr} is the broadest measure of EPU and book leverage (DTB) reflects more accurately changes in firms' debt ratios than market leverage, we present Fig. 3 based on EPU_{ovr} and DTB for analysis. The figure uses the relevant coefficient estimates in Model 2 from Table 3 to calculate the TME of EPU_{ovr} on each firm's DTB and then aggregate the results. Unlike Fig. 2 which looks at 2009, 2010 and 2011, Fig. 3 plots, for the entire sample period, the percentages of TME > 0 and of TME < 0 (Panel (a)), the means of TME > 0 and TME < 0 (Panel (b)), and the average book leverage together with the average mean of all TMEs (positive and negative). Regarding Panel (a), since some firms have missing data and hence missing values of TMEs, we use the sum of firms with available TME values as the denominator to calculate the percentages and the means. Below we make some remarks about Fig. 3.

First, according to Panel (a), throughout the entire sample period the percentage of negative TMEs is higher than the percentage of positive TMEs, including the three turbulence years (2008 to 2010) as already discussed above based on Fig. 2. This can also be said to Panel (b) where the means of positive and negative TMEs are presented. These observations confirm the conclusion drawn from Fig. 2: On average over the entire sample period, a rise in EPU_{ovr} would lead to a decline in leverage, further supporting Hypothesis 1.

Second, comparing Fig. 3 with Fig. 1 (Panel (c)), there is no discernible connection between the business cycle (LBCI) or financial market uncertainties (LVOL and LVXO) and the changing patterns of the percentages and means of TMEs. This is because, according to our panel regression model in Eq. (5), the TMEs do not depend on the three GEU variables, whose effects are controlled outside the parenthesised term measuring the TMEs but depend on firm characteristics.

