A Longitudinal Study of Sales-Based Investment and Leverage Decisions

Rihab Belguith[1] & Fathi Abid[2]

[1] University of Sfax, Institute of High Business Studies, Sfax, Tunsisia

[2] University of Sfax, Faculty of Economics and Business, Sfax, Tunisia

Correspondence: Rihab Belguith, University of Sfax, Institute of High Business Studies, Road Sidi Mnasour 10, 3061 Sfax, Tunsisia. E-mail: belguithrihab@gmail.com

Received: October 28, 2022 Accepted: November 25, 2022 Online Published: January 2, 2023

doi:10.5430/ijfr.v14n1p20 URL: https://doi.org/10.5430/ijfr.v14n1p20

Abstract

The paper develops a system-based approach to investigate the dynamic adjustment of debt structure and investment policies in a context of risky sales. Empirical results were obtained through a panel data set of US DJ-IA firms/constituents index firms with different sectors. The analysis supports that environmental change does not affect equally the different industry since operating leverage differs among industries and so the sensitivity to sales variance. Including adjusted-specific variance, we find that there is no monotonic relation between leverage, sales and investment. The firm may choose a low debt level in response to high sales variance but high leverage to attenuate the negative relation between sales variance and current level of investment. We further find that while the overall effect of debt maturity on leverage is unaffected by the level of growth opportunities, the shorter the maturity of debt is the smaller the direct effect of sales variance on investment.

Keywords: sales uncertainty, dynamic panel, investment, leverage decision

JEL Classification: F14, G28, G32, M210

1. Introduction

The uncertain decision in corporate finance remains a major problem for managers. Standard capital structure models have investigated firm's decisions about how to finance their operations. Based on Merton (1974) and Leland (1994), the main hypothesis is that the firm's asset is the contingent claim of the firm's optimal capital structure. By these models the cash flows are exogenously given and develop financing and default decisions but they tend to ignore the firm's investment possibilities. Integrating dynamic real options give rise to a various theoretical research for modeling the joint choice of financing and investment decisions. Sundaresan et al. (2015), provide a dynamic contingent-claim framework for endogenously modeling growth options with debt financing strategy regarding to the firm's sales dynamic.

After a theoretical reflection, the main idea is that the firm production efficiency guarantees the maintenance of its product exchange volume in the market. High sales volume enables the firm to generate higher cash-flows as well as create more future investment opportunities. However in competitive market, sales become stochastic and the expected sales growth rate becomes volatile to environmental changes such as competitiveness, technology, global crises, etc. To take into account this uncertainty, firms may restructure their endogenous financing and investment decisions with anticipating the effect of sales volatility that may arise in the future on the one hand and the exploitation of valuable investment opportunities on the other hand. Therefore, sales and growth opportunities constitute the state variables of the firm's debt and investment policies. In this paper, we present empirical evidence regarding the relative importance of dynamic real options in the simultaneous choice of leverage, debt maturity and investment policies for corporate panel datasets with different industries.

Following recent empirical research (Elyasiani, et al. 2002; Aivazian, et al. 2005b; Barclay, et al. 2003), we develop a system-based approach for explaining reverse causality between leverage and investment. Dynamic panel models play an important role in corporate finance models to explain the speed of adjustment of firm's decisions and the dataset characteristics impact on the estimator's performance.

Sales price may capture relevant information of the firm's potential on the market allowing a significant signal for both lenders and investors. Internal reasons also can explain the importance of sales, especially in debt and investment decision-making. Faced debt financing costs, the company prefers to finance its investment through internal funds, so that the optimal investment policy and the value of the company depend on its net income. However, high risk activities will cause uncertainty, so debt holders will carefully give debt to avoid risk by controlling over the fund borrowed tightly. With this condition, an increase in sales volatility will lower the firm's ability to issue more debt. Thus, integrating the composition of growth opportunities and stochastic sales may quantitatively influence the manner in which the firms anticipate its debt level to finance investment decision.

In panel data set, sales growth uncertainty does not equally affect the different industries since leverage differs among industries with different capital structure and investment strategies, and so the sensitivity to sales volatility. The aim of this paper is first to provide whether sales-variance, in panel data set, is an important predictor of the sensitivity of sales growth volatility to environmental change and second to simultaneously model corporate leverage and investment with empirically showing that integrating of both sales risk with growth opportunities may significantly affect the interrelations between capital structure and investment of the US Dow Jones-Industrial Average (DJ-IA) firms/constituents index.

The methodology combines the use of sales stochastic diffusion process and the econometrics of dynamic panels and simultaneous equations to provide a longitudinal analysis of the US DJ-IA firm's index on its dynamic capital structure. Using a causal framework for three simultaneous dynamic panel models of endogenous debt structure (level and maturity) and investment, we show that there is a nonlinear and non-monotonic relation between corporate policies with sales growth volatility and growth opportunities. Since sales growth uncertainty does not affect equally the different industry since operating leverage differs among industries and so the sensitivity to sales volatility, we predict the individual-sales variance referring to the estimated growth rate and volatility sales to each firm after controlling for heterogeneity across firms. The predicted variance is used as state variable with growth opportunities in the econometric model using Three-Stage Least Squares (3SLS) estimation method.

This article is organized as follows. Section 2 presents the related review. Section 3 describes the data and the empirical research design. Section 4 discusses the empirical results with several robustness tests. Section 5 concludes.

2. Related Review

Recently there is a growing body of theoretical and empirical researches on the interrelations between capital structure and investment decisions. Empirical capital structure studies require the use of dynamic panel models to estimate corporate leverage. A number of recent studies have explored the firm's speed of adjustment toward target leverage (eg. Fama and French, 2002; Welch, 2004; Lemmon et al., 2008). Flannery and Rangan, (2006) develop a model to estimate the firm's partial adjustment toward target leverage ratio that depend on firms characteristics. They show that firms with high leverage are more likely to move toward their target than those with low leverage. Huang and Ritter (2009) have examined the relation between external funds and dynamic leverage for publicly traded US firms. Using long differencing estimation method for the speed of adjustment toward target leverage, they find that US firms are much more likely to use external equity financing when the relative cost of equity is low. Using panel models, Johnson (2003) and Billett, et al., (2007) examined the impact of growth opportunities on the simultaneous dynamic choice of debt and debt maturity. Aivazian et al. (2005b) and Dang (2011) extend these studies on interactions between corporate financing and investment with modeling investment as endogenous variable using a system based approach. The use of structural equations with dynamic panel, give rise for the potential importance of choosing an appropriate estimation methods. In this area, Flannery and Hankins (2013) test several estimation methods for dynamic adjustment leverage models using different panel data sets. While the aforementioned studies have explored the impact of growth options in debt and investment strategies in a reverse causality framework, we focus on the firm's sales importance in corporate decisions. Specifically, it aims to respond at the following questions. Empirically, can sales dynamics reflect the effect of environmental change on firm debt for a sample of different firms: from different sectors and with different characteristics? What is the role of sales in corporate decision making in a dynamic real options environment? In term of methodology, we follow the above empirical studies on modeling corporate financing and investment using a system based approach of dynamic panel models. This paper develops an empirical methodology based on Sundaresan et al., (2015) theoretical model. The main hypothesis is that firms frequently rebalance their capital structure and investment decisions regarding their growth opportunities and sales dynamics. Models on the effect of sales variance on investment and models of relationship between sales and debt structure have proceeded relatively independent of each other. Our paper builds on the insights of both literatures to integrate simultaneously stochastic sales with growth opportunities in debt and investment modeling. The literature distinguishes two types of sales metrics in investment models. Those who study the effect of sales risk as a measure of environmental change and those who study the effect of sales volume as a measure of business growth. In this paper, we examine the interrelations among sales, debt and investment. Some empirical studies like Dessí and Robertson (2003); Margaritis and Psillaki (2010) and Psillaki et al. (2010) have reported a positive effect of growth opportunities on firm performance and have measured growth opportunities by sales growth. Using a Modigliani-Miller benchmark measures of investment, Bolton et al. (2014) find nonlinear and non-monotonic in the firm's internal funds, as the firm may prefer accumulating internal funds rather than accessing external capital markets to finance investment when internal funds are sufficiently high. With multiple rounds of growth options, they show that a value-maximizing financially constrained firm may choose to over-invest via accelerated investment timing in earlier stages in order to mitigate under-investment problems in later stages. Nikolov et al. (2019) show that modeling credit lines as contingent liquidity provides novel empirical predictions and rationalizes several stylized facts regarding credit line usage, covenant violations, and cash holdings. Using calibrated dynamic capital structure model, Chen and Manso (2014) show that the costs of debt overhang become higher in the presence of macroeconomic risk. This paper contributes to the existing literature in including sales-variance as state variable in leverage and investment models. The main idea is to highlight the importance of sales' informational content and its direct effect on activity cash flows, market share, productivity and competitiveness of the firm. The higher the sales volume, the more opportunities the company will have to exercise more growth options in the future and anticipate reducing future debt-overhang. The simultaneous dynamic system of equations used in this paper includes the role of sales on debt, debt maturity and investment relations in order to test whether sales inversely affects leverage (debt maturity) and investment and whether the direction of this relation is conditional on debt maturity (leverage) and investment.

