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Cash Flow-Investment Relationship in Malaysia: A Panel Threshold Regression Analysis

(Hubungan Aliran Tunai-Pelaburan di Malaysia: Satu Analisis Penganggaran Nilai Ufuk)

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ABSTRACT

The objective of this article is to analyse the relationship pattern of cash flow-investment among low and high debt firms. To investigate the issue, we employed Hansen's (1999) threshold method of non-dynamic panel data. In this article, the firm debt ratio was used as threshold variable. A balanced panel data of companies listed on Bursa Malaysia, comprising of 234 companies for a period from 2004 to 2010, was utilized in this study. The results showed that debt ratio has a significant role at explaining the cash flow-investment relationship among firms. In particular, the results showed that low debt firms exhibit significant support to the financial constraints hypothesis, while high debt firms demonstrate support to the free-cash flow hypothesis. This finding explains why the cash flow-investment relationship of certain firms is negative, while other firms are positive. It also signifies the inability of constrained firms to access to external financing; thus, leading the firms to significantly rely on their internal financings.

Keywords: Investment; cash flow; non-dynamic panel; threshold regression

ABSTRAK

Artikel ini bertujuan untuk menganalisis sama ada hubungan aliran tunai-pelaburan mempunyai bentuk yang sama bagi firma yang keberhutangan tinggi dan yang keberhutangan rendah. Untuk mengkaji isu ini, kami menggunakan kaedah nilai ufuk Hansen (1999) bagi data panel tidak dinamik. Dalam artikel ini, nisbah hutang firma digunakan sebagai pembolehubah nilai ufuk. Dengan menggunakan sampel data panel berimbang yang terdiri daripada 234 syarikat tersenarai di Bursa Malaysia bagi tahun 2004 hingga 2010, keputusan kajian menunjukkan bahawa nisbah hutang memain peranan penting dalam menerangkan hubungan aliran tunai-pelaburan dalam firma. Keputusan menunjukkan bahawa firma keberhutangan rendah menetapi hipotesis kekangan kewangan, manakala firma keberhutangan tinggi menetapi hipotesis aliran tunai bebas. Dapatan ini menjelaskan mengapa ada syarikat mempunyai hubungan aliran tunai-pelaburan yang negatif, sedangkan yang lainnya mempunyai hubungan positif. Ini menunjukkan bahawa kesukaran firma untuk memperoleh akses kepada sumber pembiayaan luar akan menyebabkan firma terpaksa bergantung kepada sumber pembiayaan dalaman mereka.

Kata kunci: Pelaburan; aliran tunai; panel tidak dinamik; penganggaran nilai ufuk

INTRODUCTION

Under Modigliani and Miller's (1958) theorem of perfect capital market[1], firm value is irrelevant to financial structure. Thus, it is argued that firm investment is also irrelevant to its financing. This irrelevance has been the main assumption to the neo-classical investment theory of Jorgenson (1963). The theory argues that firms will acquire new capital so that the marginal cost of capital equals to the marginal product of capital. Therefore, some factors such as interest rates, taxation and technology that affect the cost of capital are considered in the theory. This theory holds under the frictionless world, in which sources of financing are perfect substitutes, and all market agents are well-acquainted with market information. In contrast, the real world is imperfect. Financial products are differentiated and imperfectly substitutable. In addition, some agents are bestowed with market information, while others are struggling to obtain it. In this case, Lin and Chang (2011) argued that Modigliani and Miller's perfect market assumptions are not only contradictory to ground operation but the assumptions also contradict theoretical intuitions. As such, the main causes of these imperfections are studied by economists, in which the blame is put on information asymmetries and agency problem as causes to the demolishment of classical ideas. In this regard, Oliner and Rudebusch (1992), Kadapakkam et al. (1998) and Koo and Maeng (2005) argue that information asymmetries, agency cost and transaction cost are three major sources of capital market imperfection. Furthermore, Bhaduri (2005) argued that the magnitude of imperfection varies in parallel with the information asymmetries and agency problem.