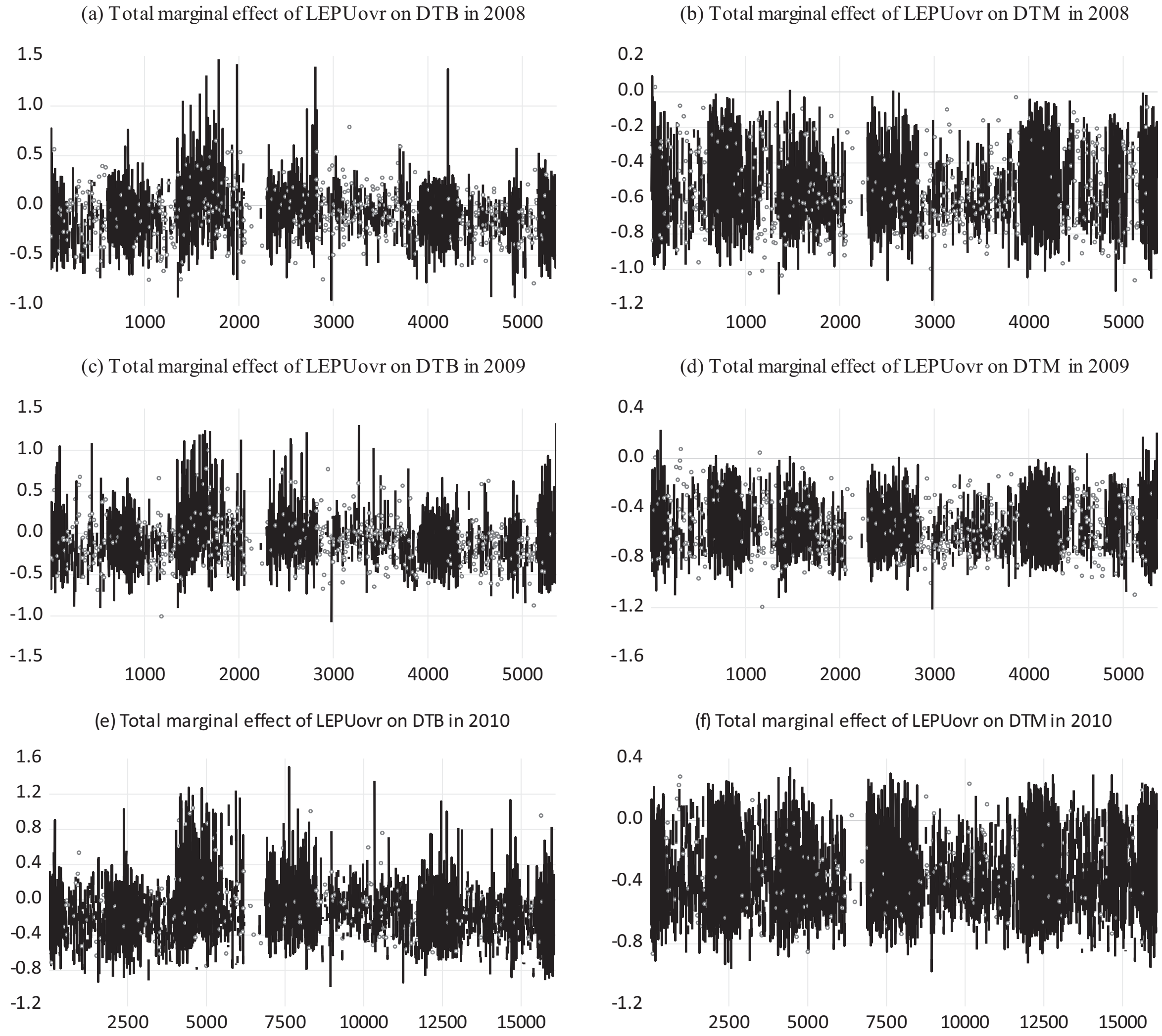

Fig. 2. Total marginal effects of overall EPU on leverage in 2008, 2009 and 2010. *Note*. Based on relevant coefficient estimates in Models 2 and 4 (including those in CONTROL 1 and CONTROL 2) from Table 3, and the timing of the financial crises relevant to 2007, 2008 and 2009, we calculate the total marginal effects for DTB in (a), (c) and (e) as: $TME_{i,t}^{DTB} = -1.6808 + 0.0881 * \mathrm{Size}_{i,t-1} - 0.6149 * \mathrm{Tang}_{i,t-1} - 1.0292 * \mathrm{Prof}_{i,t-1} + 0.0322 * MTB_{i,t-1} + 0.0440\mathrm{Capex}_{i,t-1} - 0.0202 * Z_{recession,t-1}$ and the total marginal effects for DTM in (b), (d) and (f) as: $TME_{i,t}^{DTM} = -1.7087 + 0.0697 * Size_{i,t-1} - 0.2472 * \mathrm{Tang}_{i,t-1} - 0.4319 * \mathrm{Prof}_{i,t-1} + 0.0131 * \mathrm{MTB}_{i,t-1} + 0.0267 * \mathrm{Capex}_{i,t-1} + 0.3196 * \mathrm{Div}_{i,t-1} - 0.2799 * Z_{subprime,t-1}$. The vertical axis measures TME, and the horizontal axis gives the ordinal numbers of companies. Panel (a): No. of ($TME^{DTB} > 0$) = 942. No. of ($TME^{DTB} \leq 0$) = 1721. No. of missing obs = 2698. $\overline{TME}^{DTB} = -0.0786^{***}$. Panel (b): No. of ($TME^{DTM} > 0$) = 4. No. of ($TME^{DTM} \leq 0$) = 2650. No. of missing obs = 2707. $\overline{TME}^{DTM} = -0.5423^{***}$. Panel (c): No. of ($TME^{DTB} > 0$) = 844. No. of ($TME^{DTB} \leq 0$) = 1771. No. of missing obs = 2746. $\overline{TME}^{DTB} = -0.0869^{***}$. Panel (d): No. of ($TME^{DTM} > 0$) = 13. No. of ($TME^{DTM} \leq 0$) = 2594. No. of missing obs = 2754. $\overline{TME}^{DTM} = -0.5381^{***}$. Panel (e): No. of ($TME^{DTB} > 0$) = 882. No. of ($TME^{DTB} \leq 0$) = 1731. No. of missing obs = 2748. $\overline{TME}^{DTB} = -0.0825^{***}$. Panel (f): No. of ($TME^{DTM} > 0$) = 388. No. of ($TME^{DTM} \leq 0$) = 2210. No. of missing obs = 2763. $\overline{TME}^{DTM} = -0.2645^{***}$. *** indicates significance at the 1% level.