3. Sales-Based Debt and Investment Modeling

3.1 Research Design

The system of equations is composed of three dynamic panel models of debt, debt maturity and investment using a balanced panel dataset of the US Dow-Jones firms/constituents index for different sectors over the period from March-1990 to September-2017. Since sales growth uncertainty does not affect equally the different industry, we predict the individual-sales variance referring to the estimated growth rate and volatility sales to each firm after controlling for heterogeneity across firms. The predicted variance is included as state variable with growth opportunities in the econometric system of equations model using Three-Stage Least Squares (3SLS) estimation method. All variables definitions are presented in Table 1.

In the spirit of Sundaresan et al. (2015), the main hypothesis is that the sales company, S, is exogenous and following a Geometric Brownian Motion (GBM) process where W is a standard Brownian motion, μ is the expected return, and σ is the sales dynamics constant volatility:

$$\partial S(t) = \mu S(t)\partial t + \sigma S(t)\partial W(t) \tag{3.1}$$

The standard deviation of the logarithm of the sales value is $\sqrt{t}$. During a short scale of time dt, $dw = \varepsilon\sqrt{dt}$.

Where ε is normally distributed with a mean of zero and a standard deviation of 1 but the changes in sales price are *log normally* distributed. Then, the discrete-time continuous-state stochastic process can be represented by the following formula:

$$S_{t+\Delta t} = S_t + \mu S_t \Delta t + \sigma S_t \sqrt{\Delta t}\varepsilon_t \tag{3.2}$$

In the same sample, the use time series data can neglect the heterogeneity across individuals, the panel data structure has been proposed by a growing body of recent empirical economic and financial research. The first-order autoregressive AR (1) or the primary dynamic panel model specification with two dimensions: $i \in [1, N]$ cross-sections and $t \in [1, T]$ time-series, the intercept, α, and the time-variant variable, γ_t and the error term, ε_{it} is as follows:

$$S_{it} = \beta S_{it-1} + \alpha + \gamma_t + \varepsilon_{it} \tag{3.3}$$

For stationary model $|\beta| < 1$ with $E[\varepsilon_{it} | S_{i0,...,}S_{it-1}] = 0$, and homoskedastic and serially uncorrelated errors term $\varepsilon_{it} \sim iid(0, \sigma_{\varepsilon}^2)$. In order to obtain consistent estimators, we apply specification tests and we estimate the growth rate and volatility sales of the panel set. Then, the forecasting individual-sales variance referring to these estimated variables, SV_{it} is introduced as a state variable in leverage and investment models. To empirically investigate the causal proposed framework, we specify the dynamic econometric models:

$$\begin{cases} LEV_{it} = \delta_{lev} LEV_{i,t-1} + \alpha_1 DM_{it} + \alpha_2 GO_{it} + \alpha_3 SV_{it} + \alpha_4 GO \times DM_{it} + \alpha_5 SV \times DM_{it} + \alpha_6 SV \times GO_{it} + x_{it}^{lev} \beta^{lev} + u_{it} & (3.4) \\ DM_{it} = \delta_{dm} DM_{i,t-1} + \gamma_1 LEV_{it} + \gamma_2 GO_{it} + \gamma SV_{it} + \gamma_4 GO * LEV_{it} + \gamma_5 SV * LEV_{it} + \gamma_6 SV \times GO_{it} + x_{it}^{dm} \beta^{dm} + v_{it} & (3.5) \\ INV_{it} = \delta_i INV_{i,t-1} + \varphi_1 LEV_{i,t-1} + \varphi_2 DM_{i,t-1} + \varphi_3 GO + \varphi_4 SV_{i,t-1} + \varphi_5 GO \times LEV_{i,t-1} + \varphi_6 GO \times DM_{i,t-1} + \varphi_7 SV \times LEV_{i,t-1} + \varphi_8 SV \times DM_{i,t-1} + \varphi_9 SV \times GO_{i,t-1} + \varphi_{10} CF_{i,t-1} + w_{it} & (3.6) \end{cases}$$

a) Leverage and debt maturity equations

LEV_{it}, DM_{it} GO_{it} and SV_{it} are book leverage, debt maturity, growth option and forecasting sales variance at time *t* respectively. x_{it}^{lev} is a 1**k* vector of the *k* determining factors of leverage and β^{lev} is a *k**1 vector of the coefficients, x_{it}^{dm} represents a 1**l* vector of the *l* determining factors of debt maturity and β^{dm} is a *l**1 vector of coefficients.

Recent literature on firm capital structure panel models provides that fixed-effects are required to control for unobserved time-invariant differences across firms (Ozkan, 2000; Faulkender et al., 2012). However, in dynamic panel models, the correlation between fixed-effects and lagged dependent variables will produce biased and inconsistent coefficients estimate (Faulkender et al., 2012). Therefore, employing OLS or Fixed-Effects (FE) estimators do not address to correct this bias. Several econometric techniques have been proposed including instrumental variables (IV), generalized method of moments (GMM), and first-differenced (FD) estimators. Applying these techniques involve transforming data to eliminate the fixed effects and require the no autocorrelation of the error terms. We exclude unobserved individual fixed effects and apply the Three Stage Least Squares (3SLS) estimator, equivalent of Generalized Least Squares (GLS) with specific variance-covariance matrix of equations errors for two reasons. First, is to eliminate any potential correlation with lagged variables. Second, the unreported FD estimation results are not satisfactory for the debt maturity and investment equations due to the second-order serial correlation problem of errors detected by an AR (2) test. u_{it} and v_{it} represent the error terms such that

u_{it} / $v_{it} \sim iid(0, \sigma^2_{u/v})$. In leverage equation, x^{lev}_{it} includes Non-Debt tax shields, tangibility, profitability and firm size. In debt maturity equation the control variables vector x^{dm}_{it} includes asset maturity structure, tax ratio, the term structure of interest rates, cash-flows variance, and firm quality (Johnson, 2003; Aivazian et al., 2005a; Hart and Moore, 1994). Following trade-off-theory, the model specification includes lagged values of leverage and debt maturity to control for dynamic adjustment towards target leverage (Flannery and Rangan, 2006; Johnson, 2003; Dang, 2011). The speed of adjustment is expected to be significantly positive. The model also includes interaction terms among debt maturity, leverage and growth opportunities to capture the role of growth opportunities on corporate debt structure (Barclay, et al. 2003; Johnson, 2003; Childs, et al., 2005; Dang, 2011). Similarly, an interaction term between growth and sales variance is included in leverage and debt maturity equations to model the joint impact of future opportunities and sales dynamics on debt policy.

b) Investment equation

In line with Sundaresan et al. (2015), our model endogenizes investment decision. Although firm investment is not included as an explanatory variable in the leverage and debt maturity equations, it represents the dependent variable in the investment equation. Lagged leverage and debt maturity are included rather than current values suggesting that initial simultaneous choice of leverage and debt maturity affect the ex post investment decision (Aivazian, et al, 2005a, 2005b; Dang, 2011). Hence, current investment decision depends on historical capital structure. The reason why current investment is included as endogenous variable and growth options as explanatory variable in leverage and debt maturity equations. The investment, $INV_{i,t-1}$ is measured as capital expenditures minus depreciation normalized by lagged net fixed assets. Here we directly test for the relationship between debt maturity, leverage, growth opportunities and firm's sales with the investment on fixed assets. $INV_{i,t-1}$ is the firm investment in fixed assets; $CF_{i,t-1}$ represents cash-flows at $t-1$, and the error term $w_{it} \sim iid$ $(0, \sigma^2_w)$. Consistent with the model specification for previous equations, lagged sales variance, SV_{it-1} is included as explanatory variable to test the direct effect of environmental change on investment cash-flows. An increase in sales volatility may lower the payoff value from growth option exercising. However, when the growth option becomes on the money, the volatility effect becomes less important and the positive impact of growth dominates (Sundaresan, et al., 2015). Therefore, an interaction term between sales variance and growth options is included to empirically model the combination of sales and real option. If the coefficient is negative so firms with high growth opportunities may reduce the negative impact of environmental risk on investment. We also incorporate two interaction terms among sales variance, leverage and debt maturity assuming that firms endogenously decide its investment after controlling for debt level and maturity strategies. The sign of the coefficient on the interaction term between sales variance and leverage indicates whether leverage attenuates the negative effect of environmental change on investment. The role of simultaneous leverage and debt maturity on exercising profitable future growth options is estimated by the interaction terms between growth and these two variables.

c) ***The endogeneity problem and Robustness tests***

Leverage and its maturity structure are not exogenous to investment. Due to the endogeneity of the firm's decisions, the separate estimation of each equation independent of each other can lead to inconsistent and biased results. Thus, it may be that debt structure has no significant impact on investment if the endogeneity bias is taken into account.