Over the last two decades[2], many studies had taken the imperfect market's conditions into account. Since then, the role of financial factors in firms' investment decision has never been neglected. Many variables have been tested to examine the relationship between finance and investment, but the most explainable variable to this relationship is cash flow (Carpenter et al. 1998; Degryse & Jong 2006). However, previous literature exhibited two contradictory findings regarding to the direction of cash flow-investment relationship. The first finding discovered a significant positive relationship as shown in Fazzari et al. (1988). On the other hand, the second finding showed a significant negative relationship.

Vogt (1994) extensively explained the relationship between cash flow and investment. The positive relationship is based on the pecking-order hypothesis of Myers and Majluf (1984). The hypothesis is also known as the financial constraints hypothesis. This hypothesis states that the least costly source of financing is always preferred. The preference arises due to information asymmetric problem among firms' insiders and outsiders. The insiders are always in better position in knowing about their firms' values. Therefore, in order to avoid financing bad lemons, the outsiders impose credit rationing on the financing of firm investment. Contemporaneously, the outsiders may also demand for a premium or ask for a reduced price when they give out loans to firms, or purchase firms' equities. Consequently, firms with low accessibility to financing sources have to forgo some profitable investments to save their internal funds. Alternatively, firms have to retain their current earnings to finance those prospective profitable investments. Overall, this relationship indicates positive correlation between investment and internal fund; whereby in order to increase investment, the firms need to retain more cash.

In contrast, there are two causes to negative relationship. First, the negative relationship can be seen when distressed firms with operating losses invest more in the current year than the previous year. Even though these losses reduce internal funds, firms are still able to invest because they receive financings from other sources including equity claimants (Bhagat et al. 2005). Second, if we exclude the distressed firms from the estimation sample, the negative relationship can still occur as explained by the free-cash flow hypothesis. The hypothesis is developed based on agency problem; whereby the management of the company and its shareholders pursue their own interests. Originally, the management acts in a way to maximise shareholders' value, but under low monitoring system, managers tend to increase their benefits at the cost of shareholders. They will overinvest the cash in less-profit making activities.

The first study that examines the cash flow-investment relationship is carried out by Fazzari et al. (1988). In the study, they segmented the sample of US listed companies into three subsamples according to dividend pay-out ratios. The results showed that cash flow is significant and has positive sign. The magnitude of cash flow coefficient for low-dividend companies is the highest among the three groups. This implies that low-dividend companies heavily rely upon internal funds to finance their investments; rationalising why they are paying less dividends. This finding supports the first hypothesis mentioned above.

Since then, many researchers have attempted to reassess and replicate the study. They produced mixed results. Cleary (2006) used similar classification as in Fazzari et al. (1988); however, the study found contradictory results, i.e. high-payout companies are more sensitive to internal funds than small and low-payout companies. Using different classifications, Kadapakkan et al. (1998) classified the sample of firms into three categories of firm size: firm value, total assets and sales. They studied six member countries from the Organization for Economic Cooperation and Development (OECD) and found that investment sensitivity is high among large firms and low among small firms. Bhaduri (2002) found that the financial liberalization that took place in India benefits middle-sized firms, but small firms have higher investment sensitivity after the liberalization. The same scenario happened in Ecuador. Using a sample of 420 Ecuadorean manufacturing companies for a period of 1983-1988, Jaramillo et al. (1996) found that large and matured firms did not encounter cash flow sensitivity[3], whereas small firms continued to be sensitive. Agung (2000) who tested Indonesian samples also found a similar pattern of sensitivity. Similarly, Ismail et al. (2010a) also found that Malaysian firms are unable to have easy access to external forms of financing for investment purpose. Using size split, Ismail et al. (2010b) found that large firms are not sensitive to cash flow availability, but small firms are significantly sensitive to the availability of cash flow.

The studies mentioned above used a priori classification to assume possible relationships among different groups of firms. Normally, the researchers used theoretical explanations and rhetorical intuitions in explaining the relationships. They argued that small (Jaramillo et al. 1996; Kim 1999; Schiantarelli & Sembenelli 2000; Ismail et al. 2010b), new (Carpenter & Rondi 2001), private (Colombo & Stanca 2006) and independent (Schiantarelli & Sembenelli 2000) firms are financially constrained because these firms are new entrants to the market; they have no close relationship with banks or an impressive balance sheet history. As a result, those firms have less access to external financing.