Third, from Panel (c) of Fig. 3, there is no discernible connection between the average mean of TMS and the average book leverage. This is not difficult to understand. Again, Eq. (5) implies that a firm's debt ratio is dependent not just on the TME but also on EPU *per se* as well as other factors including firm characteristics and GEU.

7. Summary and conclusion

Previous studies have ignored the possibility that economic policy uncertainty and firm characteristics can jointly, not just respectively, affect capital structure choices. As an endeavour to fill the void, the present study investigates the joint leverage effects of EPU and firm characteristics, for US companies. Inspired by Fama and French's (2002) approach, we propose a research framework that allows EPU and firm characteristics to form interaction terms in the dynamic panel regression models to jointly determine target and hence actual book or market debt ratio. We consider the most comprehensive

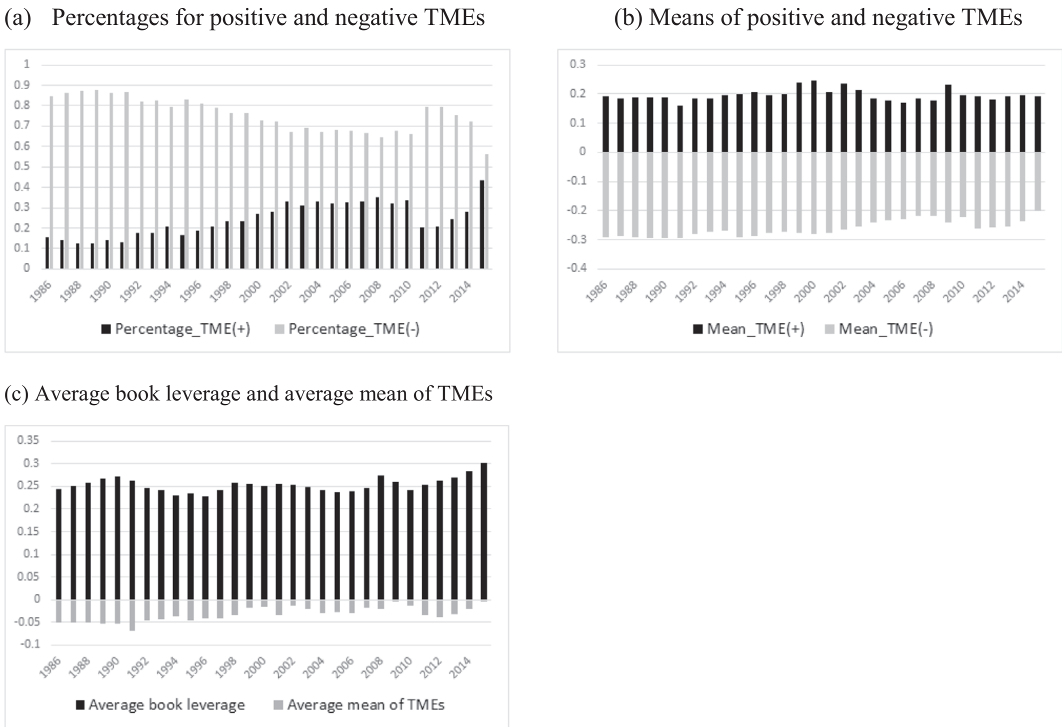

Fig. 3. Total marginal effects of overall EPU on book leverage, 1986–2015. *Note*. Based on relevant coefficient estimates in Model 2 from Table 3, and the timing of the various financial/economic crises over the entire sample period from 1986 to 2015, we calculate the TME of the overall EPU index on each firm's book leverage (DTB). This figure depicts the percentages for positive and negative TMEs respectively (Panel (a)), the means for positive and negative TMEs respectively (Panel (b)), and the average book leverage and the average mean of TMEs. The average mean of TME = (the mean of positive TMEs + the mean of negative TMEs)/2.

measure of EPU, as well as one of its components - the most widely used news-based EPU index - for comparison purposes. We also control for general economic uncertainty (GEU) and global financial crises. Thanks to the research framework, we are able to obtain novel results, and conduct analyses of the EPU implications of these results for corporate leverage. The main conclusions are summarized as follows.