Previous empirical studies employ different approaches to correct this bias. The use of a system-based framework is consistent with recent theoretical and empirical research on the interdependence of corporate financing and investment (e.g., (Elyasiani, et al. 2002; ; Barclay, et al. 2003); Dessí and Robertson, 2003; Johnson, 2003; Lang, et al., 1996; Aivazian, et al. 2005a, 2005b; Billett, et al., 2007; Dang, 2011). For example, Aivazian, et al., (2005b) used two approaches: the first one is following Lang, et al. (1996) who distinguish between the impact of leverage on growth in a firm's core business that in its non-core business. The second approach uses the instrumental variables method to address the endogeneity problem.

These results hold even after controlling for the endogeneity problem inherent in the relationship between total leverage, the maturity composition of leverage, and investment. Supporting that leverage and its maturity structure are not exogenous. For the same objective, Johnson (2003) used also two approaches. A single-equation framework and a system-equation framework to control for endogoneity of debt structure decisions.

In our paper, we examine the corporate investment after controlling for the joint choice of leverage and debt maturity in context of dynamic real options and risky sales. In term of methodology, we follow Johnson (2003) who used an alternative approach consists on modeling corporate investment decision in a single-equation OLS framework to explore the sensitivity of the results to the simultaneous-equations framework. Unreported results from this analysis show inconsistent results and significant coefficients only for debt maturity and sales-variance. Thus, in line with Johnson (2003),OLS regressions can be relatively robust to specification of some variables and estimation efficiency but not to be driven by specification in the simultaneous equations system. For simultaneous-equations framework, we follow these studies and use instrumental variables method to deal with the endogeneity problem. The first step of the instrumental variable approach is to find exogenous variables strongly correlated with the endogenous (explanatory) variable but not correlated with the dependent variable (to be explained). Debt is instrumented by tangibility, profitability and tax unrelated to debt. Debt maturity is instrumented by the asset maturity structure and the interest rate structure (Stohs and Mauer, 1996). The choice of these instruments is consistent with (Aivazian, et al. 2005a). Leverage (debt maturity) is included as an endogenous variable in the debt maturity equation (leverage). The estimated variables are included in the investment equation to test the hypothesis of anticipation of future growth opportunities after controlling for the debt structure (Dang, 2011). To address this endogeneity problem, we adopted a two-stage estimation procedure that requires the replacement of endogenous variables by their estimated values from the reduced form regression models on the exogenous and instrumental variables (the first stage of estimation) (Wooldridge, 2005). This step consists in modeling each endogenous variable according to its instruments and the exogenous variables of the equation of the system studied. Hence, it is necessary to identify and test the validity of instruments for endogenous variables (Note 1). Since the number of exogenous variables excluded from equations is larger than the number of endogenous variables included in all equations, the identification condition is satisfied.

In the leverage equation, debt maturity is instrumented by one of the exogenous variables included in the debt and investment maturity equation, i.e. the maturity structure of the asset, tax, term structure, volatility, cost of equity and cash flows. The maturity structure of the asset and the term structure are chosen because the other variables are strongly correlated with leverage (Harris and Raviv, 1991; Aivazian, et al. 2005a; 2005b). In the debt maturity equation, leverage is instrumented by non-tax debt, tangibility and profitability because they are theoretically unrelated to the maturity structure of the debt (Johnson, 2003). For robustness test, we estimate the coefficients of correlations among these variables using Pearson correlation matrix. Unreported results indicate low coefficients for debt maturity with tangibility by (0.400), profitability by (-0.08) and non-debt tax (0.26). Similarly, for the coefficients of correlation between leverage and term structure by (0.00) and asset maturity structure by (0.40), which confirms the choice of valid instruments and equations identification is satisfied.

3.2 Data

Our sample consists of US IA-Dow Jones firms/constituents of the index that were collected from the *Datastream* database. Following standard practice, we exclude financial and utilities because of their capital structure regulatory accounting considerations. The data basis is composed of two balanced panel sets: cross-firm/sector sales data using Income Statements from March-1990 to September-2017, resulting 2 331 firm/sector-quarterly observations and quarterly Ratios Matrix using Balance Sheets from March-1997 to September-2017, resulting 24 570 firm-quarter observations. To control for the unobserved-firms heterogeneity, data are staked by firm’s index to obtain quarterly observations for each firm with respect to chronological annual order and the sample homogeneity. Data treatment is used to transform data to balanced panel data sets including, for each company, the observations of each quarter of each year. The obtained observations or staked data correspond to a quarterly panel-series for all firms of the whole sample. Table 1 presents the data matrix of all variables, definition and code that are included in three panel models:

Panel A for leverage equation, Panel B for debt maturity equation and Panel C for investment equation. A potential problem in this estimation process is the possible high correlation between growth option and sales variance. To ascertain the degree of multicollinearity, unreported results of Pearson correlation matrix between dependent variables and growth opportunities and sales ratio show that the correlation between growth option and sales variance is -0.01, and the correlation between sales variance and dependent variables: leverage, debt maturity and investment are 0.07; -0.01; and 0.01 respectively. Thus, multicollinearity is not a serious problem in our study.

Table 1. Data Matrix Definition

Panel A		
Leverage equation		
Ratio	**Definition**	**Code**
Growth Option	Market value of equity plus book value of debt divided by total assets	GO
Sales variance	Forecasting value	SV
Tangibility	Ratio of fixed assets to total assets	TG
Profitability	Ratio of EBITDA to total assets	PF
Non-Debt Tax Shield S	Ratio of depreciation to total assets	NDTS
Size	Log of total assets in 1995 price	SZ
Panel B		
Debt maturity equation		
Growth option	Market value of equity plus book value of debt divided by total assets	
Sales variance	Forecasting value	SV
Asset maturity structure	Net property, plant, and equipment (PPE) divided by depreciation	AMS
Variance (Note 2)	Difference between relation variation and average of this change	VAR
Firm quality	First difference of EPS to share price	FQ
Size	Log of total assets in 1995 price	SZ
Tax	Total tax charge divided by pre-tax income	Tax
Panel C		
Investment Equation		
Growth option	Market value of equity plus book value of debt divided by total assets	GO
Sales variance	Forecasting value	SV
Cash Flows	EBITDA plus depreciation, all divided by total assets	CF

4. Results Analysis and Managerial Implications

4.1 Sales Growth Rate and Volatility: Within Estimation Method

In this section, we will discuss the sales process parameters estimation and the system of equations results analysis. The test procedures differ in important ways to make it interesting to compare their properties and provide some guidelines for the empirical analysis of panel data with two dimensions: time-series and cross-sections. The first one, Hausman test, is to decide between panel structure as Fixed Effects (FE) and Least Squares Dummy Variables (LSDV) or within group (WG) estimator is consistent or Random Effects (RE) models and Generalized Least Squares (GLS) is more appropriate. As shown in Table 2, p-value is significant for the two transformed data, we accept the alternative hypothesis that Fixed-effect model is preferred, thus no correlation between lagged sales and the error term, $E[S_{it-1}, \varepsilon_{it}] = 0$ and the intercept is different across firms or sectors. However, the lagged variable coefficient, β, is only significantly different across sectors. Thus, the panel where data is indexed by firm is more appropriate. For serial correlation and heteroscedasticity tests, we use Wooldridge and B-P, results show significant serial correlation with heteroskedastic errors for both panel data sets. In panel data, the problem of cross section dependence can arise due to spatial effects or to unobservable common factors. In this study, we apply the Pesaran (2004) test. Results, in Table 2, show significant cross-sectional dependence into two panel data with p-value < 0.05.