On the basis of the above argument, previous researchers split the sample into different groups according to their priori classifications. Fazzari et al. (1988) used cross tabulations between retention practices and other characteristics of firm such as firm size and access to external funds to determine a suitable classification. Finally, they managed to classify firms into three subsamples: high, medium and low pay-out firms. The cross tabulation method is also used by Hsiao and Tahmiscioglu (1997). They plotted liquidity measures against firm's capital intensity to determine a plausible cut-off point in order to classify firms according to capital intensity. Basu and Guariglia (2002) used coverage ratios distribution such that firms with coverage ratios that are in the upper two-thirds of the distribution of these variables for at least 10 years will be classified as financially unconstrained firms, and vice versa. Carpenter and Guariglia (2008) used a cut-off point of 250 employees to divide firms into size categories: small and large. Median criterion was employed by Ismail et al. (2010b) as the cut-off point to categorize firms into small and large firms. They used firm value as firm size's measure.

In this regard, Kadapakkam et al. (1998) and Koo and Maeng (2005) argued that the priori classifications must take into account the exogeneity of the variable used for the classifications. Otherwise, the estimations will produce inconsistent results. Nevertheless, many earlier studies had failed to take into consideration the exogeneity variable as the variable split. Consequently, the results were unable to explicitly justify the truth behind the cash flow-investment relationship. Moreover, the sample splitting method used as mentioned above has some drawbacks. The method does not take into account the possible dynamic change of firms; whereby some firms may change in terms of size, ownership structure and affiliation to business groups, in which splitting method considers only static classification. Also, the variance of subsequent subsamples under the splitting method may considerably differ. Thus, comparing the sample's results will produce flawed conclusion.

Therefore, taking into consideration the exogeneity condition problem and dynamics of firm, this study aims to analyse whether cash flow and investment have similar pattern of relationship between low and high debt regimes. The debt ratio was used to classify firm behaviour because Whited (1992) argued that firms cannot influence their debt limits. This is because debt limit indicates the credit-worthiness of the firms, i.e. indicating their ability to repay. In this study, the debt ratio is measured by the total of firm debt divided by its total assets. Jensen and Meckling (1976) and Myers and Majluf (1984) argued that there are two problems that arise from debt, namely moral hazard and adverse selection. The moral hazard happens when high debt firms tend to invest in risky projects with higher expected returns to shareholders. On the other hand, adverse selection occurs when outside investors receive wrong signal; which is, high debt firms are truly good firms, but most of them are lemons. Therefore, it is crucial to empirically investigate the behaviour of high debt firms and low debt firms with respect to the investment financing using internal funds, i.e. cash flows.

This article's aim was to analyse firm behaviour in Malaysia; i.e. how firm investment behaviour describes the fluctuation in aggregate investment in Malaysia. While studies such as Ismail et al. (2010a) used full sample approach to investigate the cash flow and investment relationship and Ismail et al. (2010b) used exogenous sample split to analyse the relationship, this study employed the threshold regression proposed by Hansen (1999). This method is able to analyse the relationship between cash flow and investment among different firm groups. These groups are formed endogenously rather than exogenously as in previous studies. The groups are not classified based on discrete values, but individual observations; whereby they are divided into groups based on a specified threshold variable. A bootstrap method is used to examine the significance of the threshold level. The method will be discussed in the next section. If the relationship between cash flow and investment is different among groups, this suggests that there is a threshold as a split between the groups. As a result, the slow economic recovery after the Asian financial crisis is clearly explained.

This study is crucial because it can provide a better explanation of firm investment behaviour. The relationship will uncover the ability of firms to strategize their future investments' planning in order to maximize their values. Furthermore, if they are sensitive to cash flow, they may be considered as risky investments. This will hinder the firm's potential for growth. Eventually, the investors will rate the firm badly and sell off the shares, thus affecting the overall market value of the firm.