EPU and firm characteristics jointly determine firms' leverage targets and then their actual leverage ratios to adjust partially towards the targets, in two dimensions. Over time, the marginal effects of a firm's characteristics on its debt ratios are not constant but changes with EPU, and so can be positive or negative. Across firms at a given year, the marginal effects of EPU on their debt ratios are not the same but differ due to different firms having different characteristics and can be positive or negative too. These results are not seen in the empirical evidence provided by the existing capital-structure studies. We view the results as the main contribution of our study.

Regarding EPU implications for corporate leverage, in tranquil years, it is firm characteristics and their coefficients that determine the TME – i.e., the responsiveness of corporate leverage to EPU innovations. Such responsiveness can be viewed as reflecting firms' conservativeness or aggressiveness in their capital structure choices. Brogaard and Detzel (2015) note that government policymakers can contribute to uncertainty regarding fiscal, regulatory, or monetary policy which the authors refer to as EPU. This implies that changing the transparency and stability of implementing economic policies (i.e., changing EPU) may move the cross-economy average debt ratio up or down, given firms' negative responsiveness of corporate leverage to EPU at the aggregate level.

Our results also demonstrate that GEU does not subsume EPU in terms of their impacts on corporate leverage, nor vice versa. We find that business cycles and implied stock market volatility have a negative, while realized stock market volatility has a positive effect, on book and market leverages, for the overall EPU index and the news-based EPU index. Therefore, the effects of GEU on leverage are independent of those of EPU detected. These results are not seen either in the existing capital structure studies which consider macroeconomic conditions but not economic policy uncertainty.

In addition, we find that using the news-based EPU index leads to the main conclusions that are in line with those of using the overall EPU index, but also some conclusions that are not. We argue that since the overall EPU index better captures the comprehensiveness of economic policy uncertainty than any of its components, the regression results based on the index are less subject to the omitted-variable bias and hence should produce more reliable conclusions and policy implications.

Declaration of Competing Interest

None.

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Appendix A

See Table A1.

Table A1
Summary of sample composition.

Sector	Active firms	Delisted firms	Total firms
Industrials	367	479	846
Energy	222	231	453
Materials	183	188	371
Consumer discretionary	298	416	714
Consumer staples	313	346	659
Health care	387	471	858
Information technology	485	854	1,339
Telecommunication	29	91	120
All sectors	**2,284**	**3,076**	**5,360**

Appendix B

We apply panel Granger causality test and present the results in Table A2. From the table, the null hypothesis that each of the two EPU index versus each of the two measures of leverage ratio do not Granger cause one another is decisively rejected, for both level and difference, especially where three lags are allowed for. Thus, there is overwhelming evidence that there exists a bi-directional Granger causality between EPU and leverage. Although this causality evidence is preliminary and statistical in nature, it does encourage us to further explore the question of in what way EPU *causes* leverage. The detected Granger causality also conveys an additional warning message that estimating dynamic panel data models needs to address the potential endogeneity problem.

Table A2
Panel Granger causality test results.

Null hypothesis	Lag 1	Lag 2	Lag 3
$LEUP_{ovr}$ does not Granger cause DTB	19.9525 [0.000]	27.8338 [0.000]	62.4153 [0.000]
DTB does not Granger cause $LEPU_{ovr}$	12.6254 [0.000]	12.0207 [0.000]	7.21791 [0.000]
$\Delta LEUP_{ovr}$ does not Granger cause ΔDTB	50.0701 [0.000]	97.6756 [0.000]	78.6915 [0.000]
ΔDTB does not Granger cause $\Delta LEPU_{ovr}$	0.03004 [0.000]	9.32194 [0.000]	32.4469 [0.000]
$LEUP_{ovr}$ does not Granger cause DTM	648.893 [0.000]	335.877 [0.000]	249.804 [0.000]
DTM does not Granger cause $LEPU_{ovr}$	218.634 [0.000]	87.0943 [0.000]	65.2577 [0.000]
$\Delta LEUP_{ovr}$ does not Granger cause ΔDTM	138.516 [0.000]	265.061 [0.000]	430.965 [0.000]
ΔDTM does not Granger cause $\Delta LEPU_{ovr}$	282.662 [0.000]	112.399 [0.000]	190.817 [0.000]
$LEUP_{news}$ does not Granger cause DTB	40.5587 [0.000]	25.0754 [0.000]	37.1789 [0.000]
DTB does not Granger cause $LEPU_{news}$	11.2629 [0.001]	12.3113 [0.000]	7.13517 [0.000]
$\Delta LEUP_{news}$ does not Granger cause ΔDTB	3.64655 [0.056]	57.7248 [0.000]	56.8575 [0.000]
ΔDTB does not Granger cause $\Delta LEPU_{news}$	0.22248 [0.637]	11.2162 [0.000]	31.6791 [0.000]
$LEUP_{news}$ does not Granger cause DTM	856.912 [0.000]	488.526 [0.000]	323.130 [0.000]
DTM does not Granger cause $LEPU_{news}$	178.902 [0.000]	91.4009 [0.000]	43.7837 [0.000]
$\Delta LEUP_{news}$ does not Granger cause ΔDTM	35.0027 [0.000]	199.490 [0.000]	356.559 [0.000]
ΔDTM does not Granger cause $\Delta LEPU_{news}$	182.978 [0.000]	140.364 [0.000]	174.340 [0.000]