Table 2. Poolability, Cross-sectional dependence (CXD), Serial correlation (SC) and Heteroskedasticity (HTSC) tests

Test	DJ-index across sectors	DJ-index across firms
Hausman	Q = 699.817 (0.000)***	Q = 89.987 (0.000)***
Heterogeneity across coefficients	F= 17.273 (0.000)***	F= 1.2149 (0.231)
Heteroskedasticity	BP = 8.238 (0.004)***	BP = 139.511 (0.000)***
Cross-section dependence	Z=-8.156 (0.000)***	Z=87.926 (0.000)
Serial Correlation	Q = 295.04 (0.000)***	Q = 858.78 (0.000)***

This table reports test specification results applied on the two data panel sets. P-value of test estimation is in parentheses. Two Poolability tests are applied: first only on the intercept and then on both intercept and coefficient. Hausman test is a comparison between LSDV and GLS estimators. Under the null of no significant difference, if this is rejected the more efficient fixed effects estimator (Within Group) is chosen. The CXD test so-called Pesaran's test (Pesaran, 2004) which is based on the product-moment correlation coefficient of a model's residuals, defined as averages over the time dimension of pairwise correlation coefficients for each pair of cross-sectional units. Finally SC test is proposed by (Wooldridge, 2002) for foxed-effects model for testing residuals serial correlation. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively.

Allowing for cross-sectional dependence, different newly proposed unit root tests have been developed (Pesaran, 2004; Moon and Perron, 2004; Breitung and Das, 2005). Below, we will present two different panel data unit root tests. The first test of Levin, et al., (2002) so-called LLC based on Augmented Dickey-Fuller (ADF). For each individual i, an ADF regression is implemented:

$$\Delta S_{it} = \beta\, S_{it-1} + \alpha_i + \sum_{j=1}^{\rho_i} \rho_{ij} \Delta S_{i,t-j} + \varepsilon_{it} \tag{4.1}$$

The lag order ρ_i is permitted to vary across firms with $j \in [1, T-1]$ and ε_{it} is the regression error. The second test of Pesaran, (2004) so-called CIPS test for cross sectional panel data, he proposes a test based on the t-ratio of the OLS estimate $\hat{\beta}_i$ in the following cross-sectionally augmented DF (CADF) regression:

$$\Delta S_{it} = \alpha_i + \beta_i\, S_{it-1} + \phi_i \bar{S}_{t-1} + \chi_i \Delta \bar{S}_t + \varepsilon_{it} \tag{4.2}$$

Where $\bar{S}_t = \frac{1}{N}\sum_{i=1}^{N} S_{it}$, $\Delta\bar{S}_t = \frac{1}{N}\sum_{i=1}^{N} \Delta S_{it}$ and ε_{it} is the regression error. The cross-sectional averages $\bar{S}_{t-1}$ and $\Delta\bar{S}_t$ are included as proxy for unobserved common factors. Table 3 presents results for these two tests.

Table 3. Unit Root Test Results

Tests	**LLC(2002)**	**CIPS (2007)**
DJ-Index	LLC = -5.1726 (0.000)***	CIPS = -3.1139 (0.010)*

This table presents two unit root tests from two different generations. The first one from first generation (1st G) LLC test: and the second one CIPS test from the second generation (2nd G): CIPS model: P-values are in parentheses. Both tests are applied on transformed data.

Unlike the previous tests, the unit root test is applied to the transformed data, company / sector, gives the same results. The results of the Dickey-Fuller, from the two tests above, show that the first difference in the sales series of US IA-DJ index for all individuals is stationary. Table 4 show results for firm/specific coefficient and variances for integrated sales process with WG or LSDV estimator:

$$\hat{\beta}_{FE} = (\sum_{i=1}^{n} \bar{S}_{i,-1}\bar{S}_{i,-1})^{-1} \sum_{i=1}^{n} \bar{S}_{i,-1}\bar{S}_i \tag{4.3}$$

with

$$S_{it} - \frac{1}{T}\sum_{t=1}^{T} S_{it} = \beta_i (S_{i,-1} - \frac{1}{T}\sum_{t=1}^{T} S_{it}) + u_{it} - \frac{1}{T}\sum_{t=1}^{T} u_{it}$$

and

$$S_{it} - \bar{S}_i = \beta_i (S_{i,-1} - \bar{S}_i) + u_{it} - \bar{u}_i$$

The process parameters include the expected return (estimated) $\hat{\mu}_S$ and the sales growth rate volatility, var_S :

$$\hat{\mu}[S_{it}, \hat{\alpha}_i] = \hat{\alpha}_i /(1-\hat{\beta}); \qquad \mathrm{var}[S_{it}, \hat{\alpha}_i] = \frac{\sigma_{\hat{u}}^2}{1-\hat{\beta}^2}$$

$\hat{\alpha}_i$ is the individual fixed-effect, $\hat{\beta}$ represents the sales growth rate, the standard deviation $\hat{\sigma}(S_{it}|\alpha_i)$ is the sales growth volatility and the estimated expected mean of sales variance, $\hat{\mu}_i$.

Table 4. Robust Covariance Least Squares Dummy Variable (LSDV) Estimator: Individual-Fixed Effects

Coefficient $\hat{\beta}$	**Standard deviation** $\hat{\sigma}$
0.03528 (0.000)***	0.2183

Firm/estimate	$\hat{\alpha}_i$	$\hat{\mu}_i$
3M	0.638 (0.004)*	0.02895
APPLE	2.034 (0.000)***	0.0922
BA	1.845 (0.000)***	0.0836
CAT	0.960 (0.003)**	0.04355
CSCO	0.803 (0.011)*	0.0364
DIS	0.970 (0.002)**	0.044031
GE	3.547 (0.000)***	0.160894
HD	1.697 (0.000)***	0.07698
IBM	2.521 (0.000)***	0.11433
INTEL	1.136 (0.000)***	0.0488
JNJ	1.363 (0.000)***	0.01618
KO	0.826 (0.006)**	0.0374
MCD	0.546 (0.008).	0.02479
MRK	0.886 (0.000)**	0.04019
MSFT	1.387 (0.000)***	0.00629
NIKE	0.492 (0.121)	0.02233

PFIZER	0.72545 (0.029)*	0.03236
PG	1.74036 (0.000)***	0.075095
UTX	1.655 (0.000)***	0.05542
VZ	2.429 (0.000)***	0.110179
WMT	2.521 (0.000)***	0.11433

This table reports the estimation parameter results when heterogeneity is across firms for unbalanced Panel with n=21, T=109 and N=2289, TSS=386 850, RSS= 14 182 and R^2 =74,163%. $\hat{\alpha}_i$ is the estimated individual intercept, $\hat{\beta}$ is identical for all individuals represents the sales growth rate, $\hat{\mu}_i$ and $\hat{\sigma}$ are respectively the individual estimated expected return and the sales variance standard deviation deduced from estimated parameters $\hat{\alpha}_i$ and $\hat{\beta}_{cse}$. P-values are in parentheses. The FE estimator of $\hat{\beta}_{FE}$ is the pooled OLS estimator on the transformed model: $\hat{\beta}_{FE} = (\sum_{i=1}^{n} \tilde{S}_{i,-1}^{'} \tilde{S}_{i,-1})^{-1} \sum_{i=1}^{n} \tilde{S}_{i,-1}^{'} \tilde{S}_i$. The estimation method is obtained with demeaning sales values by time-series mean (integrated values) to eliminate the fixed-effects (Note 3). *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively.

We can see that there is significant heterogeneity in intercepts, $\hat{\alpha}_i$, with almost p-values are lower than 5% only for one firm (Nike) is insignificant with p-value is 0.121. In our model, $\hat{\alpha}_i$, captures the differences on sales growth across US DJ-IA firms during the sample period. Despite belonging to the same market and the same index, the intercept indicates significant differences between firms. In contrast, the lagged variable coefficient, $\hat{\beta}$, is identical for all firms which indicate that all sample firms have the same growth rate and heterogeneity is essentially coming from the specific factors like production and sales price strategy, specific assets composition between firms, competitiveness, high-technology, global crisis, etc. All these factors may explain the sensitivity of sales dynamics to environmental change and so the firms leverage and investment decisions.