On the other hand, the information of different behaviours is important for policy makers at ascertaining the appropriate policy measures for market intervention in order to release the financial constraints faced by firms. Firms that are suffering from financial constraints will not able to grow and invest beyond their existing capacities. At the same time, if the firms experience losses, they will not be able to quickly recover because the losses will restraint the availability of internal fund and reduce their access to external fund. Consequently, the aggregate investment drops as the desired investment decreases; and so does the national output. Therefore, the policy makers' intervention is needed in reducing the impact of financial constraints in order to avoid such consequence.

In doing so, we chose a sample of listed companies from Bursa Malaysia. In this article, the Q model was used. The model requires the market value of shares to measure the Q; as such, it cannot be applied to non-listed companies (Ismail et al. 2010a). This study found that the threshold variable of debt is significant; suggesting different behaviours of firms.

This article is organized as follows: The next section discusses the methodology of threshold regression, followed by discussion on data sources and estimation results. In the last section, we conclude this article with a summary and recommendations.

METHODOLOGY

This study employed Hansen's (1999) threshold regression method of non-dynamic panel data. However, before constructing the regression model, first and foremost, the unit root tests were run to test for stationarity.

UNIT ROOT

Baltagi (2008) argued that to totally rely on standard pooled estimators including the ordinary least squares and fixed-effects without considering the estimated parameters that are heterogeneous across panels, and the regressors that are serially correlated, may potentially produce large bias. Also, spurious regression is a problem in panel data. The problems can be detected with the use of panel unit root tests. Even though testing for unit roots in panel is a new practice (Baltagi 2008), econometricians have provided several techniques. Lin and Chang (2011) argued that the application of Hansen's method requires the variables in data to be free from unit roots in preventing the spurious regression problem. Therefore, in this article, we adopted the tests of Levin, Lin and Chu (LLC) (2002), Im, Pesaran and Shin (IPS) (2003) and Harris and Tzavalis (HT) (1999) for the testing of unit roots.

THRESHOLD MODEL

Next, a threshold model is developed as to examine the cash flow-investment relationship. Here, a representative firm is assumed to maximize its net present value of streams of future dividends.

$$V\left(K_t, \xi_t\right) = \max_{\{I_{t+s}\}_{s=0}^{\infty}} \left\{ D_t + E_t \sum_{S=1}^{\infty} \beta_{t+s-1} D_{t+s} \right\}$$

which is subjected to constraints,

$$D_t = \Pi\left(K_t, \xi_t\right) - C\left(I_t, K_t\right) - I_t$$

$$K_{t+1} = \left(1 - \delta\right) K_t + I_t$$

where, K_t and K_{t+1} are the beginning of period capital stock; ξ_t is the technological shock; I_t is the net investment; E_t is the expectation operator; β_{t+s-1} is the discount factor; Π is the profit function; C is the adjustment cost of capital; δ is the depreciation rate. The subscripts t and s represent current time period and its increment, respectively.

The cost of capital is assumed to be convex (Hayashi 1982)[4] and takes the form of

$$C\left(I_t, K_t\right) = \frac{\omega}{2}\left[\left(\frac{I}{K}\right)_t - v\right]^2 K_t$$

where, ω is a functional parameter; v is the constant to adjust towards $\left(\frac{I}{K}\right)_t$. Using the first order maximization with respect to investment, and setting $Q_{it} = \left(\frac{\partial V}{\partial K}\right)_{t+1}$, a non-dynamic type of Q model[5] is obtained as follows:

$$\left(\frac{I}{K}\right)_{it} = \mu_i + \beta_1 Q_{it} + \beta_2\left(\frac{CF}{K}\right)_{it} + \beta_3 D_{it} + \varepsilon_{it} \quad (1)$$

The model includes panel subscript i of firm[6] identifiers. In equation (1), both $\left(\frac{CF}{K}\right)_{it}$ and D_{it} are additive terms and not technically derived from above equations. The term $\left(\frac{CF}{K}\right)_{it}$ is the cash flow-capital ratio, while D_{it} is the firm total debt to total assets. The former is to represent internal funds. The latter is to denote firm debt effect. Equation (1) also consists of time-invariant unobserved firm fixed effects, μ_i.