Note. This table presents panel Granger causality test results. $LEPU_{ovr}$ is the natural logarithm of the EPU_{ovr} index. $LEPU_{news}$ is the natural logarithm of the EPU_{news} index. DTB and DTM stand for the book and the market debt ratio, respectively. Figures in brackets are p-values.

Appendix C. Long differencing transformation of Eq. (5)

Rewrite Eq. (5) in the paper as:

$$\begin{aligned} Lev_{i,t} = {} & \gamma Lev_{i,t-1} + (a_1 + a_2 Size_{i,t-1} + a_3 Tang_{i,t-1} + a_4 \mathrm{Prof}_{i,t-1} + a_5 MTB_{i,t-1} + a_6 Capex_{i,t-1} + a_7 Div_{i,t-1} \\ & + \sum_{j=1}^{7} d_j Z_{j,t-1}) * LEPU_{t-1} + c_1 LBCI_{t-1} + c_2 LVOL_{t-1} + c_3 LVXO_{t-1} + \beta_2 Size_{i,t-1} + \beta_3 Tang_{i,t-1} \\ & + \beta_4 \mathrm{Prof}_{i,t-1} + \beta_5 MTB_{i,t-1} + \beta_6 Capex_{i,t-1} + \beta_7 Div_{i,t-1} + \sum_{j=1}^{7} g_j Z_{j,t-1} + \delta\eta_i + v_{i,t} \end{aligned} \quad (A1)$$

Lagging both sides of (A1) by k, we have:

$$\begin{aligned} Lev_{i,t-k} = {} & \gamma Lev_{i,t-1-k} + (a_1 + a_2 Size_{i,t-1-k} + a_3 Tang_{i,t-1-k} + a_4 \mathrm{Prof}_{i,t-1-k} + a_5 MTB_{i,t-1-k} + a_6 Capex_{i,t-1-k} + a_7 Div_{i,t-1-k} \\ & + \sum_{j=1}^{7} d_j Z_{j,t-1-k}) * LEPU_{t-1-k} + c_1 LBCI_{t-1-k} + c_2 LVOL_{t-1-k} + c_3 LVXO_{t-1-k} + \beta_2 Size_{i,t-1-k} + \beta_3 Tang_{i,t-1-k} \\ & + \beta_4 \mathrm{Prof}_{i,t-1-k} + \beta_5 MTB_{i,t-1-k} + \beta_6 Capex_{i,t-1-k} + \beta_7 Div_{i,t-1-k} + \sum_{j=1}^{7} g_j Z_{j,t-1-k} + \delta\eta_i + v_{i,t-k} \end{aligned} \quad (A2)$$