In a robustness test, we include firm-invariant time-specific effects, $\hat{\gamma}_t$, which control for potential macroeconomic shocks and changes in the state of the economy. In the table above, we present the time-specific effect results coefficients:

Table 5. Robust Covariance Least Squares Dummy Variable (LSDV) Estimator: Time-Fixed Effects

Quarterly-Observations	$\hat{\gamma}_t$	P-value
March-1990	-	-
March-2007	1.834	0.023 *
March-2008	2.144	0.008 **
Jun-1990	-10.487	0.000 ***
Jun-2007	2.132	0.008 **

Jun-2008	2.408	0.003 **
Sep-1990	-10.882	0.000 ***
Sep-2007	2.211	0.006 **
Sep-2008	2.104	0.009 **
Dec-1990	-10.965	0.000 ***
Dec-2007	2.624	0.001 **
Dec-2008	0.633	0.437 NS

This table reports an extract of the estimation parameter results when heterogeneity is across time only for significant observations with R^2 =85,506% and p-value =0.000. The first observation was eliminated by lagged variable. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively. NS means no significant.

The table results show efficient parameters estimation with R-Squared = 85% and p-value = 0.000. The coefficients of significant time-effects are observed mainly for 1990 and the period from 2007 to 2013. In fact, the temporal effects of 1990, can be explained by the recession which affected a large part of the world at the end of the 1980s and the beginning of the 1990s and in particular the crash of October 1987 (a decrease of the Dow Jones Industrial Average) which seriously damaged the American economy. The global economic situation was driven until the end of the 1980s by the ebb of inflation in the major industrial production firms and relatively the recession in the operating cycle. From 2007 to 2013, it was the period marked by the financial crisis that affected the sub-prime mortgage sector in the United States from July 2007 and turned into a global open crisis. The significance of the observations linked to these two phenomena proves that the uncertainty of sales in this index could have significantly reflected the sensitivity of the volatility of sales growth to environmental changes. Unless, sales growth uncertainty does not affect equally the different industry since operating leverage differs among industries and so the sensitivity to sales volatility. Subsequently, its consideration in capital structure and investment modeling will provide managerial implications for the firms sample decision-making process.

4.2 Adjusted Firm-Specific Sales Variance

From the estimated parameters, we deduce the forecasting firm-specific variance which takes into account both the temporal and individual effects detected and thus any form of correlation and heteroskedasticity of the errors which cannot be controlled by a variance or variation measured by the values of observable sales. The two curves in Figure 1 present the variance calculated from the accounting data (in black) and the forecast variance (in red) of the sales panel. The observations, (on the abscissa), relate to all companies throughout the study period:

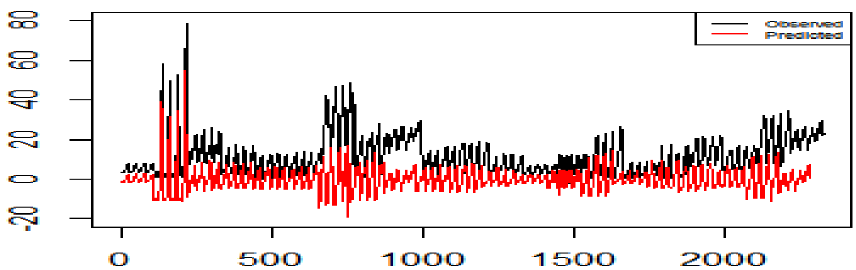

Figure 1. Adjusted firm-specific sales variance

This figure shows that the observed sales curve (from accounting information) and that of the values extracted from our prevision model have the same curves. Our model therefore makes it possible to reproduce the upward and downward trends of observed sales of the sample. However, we can see a difference between the two curves in terms of magnitude. This difference is due to the fact that the forecasting sales variance captures the heterogeneity detected in the composition of the US DJ-IA index. Thus, the heterogeneity between companies and the specifications of the errors have a significant impact on sales price growth and volatility. As well, the adjusted-sales by growth rate and volatility can influence the variance of sales. All of these factors can significantly affect the forecasting values of sales variance. Indeed, both curves report the same increases (up) corresponding to the same periods for all companies. In particular, the period between 2007 and 2011 is marked by high volatility in the US economy. This can be explained by the sensitivity of sales price of the index to the environmental change risk. This confirms the hypothesis that the sales dynamics reflect relevant information on the effect of any external environmental change that may affect the adjustment of the capital structure of the firm and its investment policy. To highlight these macro-economic effects on the managers financing and investment decisions, the following section will present an analysis of the direct and indirect impact of this forecasting specific-industrial firm variance on the debt and dynamic investment adjustment.

4.3 The System of Econometric Panel Models Results

4.3.1 Parameters Estimation Method: Three-Stage Least Squares (3SLS)

The Seemingly Unrelated Regressions (SUR) method is a generalization of a linear regression model which consists of several equations each has its own dependent variables and its own variables, which are exogenous. Each equation can be estimated separately. This estimation requires the presence of correlation of the residuals between equations but not between one or more variables of an equation with the error terms. This is the equivalent of a Generalized Least Squares (GLS) with a specific variance-covariance matrix where the error terms between the equations are correlated. In this case, the Ordinary Least Squares (OLS) method for each equation is unbiased and efficient under the previous assumptions when the number of explanatory variables is identical for all the equations. In case of the presence of instrumental variables, this method does not make it possible to obtain an efficient estimate of the parameters of the equations system. The Two-stage Least Squares (2SLS) and 3SLS are instrumental methods of systemic variables for which all the parameters of the model are estimated jointly. 3SLS can be applied in three steps: the first two are those of 2SLS to each equation of the system and the third is an estimate by GLS on a SUR system. This method consists in applying the principles of the generalized method of moments (GMM) to the system of simultaneous linear equation models, under the assumption that the endogenous variables are predetermined. 3SLS is more efficient than 2SLS because it takes into account the structural differences between the equations. Assuming the number of equations in the system of equations, A, with $a \in [1 \ldots A]$, y_a the dependent variables vector, E_a is the explicative variables matrix, θ_a is the coefficients vector, ξ_a is the error term of the equation

a , knowing that all the equations have the same number of observations, *NT* (*N* firms and *T* temporal series):

$$y_a = E_a \theta_a + \xi_a$$

The system is given by:

$$y = E \ \theta + \xi$$

Assuming no correlation of residuals between observations, NT , of each equation, $E[\xi_{a,it}, \xi_{b,js}]$, $\forall i \neq j; t \neq s$, with $a, b \in [1..A]$ and $i, j; t, s \in [1...NT]$, but residuals between equations are correlated $E[\xi_{a,it}, \xi_{b,it}] = \sigma_{ab}$. The residual covariance matrix:

$$E[\xi, \xi^{NT}] = \Omega = \sigma_{ab} \otimes I_{NT}$$

σ_{ab} is the residual covariance matrix between equations, $\otimes$ the Kronecker product, I_{NT} is the identity matrix with NT observations. Note that Z_a instrumental variables of equation, a . with the two methods, instrumental variable in an equation is correlated with the endogenous variable but not with the error term, $E[\xi^{NT}, Z_a] = 0$. The estimated endogenous variable in the first stage:

$$\hat{E}_a = Z_a (Z_a^{NT} Z_a)^{-1} Z_a^{NT} E_a \qquad (4.4)$$

The estimated coefficient:

$$\hat{\theta} = (\hat{E}^{NT} \hat{\Omega}^{-1} \hat{E})^{-1} \hat{E}^{NT} \hat{\Omega}^{-1} y \qquad (4.5)$$

The covariance matrix estimator with $\hat{\Omega} = \hat{\sigma}_{ab} \otimes \ I_{NT}$,

$$C\hat{o}v[\hat{\theta}] = (\hat{E}^{NT} \hat{\Omega}^{-1} \hat{E})^{-1} \qquad (4.6)$$

The 3SLS-Schmidt estimator is:

$$\hat{\theta}_{TMC-Schmidt} (\hat{E}^{NT} \hat{\Omega}^{-1} \hat{E})^{-1} \hat{E}^{NT} \hat{\Omega}^{-1} Z (Z^{NT} Z)^{-1} Z^{NT} y \qquad (4.7)$$

4.3.2 Empirical Results Analysis

In this section, we present the system equations estimation results. We develop appropriate hypothesis and discuss empirical sensitivity analysis among different models specifications.