To construct a threshold model, the model (1) is modified according to Hansen (1999). The model becomes

$$\left(\frac{I}{K}\right)_{it} = \mu_i + \gamma'_1\left(\frac{CF}{K}\right)_{it} I\left(D_{it} \le q\right) + \gamma'_2\left(\frac{CF}{K}\right)_{it} I\left(D_{it} > q\right) + \alpha' x_{it} + u_{it} \quad (2)$$

where, q is a threshold variable; $I(\cdot)$ is the indicator function; x_{it} is the vector of other exploratory variables; u_{it} is the independent and identically distributed (i.i.d) errors. The selection of final model will be discussed later in this article. Equation (2) can be alternatively rewritten as:

$$\left(\frac{I}{K}\right)_{it} = \begin{cases} \mu_i + \gamma'_1\left(\frac{CF}{K}\right)_{it} + \alpha' x_{it} + u_{it}, & D_{it} \le q \\ \mu_i + \gamma'_2\left(\frac{CF}{K}\right)_{it} + \alpha' x_{it} + u_{it}, & D_{it} > q \end{cases}$$

Equation (2) or its alternative denotes that the observations are divided into two groups or regimes. The first regime is where $D_{it} \le q$, while the second regime is where $D_{it} > q$. Both γ'_1 and γ'_2 represent regression coefficients of the two regimes, respectively. In this article, we used debt-asset ratio as the threshold variable to analyse the cash flow-investment relationship. The variable is exogenous in nature; as discussed in Introduction. It is also a time-variant. The model implies that high debt firms and low debt firms have different slopes of cash flow-investment relationship. Being low indebted firms is a result of having less accessibility to external financing as well as the factors such as, the ability of firms to repay the debt and the presence default risk.

ESTIMATION

Using $\gamma = \left(\gamma'_1, \gamma'_2\right)'$, $\varphi = \left(\gamma', \alpha'\right)'$ and $y_{it} = \left(\frac{I}{K}\right)_{it}$ for simplicity, Equation (2) can be rewritten as:

$$y_{it} = \mu_i + \varphi' X_{it} + u_{it} \tag{3}$$

where, $X = \left(\left(\frac{CF}{K}\right)_{it} I(D_{it} \le q), \left(\frac{CF}{K}\right)_{it} I(D_{it} > q), x_{it} \right)$. Then, Equation (3) is averaged over time, T, so that

$$\bar{y}_i = \mu_i + \varphi' \bar{X}_i + \bar{u}_i \tag{4}$$

where,

$$\bar{y}_i = 1/T \sum_{t=1}^{T} y_{it}$$

$$\bar{u}_i = 1/T \sum_{t=1}^{T} u_{it}$$

$$\bar{X}_i = 1/T \sum_{t=1}^{T} X_{it} = \begin{cases} 1/T \sum_{t=1}^{T} X_{it}(D_{it} \le q) \\ 1/T \sum_{t=1}^{T} X_{it}(D_{it} > q) \end{cases}$$

Subtracting (3) from (4) produces

$$y^*_{it} = \varphi' X^*_{it} + u^*_{it} \tag{5}$$

where, $y^*_{it} = y_{it} - \bar{y}_i$, $X^*_{it} = X_{it} - \bar{X}_i$ and $u^*_{it} = u_{it} - \bar{u}_i$. Meanwhile, $\mu_i - \mu_i = 0$, because the average of it, is itself. Therefore, the operation wipes out the unobserved time-invariant firm fixed effects. The stacked data and errors for each individual taking the forms as follows:

$$y^*_i = \begin{pmatrix} y^*_{i2} \\ \vdots \\ y^*_{iT} \end{pmatrix}, X^*_i = \begin{pmatrix} X^*_{i2} \\ \vdots \\ X^*_{iT} \end{pmatrix} \text{ and } u^*_i = \begin{pmatrix} u^*_{i2} \\ \vdots \\ u^*_{iT} \end{pmatrix}$$

where, one time period is deleted, we can rewrite the model (Equation (5)) in vector form so that it becomes