Subtracting (A2) from (A1) yields:

$$\begin{aligned} Lev_{i,t} - Lev_{i,t-k} = {} & \gamma(Lev_{i,t-1} - Lev_{i,t-1-k}) + a_1(LEPU_{t-1} - LEPU_{t-1-k}) + a_2(Size_{i,t-1} * LEPU_{t-1} - Size_{i,t-1-k} * LEPU_{t-1-k}) \\ & + a_3(Tang_{i,t-1} * LEPU_{t-1} - Tang_{i,t-1-k} * LEPU_{t-1-k}) + a_4(\mathrm{Prof}_{i,t-1} * LEPU_{t-1} - \mathrm{Prof}_{i,t-1-k} * LEPU_{t-1-k}) \\ & + a_5(MTB_{i,t-1} * LEPU_{t-1} - MTB_{i,t-1-k} * LEPU_{t-1-k}) + a_6(Capex_{i,t-1} * LEPU_{t-1} - Capex_{i,t-1-k} * LEPU_{t-1-k}) \\ & + a_7(Div_{i,t-1} * LEPU_{t-1} - Div_{i,t-1-k} * LEPU_{t-1-k}) + \sum_{j=1}^{7} d_j Z_{j,t-1} * LEPU_{t-1} - \sum_{j=1}^{7} d_j Z_{j,t-1-k} * LEPU_{t-1-k} \\ & + c_1(LBCI_{t-1} - LBCI_{t-1-k}) + c_2(LVOL_{t-1} - LVOL_{t-1-k}) + c_3(LVXO_{t-1} - LVXO_{t-1-k}) \\ & + \beta_2(Size_{i,t-1} - Size_{i,t-1-k}) + \beta_3(Tang_{i,t-1} - Tang_{i,t-1-k}) + \beta_4(\mathrm{Prof}_{i,t-1} - \mathrm{Prof}_{i,t-1-k}) + \beta_5(MTB_{i,t-1} - MTB_{i,t-1-k}) \\ & + \beta_6(Capex_{i,t-1} - Capex_{i,t-1-k}) + \beta_7(Div_{i,t-1} - Div_{i,t-1-k}) + \sum_{j=1}^{7} g_j(Z_{j,t-1} - Z_{j,t-1-k}) + v_{i,t} - v_{i,t-k} \end{aligned}$$

Or equivalently:

$$\begin{aligned} \Delta Lev_{i,t,t-k} = {} & \gamma \Delta Lev_{i,t-1,t-1-k} + a_1 \Delta LEPU_{t-1,t-1-k} + a_2 \Delta SizeLEPU_{i,t-1,t-1-k} + a_3 \Delta TangLEPU_{i,t-1,t-1-k} + a_4 \Delta \mathrm{Prof}LEPU_{i,t-1,t-1-k} \\ & + a_5 \Delta MTBLEPU_{i,t-1,t-1-k} + a_6 \Delta CapexLEPU_{i,t-1,t-1-k} + a_7 \Delta DivLEPU_{i,t-1,t-1-k} + \sum_{j=1}^{7} d_j \Delta ZLEPU_{j,t-1,t-1-k} \\ & + c_1 \Delta LBCI_{t-1,t-1-k} + c_2 \Delta LVOL_{t-1,t-1-k} + c_3 \Delta LVXO_{t-1,t-1-k} + \beta_2 \Delta Size_{i,t-1,t-1-k} + \beta_3 \Delta Tang_{i,t-1,t-1-k} + \beta_4 \Delta \mathrm{Prof}_{i,t-1,t-1-k} \\ & + \beta_5 \Delta MTB_{i,t-1,t-1-k} + \beta_6 \Delta Capex_{i,t-1,t-1-k} + \beta_7 \Delta Div_{i,t-1,t-1-k} + \sum_{j=1}^{7} g_j \Delta Z_{j,t-1,t-1-k} + \Delta v_{i,t,t-k} \end{aligned} \quad (A3)$$

where $\Delta SizeLEPU_{i,t-1,t-1-k} \equiv Size_{i,t-1}*LEPU_{t-1} - Size_{i,t-1-k}*LEPU_{t-1-k}$, $\Delta ZLEPU_{j,t-1,t-1-k} \equiv Z_{j,t-1}*LEPU_{t-1} - Z_{j,t-1-k}*LEPU_{t-1-k}$, and so on. Note, all coefficients in (A3) are the same as in (A1). We take k = 4 and so estimate the coefficients in (A3) via the LD4 technique with 2SLS used by Huang and Ritter (2009). We require at least three iterations, according to the suggestion of Hahn et al. (2007). The instruments used include the residuals from the previous iteration of estimation.

Appendix D. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jimonfin.2020.102279.

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