(a) Results for the leverage equation

Results in Table 6 reveal that all coefficients for leverage equation are significant but models with interactions are more efficient in terms of the significance indicator, R-Squared, with more than 93% compared to 56% in the baseline model. Hence, the following analysis focuses on the two last models estimation results.

$$LEV_{it} = \delta_{lev} LEV_{i,t-1} + \alpha_1 DM_{it} + \alpha_2 GO_{it} + \alpha_3 SV_{it} + \alpha_4 GO \times DM_{it} + \alpha_5 SV \times DM_{it} + \alpha_6 SV \times GO_{it}$$
$$+ x_{it}^{lev} \beta^{lev} + u_{it}$$

Table 6. Panel model results for the leverage equation

	(I)	(II)	(III)
Intercept	-1.634***	-0.436***	-0.273***
$\hat{\gamma}_{lev}$	0.578***	0.796***	0.836***
DM	2.165 ***	0.444***	0.148***
NDTS	0.088***	0.007***	0.018***
TG	-0.694***	-0.013***	0.003***
PF	-0.081 ***	0.002***	-0.001***
GO	0.122***	0.022 ***	0.012 ***
SV	0.003***	-0.001***	-0.021***
SZ	0.030***	0.029***	0.032***
GO*DM	-	-0.004***	-0.004***
SV*DM	-	0.003***	0.022***
SV*GO	-	-	0.003***
Observations	1636	1636	1636
R-Squared	0.560	0.934982	0.93707

This table reports the estimation results from the regression of leverage on lagged leverage, debt maturity, growth opportunities, sales variance, interaction terms and the control variables based on Equation (5) in columns (I, II, and III) respectively. The results are estimated using a two-stage procedure; the results in the first-stage are used to generate the estimated values of maturity or leverage are not reported. In column (I) we present the based model without interaction terms. Column (II) presents the model with interactions only between endogenous variables and growth options. In column (III) we add a third interaction term between growth options and sales variance. Time dummies are excluded. The instruments for debt maturity include asset maturity structure and term structure. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively.

The model includes lagged value of leverage to control for dynamic adjustment toward target leverage. A positive coefficient supports the choice of a dynamic specification for modeling leverage adjustment. This finding is consistent with capital structure trade-off-theory models (Ozkan, 2001; Flannery and Rangan, 2006).

H.1: Relation between leverage and debt maturity ($\alpha_1 DM_{it}$ ***)***

A book leverage is a measure of the firm indebtness accumulation during its life cycle. A higher leverage reflects that capital structure is based on debt financing. There is, the firm will tend to rely on borrowing to cover its operational cost and finance its new investment. As the firm moves through time, revolving its debt issue requires longer maturity. In line with previous empirical studies (e.g, Diamond, 1991; Johnson, 2003; and Dang, 2011), this finding provides positive relation between debt level and maturity. The coefficients for this relation are found to be significantly positive at the 1% significance level in all specifications except in the baseline specification.

H.2: Relation between Growth Options and Leverage ($\alpha_2 GO_{it}$)

In leverage equation, the coefficient of growth opportunities is a measure of the sensibility of dynamic leverage on growth options variation. Positive coefficient of growth reflects anticipating increasing growth options in the future. Or, for firms based-debt capital structure faced to debt overhang and even bankruptcy problem due to inability to refund its outstanding debt, will make managers have less incentives to make profit from exercising new investment. The overall effect of growth on leverage is affected by future growth number and the firm’s ability to control the underinvestment problem. In all specifications, results show that an increase in growth option variation will make managers raise leverage. This finding is inconsistent with (Dang, 2011; Rajan and Zingales, 1995; and Johnson, 2003) who provide evidence of the underinvestment hypothesis (Myers, 1977).

The overall effects of growth opportunities on leverage are influenced by two simultaneous effects, which are captured by the interaction terms among growth, sales variance and debt maturity.

H.3: Role of growth opportunities on leverage and debt maturity relation ($\alpha_4 GO \times DM_{it}$)

Growth opportunities ratio indicates the firm future growth perspectives. In leverage and maturity equations we incorporate interaction terms among growth, debt and maturity, then, the sign of the coefficient indicates whether the growth options number affect the leverage and debt maturity relation. Firms with high growth opportunities might reduce their leverage and shorten debt maturity due to the higher ability to generate more cash-flows from exercising sequentially profitable real options. Results for leverage equation, consistent with (Dang, 2011), show significant negative coefficients of this interaction term for all specifications. However, firms with low growth perspectives in the future will make managers have less incentive to invest in a new project and effectively use higher leverage. This confirms the negative significant coefficient of this interaction in debt maturity equation for the two specifications.

Using UK companies data, (Dang, 2011) provides no economic relation between growth and maturity and firms tend to lower debt in order to alleviate the underinvestment problem. Childs, et al. (2005) added that firms prefer a low-leverage strategy to a short-term debt which exposes them to a higher liquidity risk.

H.4: Role of sales variance on leverage and debt maturity relation ($\alpha_5 SV \times DM_{it}$)

The coefficients α_5 of the interaction term among sales variance, debt maturity and leverage indicate the sales variance impact on leverage and debt maturity relation.

An increase in sales volume implies higher potential and immediate liquidity. The importance of sales' firm in terms of market potential, competition, and profitability allows the firm investing in subsequent valuable growth opportunities generating higher cash-flows. Therefore, firms that can sufficiently control its production efficiency and its trade policy may carry its share market guarantee higher future cash-flows. The coefficients are found to be positive in two specifications, the longer the firm's debt maturity is, the smaller the negative impact of sales on leverage will be.

H.5: Role of sales variance on leverage and growth option relation ($\alpha_6 SV \times GO_{it}$)

Under risky environment, an increase in sales growth uncertainty with low growth perspectives in the future will make managers have less incentive to invest in a new project and effectively raise the future debt overhang and so default risk due to the firm's debt subsequent revolving. In contrast, when firms have multiple future growth options with low effect of sales volatility, enables them to gain additional benefit from opportunities investment generating higher profit and substantially decrease their indebtness.

(b) Results for debt maturity equation

The dynamic (lagged) debt maturity coefficient has a significantly positive coefficient at the 1% level in all models. This is consistent with recent theoretical and empirical research on optimal debt maturity structures (Jun and Jen, 2003;Ozkan, 2000)

$$DM_{it} = \delta_{dm} DM_{i,t-1} + \gamma_1 LEV_{it} + \gamma_2 GO_{it} + \gamma_3 SV_{it} + \gamma_4 GO * LEV_{it} + \gamma_5 SV * LEV_{it} + \gamma_6 SV \times GO_{it} + x_{it}^{dm} \beta^{dm} + v_{it}$$

Table 7. Panel model results for debt maturity equation

	(I)	(II)	(III)
Intercept	0.218***	0.510***	0.520***
$\hat{\gamma}_{dm}$	0.875***	0.894***	0.890***
LEV	-0.027***	0.108***	0.049***
GO	-0.027***	-0.013***	-0.014***
SV	0.0007***	-0.001***	-0.003***

AMS	0.012***	-0.004***	-0.003***
TS	-1.745***	-2.003***	-2.113***
VAR	-0.010***	0.027***	0.028***
Tax	-0.026***	-0.023***	-0.024***
FQ	-0.285***	-1.170***	-1.180***
SZ	0.005***	-0.703***	-0.069***
GO*LEV	-	0.034***	0.009***
SV*LEV	-	0.005***	0.033***
SV*GO	-	-	0.0005***
Observations	1636	1636	1636
R-Squared	0.961	0.917	0.912

This table reports the estimation results from the regression of debt maturity on lagged debt maturity, leverage, growth opportunities, sales variance, interaction terms and the control variables based on Equation (6) in columns (I, II, and III) respectively. The results are estimated using a two-stage procedure; the results in the first-stage are used to generate the estimated values of maturity or leverage are not reported. In column (I) we present the based model without interaction terms. Column (II) presents the model with interactions only between endogenous variables and growth options. In column (III) we add a third interaction term between growth options and sales variance. Time dummies are excluded. The instruments for debt maturity include asset maturity structure and term structure. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively.

The results show that leverage is significantly positive in the two last models but negative in the first one. The finding that leverage increases with debt maturity is consistent with the results in the leverage equation which confirms results persistence.

H.6: Relation between sales variance and debt maturity ($\gamma_3 SV_{it}$)

An increase in income uncertainty makes debt to be more expensive, thus firms with high sales variance use short-term debt maturity strategy. Results show that sales variance has significant negative but small coefficient in models (II) and (III) with (-0.001) and (-0.003) respectively. So, firms consider the effect of environmental change in deciding lowering the amount of leverage and taking short term debt. This finding is consistent with the leverage equation and robust to different model specifications.