$$Y^* = X^*(q)\varphi + u^* \tag{6}$$

where, $Y^* = \begin{pmatrix} y^*_1 \\ \vdots \\ y^*_N \end{pmatrix}$, $X^* = \begin{pmatrix} X^*_1 \\ \vdots \\ X^*_N \end{pmatrix}$ and $u^* = \begin{pmatrix} u^*_1 \\ \vdots \\ u^*_N \end{pmatrix}$. Finally, Equation (6) is estimated using the ordinary least squares (OLS). The OLS produces for any value of q

$$\hat{\varphi} = \left(X^*(q)' X^*(q)\right)^{-1} X^*(q)' Y^* \tag{7}$$

And

$$\hat{u}^*(q) = Y^* - X^*(q)\hat{\varphi}(q). \tag{8}$$

The residual sum of squares is

$$
\begin{aligned}
RSS_1 &= \hat{u}^*(q)'\hat{u}^*(q) \\
&= Y^{*\prime}Y^* - Y^{*\prime}X^*(q)\left(X^*(q)'X^*(q)\right)^{-1}X^*(q)'Y^* \\
&= Y^{*\prime}\left(I - X^*(q)'\left(X^*(q)'X^*(q)\right)^{-1}X^*(q)'\right)Y^*
\end{aligned} \tag{9}
$$

Nevertheless, q is unknown. Therefore, Hansen (1999)[7] recommended q to be obtained from the least squares by minimizing RSS_1, such that

$$\hat{q} = \operatorname{argmin} RSS_1(q) \tag{10}$$

To obtain q that minimises errors, it involves trial and error operations. At any value of q selected, there will be NT distinct values[8] of RSS_1. In that case, Hansen (1999) suggested these following steps. The sample observations are sorted according to the threshold variable. A certain percentage of top and bottom observations is then eliminated. The remaining values of threshold variable is used to identify $\hat{q}$. The purpose of the elimination is to reduce the number of least squares estimations so that the estimations that needed to be carried out are lesser than NT. Hansen (1999) also recommended a shortcut which also produces almost identical results that further reduces the number of least squares. Based on this shortcut, the search is restricted to certain specific quartiles. Hence, in this study we used a grid that contains 400 quartiles. Drukker et al. (2005) argued that in the search for $\hat{q}$, for any q selected, each region must contain certain minimum number of observations. They argued that it should not lesser than 10 observations.

Once $\hat{q}$ is obtained, Equation (7) and (8) may produce consistent estimates such that $\hat{\varphi} = \hat{\varphi}(\hat{q})$ and unbiased errors, $\hat{u}^* = \hat{u}^*(\hat{q})$. Meanwhile, the model variance equals

$$\hat{\sigma}^2 = \frac{1}{N(T-1)}\hat{u}^{*\prime}\hat{u}^* = \frac{1}{N(T-1)}RSS_1. \tag{11}$$

INFERENCE

The threshold obtained in Equation (10) should be tested for its significance. To test for the significance of the threshold point, the null hypothesis

$$\mathrm{H}_0\text{:}\ \gamma'_1 = \gamma'_2$$

is tested against its alternative. If the null is true, the model should become

$$\left(\frac{I}{K}\right)_{it} = \mu_i + \gamma'_1\left(\frac{CF}{K}\right)_{it} + \alpha' x_{it} + u_{it}$$

or after a fixed-effect transformation (Equation (5)),

$$\left(\frac{I}{K}\right)^*_{it} = \gamma'_1\left(\frac{CF}{K}\right)^*_{it} + \alpha' x^*_{it} + u^*_{it} \tag{12}$$

For the specification comparison purpose, we rewrote (12) into a vector form equation

$$y^*_{it} = \varphi_1' X^*_{it} + u^*_{it} \tag{13}$$

where $y_{it}^{*} = \left(\frac{I}{K}\right)_{it}^{*}$, $\varphi_1 = (\gamma'_1, \alpha')'$ and $X_{it}^{*} = \left(\left(\frac{CF}{K}\right)_{it}, x_{it}\right)$. Equation (13) was also estimated using the least squares. The estimator produces slope coefficient of $\breve{\varphi}_1$, residuals $\breve{u}_{it}^{*}$ and $RSS_0 = \breve{u}_{it}^{*\prime}\breve{u}_{it}^{*}$. These results were tested against the alternative results of (7) to (9) using

$$F_1 = (RSS_0 - RSS_1(\hat{q}))/\hat{\sigma}^2. \tag{14}$$

Hansen (1999) argued that the asymptotic distribution of F_1 is non-standard and strictly dominates the χ_k^2 distribution with unknown k parameters because it depends on sample moments properties; and therefore, its critical values cannot be tabulated. Hence, Hansen (1996) suggested the use of bootstrap procedures to obtain asymptotic *p*-value. In this article, we used 300 bootstrap replications to obtain *p*-value.

Once $\hat{q}$ is known, we need to know whether the threshold is consistent for the true q. This can be done by forming confidence intervals for q (Hansen 1999). The hypothesis is to accept the null such that $\mathrm{H}_0: \hat{q} = \text{true } q$ using the likelihood ratio statistics

$$LR_1(q) = (RSS_1(q) - RSS_1(\hat{q}))/\hat{\sigma}^2. \tag{15}$$

As number of observations becomes larger ($N \to \infty$), $LR_1(q) \to \xi$, where ξ is a random variable. Maximizing Equation (15) with regard that $\hat{q}$ is obtained by minimising $RSS_1(\hat{q})$, Hansen (1999) proved that the probability distribution function of ξ is

$$P(\xi \leq X) = (1 - exp(-X/2))^2 \tag{16}$$

and its inverse is

$$c(\theta) = -2\log(1 - \sqrt{1-\theta}) \tag{17}$$

where θ is the significance level. If the null holds, the statistics fall into the no-rejection region such that $LR_1(\hat{q}) \leq c(\theta)$. If this inequality holds, the inference of $\hat{\varphi} = \hat{\varphi}(\hat{q})$ can be proceeded straightaway (Hansen 1999).

SOURCE OF DATA

A sample of listed companies from Bursa Malaysia was selected to examine the cash flow-investment relationship. The data were obtained from the Datastream. The raw data were refined as follows. Following Ismail et al. (2010a) and others such as Laeven (2002), Agung (2000) and Love (2003), we deleted firms with missing values, firms that operate less than the length of required sample period[9], firms that suffer at least three years of negative net income within the sample period, and firms that are financial firms. Finally, the usable sample comprised of 234 listed companies from 2004 to 2010. The data were relatively small as compared to market's total number of firms as the data were a balanced panel. We deleted firms with missing data during the period of 2004 to 2010. Table 1 shows the distribution of data according to business sectors as defined in the Datastream[10]. Five variables were observed; namely, investment, capital, Q, cash flow and debt-ratio. The definition of each variable is shown in Table 2.

TABLE 1. Sample distribution

Sectors	Number of firms	Number of Observations	Percentage (%)
Energy (5010)	5	35	2.14
Chemicals (5110)	9	63	3.85
Mineral resources (5120)	16	112	6.84
Applied resources (5130)	17	119	7.26
Industrial goods (5210)	14	98	5.98
Industrial services (5220)	27	189	11.54
Industrial conglomerates (5230)	1	7	0.43
Transportations (5240)	10	70	4.27
Automobiles / Auto Parts (5310)	12	84	5.13
Cyclical Consumer Products (5320)	17	119	7.26
Cyclical Consumer Services (5330)	14	98	5.98
Retailers (5340)	7	49	2.99
Food / Beverages (5410)	43	301	18.38
Personal / Household Products / Services (5420)	2	14	0.85
Food / Drug Retailing (5430)	1	7	0.43
Real Estate (5540)	19	133	8.12
Healthcare Services (5610)	4	28	1.71
Biotechnology / Pharmaceuticals (5620)	1	7	0.43
Technology Equipment (5710)	4	28	1.71
Software / IT Services (5720)	3	21	1.28
Telecommunications Services (5810)	1	7	0.43
Utilities (5910)	7	49	2.99
Total	234	1638	100

Note: Number of firms is 234. The definition of sectors is based on Datastream's classification. The codes in the parentheses are Datastream's sector classification.