The results on interaction term between growth and leverage in debt maturity show significant but small in magnitude. This finding is consistent with leverage equation results. Hence, the overall effect of debt maturity on leverage is unaffected by the level of growth opportunities. This finding does not support the role of short-term debt as a substitute for a low-leverage strategy; this poses the question as to whether US DJ-IA firms consider environmental change in debt structure strategy.

On the role of sales variance, similar results are obtained in leverage equation. The coefficient on the interaction term between sales and leverage is significantly positive and more substantial than those of growth and leverage interaction term. There are number of reasons that the effect of environmental change is more important on the relation between debt maturity and leverage. In fact, the leverage dynamics modeling under investment frictions; will reflect the importance of remaining future growth options, and the potential for premature loss from product/demand shock caused by environmental change. Hence, the firm chooses its debt in response to maximize the payoff from exercising growth options and, reduce the negative effect of sales risk caused by environmental change.

H.7: Role of sales variance on debt maturity and growth optios relation ($\gamma_6 SV \times GO_{it}$)

The coefficient, γ_6, of the interaction term between sales and growth indicates whether sales variance affect debt maturity and growth relation. Firms with high growth options may have more incentive to shorten their debt maturity to reduce agency and bankruptcy costs as well as the negative impact of environmental change. Results show negative coefficient but small in magnitude (-0.0005).

(c) *Results for investment equation*

As shown below, in Table 8, lagged investment is significantly positive and large in magnitude in three models especially in columns (II) and (III), which supports that current investment is rapidly adjusted and determined by past investment.

$$INV_{it} = \delta_i INV_{i,t-1} + \varphi_1 LEV_{i,t-1} + \varphi_2 DM_{i,t-1} + \varphi_3 GO_{i,t-1} + \varphi_4 SV_{i,t-1} + \varphi_5 GO \times LEV_{i,t-1}$$
$$+ \varphi_6 GO \times DM_{i,t-1} + \varphi_7 SV \times LEV_{i,t-1} + \varphi_8 SV \times DM_{i,t-1} + \varphi_9 SV \times GO_{i,t-1} + \varphi_{10} CF_{i,t-1} + w_{it}$$

Table 8. Panel model results for investment equation

	(I)	(II)	(III)
Intercept	0.0367***	0.039***	0.041***
$\hat{\gamma}_i$	0.997***	1.011***	1.003***
LEV	0.102***	0.010***	-0.058***
GO	-0.002***	-0.001***	-0.011***
DM	-0.089***	-0.001***	0.006***
SV	-0.0002***	-0.056***	-0.0004***
CF	0.018***	0.015***	0.018***
LEV*GO	-	-0.013***	-0.019***
DM*GO	-	0.029***	0.044***
LEV*SV	-	0.002***	0.001***
DM*SV	-	-0.002***	-0.002***
SV*GO	-	-	-0.0001***
Observations	1636	1636	1636
R-Squared	0.998	0.993	0.998

This table reports the estimation results from the regression of investment on lagged investment, lagged leverage, lagged debt maturity, lagged growth opportunities, lagged sales variance, lagged interaction terms and lagged control variables based on Equation (7) in columns (I, II, and III) respectively. The results are estimated using a two-stage procedure; the results in the first-stage are used to generate the estimated values of maturity or leverage are not reported. In column (I) we present the based model without interaction terms. Column (II) presents the model with interactions only between endogenous variables and growth options. In column (III) we add a third interaction term between growth options and sales variance. Time dummies are excluded. The instruments for debt maturity include asset maturity structure and term structure. *, ** and *** indicate the coefficient significant at 10%, 5% and 1% levels, respectively.

H.8: Relation between sales variance and investment ($\varphi_4 SV_{i,t-1}$)

Firms with high sales volume tend to make more investments. However, an increase in sales uncertainty make manager has less incentive to exercise future valuable growth opportunities. We find a significant negative coefficient on sales variance, but small in magnitude especially in columns (I) and (III). This finding is consistent with (Bloom, et al., 2001), and suggests that sales uncertainty affect negatively the investment on investment.

The overall effect of sales on investment is also affected by interactions among growth, debt maturity and leverage. Results show significant positive coefficient of the interaction term between sales variance and leverage in two columns (II) and (III) with (0.002) and (0.001) respectively. Note that the overall effect of sales variance on investment is the stand alone coefficient on sales variance and the coefficient on this interaction term multiplied by leverage. Therefore, high leverage attenuates the negative relation between lagged sales variance and current level of investment. The coefficient on lagged sales variance with debt maturity is also small in magnitude but significantly negative in two models. Thus, the shorter the maturity of debt is the smaller the direct effect of sales variance on investment. Finally, the coefficient on the interaction term between sales variance and growth opportunities, which is included only in column (III), is weakly significant and small in magnitude, but has important implications on the whole model coefficients.

H.9: Relation between growth and Investment ($\varphi_3 GO_{i,t-1}$)

Similarly, growth opportunities are proxied by market-to-book ratio, its coefficient on the investment equation reflects the sensibility of dynamic investment on growth number variation. Firms with high growth options will rationally be able to exploit more investment. However, the way that the firm's capital is structured, influences the ability to create and take advantage of growth options. In fact, risky debt would magnify the debt overhang problem and make managers reject positive net project, which lower market value of the firm implying particularly negative influence on firm's investment choice. Results show negative coefficient of growth on investment in all specifications. This result are not consistent with investment models (Aivazian, et al. 2005a, 2005b; Liu, 2009) but are partially consistent with the positive relation between growth and leverage. In a dynamic framework, with sales uncertainty and risky debt, the impact of future growth options may differently influences manager's attitudes in capital policy restructuring. The different specifications present results consistence in the majority of interdependence among growth, sales, debt and investment making decision.

Note that, for robustness check, unreported results for restricted models (interaction terms with only growth options and interaction terms with only sales variance) show approximately similar results to column (III) but extremely different to the baseline column (I), which give importance to jointly including sales variance and growth opportunities in a causal framework of leverage and investment decisions. Several new insights emerge from our analysis. The life cycle pattern driven by the endogenous composition between leverage and investment, where both growth options and sales uncertainty in term of gaining return from exercising existing growth opportunities and controlling market risk effect on firms' sales price caused especially by external factors, provide an analytically tractable framework to examine endogenous corporate investment and financing decisions.

5. Conclusion

This paper provides an empirical framework for simultaneously modeling dynamic leverage structure and investment. Referring to real option and contingent-claim approaches, we use the firm's output price variable as a state variable for financing and investment decision. Using US IA-DJ index panel data over the period 1990-2017, we find that cross-sectional heterogeneity plays an important role in explaining the sales variance. To control for this heterogeneity, we include predicted values of sales variance in a system of equations grouping simultaneously leverage, debt maturity and investment variables. The presence of sales variance as contingent-claim modifies the way of restructuring debt strategy. Econometrically, the structuring of this variable as a panel makes it possible to control heterogeneity of both changes ACROSS time and firms. Thus, including firm-specific characteristics of the sales' dynamic has an important role in explaining the effect of environmental change. We find that, when environmental change is higher, US DJ- IA firms tend to maintain the positive relation with debt maturity and leverage by using longer debt and higher leverage. The anticipation effect of the subsequent debt overhang makes equity holders carefully gaining more debt and taking into account the future conflicts of interest between equity holders and debt holders. Hence, the firm chooses its debt in response to maximize the payoff from exercising growth options and, reduces the negative effect of sales risk caused by environmental change. The paper also provides an empirical support that underinvestment remains a problem with both long and short-term debt and thus cannot be alleviated simply by shortening debt maturity. We find that US DJ-IA index firms slightly lower leverage and use more short term-debt in response to high sales variance. The explanation is that US IA-DJ firms do not suffer from a sever underinvestment problem, the hypothesis that leverage and debt maturity are negatively affected by growth opportunities. There is also a simultaneous effect of sales variance with debt maturity on investment. The shorter the debt maturity is the smaller is the effect of high sales variance on investment.

References

Aivazian, V. A., Ge, Y., & Qiu, J. (2005a). Debt maturity structure and firm investment. *Financial Management*. *34*(4), 107-119. https://doi.org/10.1111/j.1755-053X.2005.tb00120.x

Aivazian, V. A., Ge, Y., & Qiu, J. (2005b). The impact of leverage on firm investment: Canadian evidence. *Journal* *of Corporate Finance*, *11*(1), 277-291. https://doi.org/10.1016/S0929-1199(03)00062-2

Barclay, M. J., Marx, L. M., & Smith Jr, C. W. (2003). The joint determination of leverage and maturity. *Journal of Corporate Finance*, *9*(2), 149-167. https://doi.org/10.1016/S0929-1199(02)00003-2

Billett, M. T., King, T. D., & Mauer, D. C. (2007). Growth opportunities and the choice of leverage, debt maturity, and covenants. *The Journal of Finance*, *62*(2), 697-730. https://doi.org/10.1111/j.1540-6261.2007.01221.x

Bloom, N., Bond, S. R., & Van Reenen, J. (2001). The dynamics of investment under uncertainty. *IFS working paper*. https://doi.org/10.1920/wp.ifs.2001.0105

Bolton, P., Wang, N., & Yang, J. (2014). Investment under uncertainty and the value of real and financial flexibility. *Columbia Business School Research Paper* (14-1). https://doi.org/10.3386/w20610

Breitung, J., & Das, S. (2005). Panel unit root tests under cross-sectional dependence. *Statistica Neerlandica*, *59*(4), 414-433. https://doi.org/10.1111/j.1467-9574.2005.00299.x

Chen, H., & Manso, G. (2014). Macroeconomic risk and debt overhang. *SSRN 2522886*. https://doi.org/10.2139/ssrn.2522886

Childs, P. D., Mauer, D. C., & Ott, S. H. (2005). Interactions of corporate financing and investment decisions: The effects of agency conflicts. *Journal of Financial Economics*, *76*(3), 667-690. https://doi.org/10.1016/j.jfineco.2004.06.012

Dang, V. A. (2011). Leverage, debt maturity and firm investment: An empirical analysis. *Journal of Business Finance & Accounting*, *38*(1-2), 225-258. https://doi.org/10.1111/j.1468-5957.2010.02215.x

Dess í R., & Robertson, D. (2003). Debt, incentives and performance: Evidence from UK panel data. *The Economic Journal*, *113*(490), 903-919. https://doi.org/10.1111/1468-0297.t01-1-00159

Diamond, D. W. (1991). Monitoring and reputation: The choice between bank loans and directly placed debt. *Journal of political Economy*, 689-721. https://doi.org/10.1086/261775

Elyasiani, E., Guo, L., & Tang, L. (2002). The determinants of debt maturity at issuance: a system-based model. *Review of Quantitative Finance and Accounting*, *19*(4), 351-377. https://doi.org/10.1023/A:1021161309198

Fama, E. F., & French, K. R. (2002). Testing trade-off and pecking order predictions about dividends and debt. *The Review of Financial Studies*, *15*(1), 1-33. https://doi.org/10.1093/rfs/15.1.1

Faulkender, M. *et al.*. (2012). Cash flows and leverage adjustments. *Journal of Financial Economics*, *103*(3), 632-646. https://doi.org/10.1016/j.jfineco.2011.10.013

Flannery, M. J., & Hankins, K. W. (2013). Estimating dynamic panel models in corporate finance. *Journal of Corporate Finance*, *19*, 1-19. https://doi.org/10.1016/j.jcorpfin.2012.09.004

Flannery, M. J., & Rangan, K. P. (2006). Partial adjustment toward target capital structures. *Journal of Financial Economics*, *79*(3), 469-506. https://doi.org/10.1016/j.jfineco.2005.03.004

Harris, M., & Raviv, A. (1991). The theory of capital structure. *The Journal of Finance*, *46*(1), 297-355. https://doi.org/10.1111/j.1540-6261.1991.tb03753.x

Hart, O., & Moore, J. (1994). A theory of debt based on the inalienability of human capital. *The Quarterly Journal of Economics*, *109*(4), 841-879. https://doi.org/10.2307/2118350

Huang, R., & Ritter, J. R. (2009). Testing theories of capital structure and estimating the speed of adjustment. *Journal of Financial and Quantitative analysis*, *44*(2), 237-271. https://doi.org/10.1017/S0022109009090152

Johnson, S. A. (2003). Debt maturity and the effects of growth opportunities and liquidity risk on leverage. *The Review of Financial Studies*, *16*(1), 209-236. https://doi.org/10.1093/rfs/16.1.0209

Jun, S.-G., & Jen, F. C. (2003). Trade-off model of debt maturity structure. *Review of Quantitative Finance and Accounting*, *20*(1), 5-34. https://doi.org/10.1023/A:1022190205033

Lang, L., Ofek, E., & Stulz, R. (1996). Leverage, investment, and firm growth. *Journal of Financial Economics*, *40*(1), 3-29. https://doi.org/10.1016/0304-405X(95)00842-3

Leland, H. E. (1994). Corporate debt value, bond covenants, and optimal capital structure. *Journal of Finance*, 1213-1252. https://doi.org/10.1111/j.1540-6261.1994.tb02452.x

Lemmon, M. L., Roberts, M. R., & Zender, J. F. (2008). Back to the beginning: persistence and the cross-section of corporate capital structure. *The Journal of Finance*, *63*(4), 1575-1608. https://doi.org/10.1111/j.1540-6261.2008.01369.x

Levin, A., Lin, C.-F., & Chu, C.-S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1-24. https://doi.org/10.1016/S0304-4076(01)00098-7

Liu, B. (2009). Some research problems in uncertainty theory. *Journal of Uncertain systems*, *3*(1), 3-10.

Margaritis, D., & Psillaki, M. (2010). Capital structure, equity ownership and firm performance. *Journal of Banking & Finance*, *34*(3), 621-632. https://doi.org/10.1016/j.jbankfin.2009.08.023

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates*. *The Journal of Finance*, *29*(2), 449-470. https://doi.org/10.1111/j.1540-6261.1974.tb03058.x

Moon, H. R., & Perron, B. (2004). Testing for a unit root in panels with dynamic factors', *Journal of Econometrics*, *122*(1), 81-126. https://doi.org/10.1016/j.jeconom.2003.10.020

Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics*, *5*(2), 147-175. https://doi.org/10.1016/0304-405X(77)90015-0

Nikolov, B., Schmid, L., & Steri, R. (2019). Dynamic corporate liquidity. *Journal of Financial Economics*, *132*(1), 76-102. https://doi.org/10.1016/j.jfineco.2017.06.018

Ozkan, A. (2000). An empirical analysis of corporate debt maturity structure. *European Financial Management*, *6*(2), 197-212. https://doi.org/10.1111/1468-036X.00120

Ozkan, A. (2001). Determinants of capital structure and adjustment to long run target: evidence from UK company panel data. *Journal of Business Finance & Accounting*, *28*(1-2), 175-198. https://doi.org/10.1111/1468-5957.00370

Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels. https://doi.org/10.2139/ssrn.572504

Psillaki, M., Tsolas, I. E., & Margaritis, D. (2010). Evaluation of credit risk based on firm performance. *European Journal of Operational Research*, *201*(3), 873-881. https://doi.org/10.1016/j.ejor.2009.03.032

Rajan, R. G., & Zingales, L. (1995). What do we know about capital structure? Some evidence from international data. *The Journal of Finance*, *50*(5), 1421-1460. https://doi.org/10.1111/j.1540-6261.1995.tb05184.x

Stohs, M. H., & Mauer, D. C. (1996). The determinants of corporate debt maturity structure. *Journal of Business*, 279-312. https://doi.org/10.1086/209692

Sundaresan, S., Wang, N., & Yang, J. (2015). Dynamic investment, capital structure, and debt overhang. *Review of Corporate Finance Studies*, *4*(1), 1-42. https://doi.org/10.1093/rcfs/cfu013

Welch, I. (2004). Capital structure and stock returns. *Journal of Political Economy*, *112*(1), 106-131. https://doi.org/10.1086/379933

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. MIT Press, Cambridge, MA, 108.

Wooldridge, J. M. (2005). Instrumental variables estimation with panel data. *Econometric Theory*, *21*(4), 865-869. https://doi.org/10.1017/S0266466605050437

Notes

Note 1. Unreported results for Wald test of instrument relevance for leverage and debt maturity give significant results.

Note 2. We use cash-flows variance as proxy for volatility earnings which is predicted to have a negative effect on debt maturity. This measure is consistent with (Dang, 2011).

Note 3. The within transformation $S_{it}-\frac{1}{T}\sum_{t=1}^{T}S_{it}=\beta_i(S_{i,-1}-\frac{1}{T}\sum_{t=1}^{T}S_{it})+\varepsilon_{it}-\frac{1}{T}\sum_{t=1}^{T}\varepsilon_{it}$ with $S_{it}-\bar{S}_i=\beta_i(S_{i,-1}-\bar{S}_i)+\varepsilon_{it}-\bar{\varepsilon}_i$

Copyrights