TABLE 2. Variable definition

Variables	*Definition*
Capital	It is the net of fixed asset depreciation at the beginning of period *t*. The fixed assets include property, plant and equipment.
Investment	It is the ratio of current capital expenditure to capital.
Q	It is the beginning of period average Q. It constitutes book value of total debt and market capitalization divided by firm total assets which all are measured at the beginning of period.
Cash flow	It is the beginning of period operating income plus its respective total depreciation. Depreciation is comprised of total depreciation, amortization and depletion. The Cash flow is then scaled by capital to construct cash flow ratio.
Debt-ratio	It is the ratio of beginning of period total debt to total assets.

Note: The definitions are based on Ismail et al. (2010a).

ESTIMATION RESULTS

The statistical characteristics of the variables are shown in Table 3. On average, firms spend about 13 per cent out of their total capital stocks every year for investment. The average value of Q is 1.0743. This value indicates that all firms in the sample are profitable in which for any investment made, an additional value of 7.43 percent will be created by the firms. On the average, the cash flow is relatively high, whereas the debt ratio is considerably low. All variables are not normally distributed, skewed to the right and highly leptokurtic. Besides, overall, the variables are integrated at level (Table 4). This indicates that the null hypothesis of unit roots is rejected as particularly shown by LLC results. As a result, the estimation can be done at levels straightaway without taking first differences[11].

TABLE 3. Descriptive statistics

	Investment ratio	Q	Cash flow ratio	Debt-ratio
Mean	0.1304	1.0743	0.6091	0.2403
Median	0.0965	0.8186	0.2364	0.1869
Skewness	3.0269	3.5713	16.4162	15.7223
Kurtosis	23.5941	23.0281	304.2187	430.9712
Std. Dev.	0.1260	0.8780	3.5684	0.3499
Num. of observations	1638	1638	1638	1638

TABLE 4. Unit root tests results

	Levin-Lin-Chu test	Harris-Tzavalis test	Im-Pesaran-Shin test
Investment ratio	-34.3280*	-0.0404*	-7.1846*
	(0.0000)	(0.0000)	(0.0000)
Q	-40.1076*	0.1651*	-4.4882*
	(0.0000)	(0.0000)	(0.0000)
Cash flow ratio	-34.2789*	0.7157	-0.1639
	(0.0000)	(0.9999)	(0.4349)
Debt-ratio	-73.3711*	-0.1118*	-0.9153
	(0.0000)	(0.0000)	(0.1800)

Note: The statistics for Levin-Lin-Chu (LLC) test are bias-adjusted. The statistics for Harris-Tzavalis (HT) test are the point estimates of rho. The LLC and HT tests the null hypotheses of panels that contain unit root against the alternative of panels that are stationary. Im-Pesaran-Shin (IPS) test statistics are asymptotic standard normal distribution of $Z_{\tilde{t}-bar}$. The IPS tests the null hypothesis of panels that contain unit root against the alternative of some panels that are stationary. The numbers in parentheses are *p*-values. The IPS test requires the observations to be at least six observations per panel. All tests subtract the mean from the series in order to mitigate the effect of cross sectional dependence as suggested by Levin et al. (2002).

MODEL SELECTION

Model (2) is modified to include non-linear components whereby reducing possibility of spurious correlations due to omitted variable bias (Hansen 1999). In deciding the components that are to be included in the model, this article followed Lindsey and Sheather's (LS) (2010) technique of variable selection. Using stepwise backward selection method, the results of the selected model are as follows:

$$\frac{I}{K}_{it} = \mu_i + \alpha_1 Q_{it} + \alpha_2 Q_{it}^2 + \alpha_3 D_{it} + \alpha_4 D_{it}^2 + \alpha_5 D_{it}^3 + \alpha_3 \; Q \,\square\, D_{\;it} + \gamma_1 \frac{CF}{K}_{it} I \; D_{it} \leq q + \gamma_2 \frac{CF}{K}_{it} I \; D_{it} > q + u_{it} \qquad (18)$$

Model (18) inserts powers of *Q* and *D*, and their interactions. The number of powers is determined by the LS test. The selection is made based on the goodness of fit criteria which include the adjusted R^2, Akaike's information criterion (AIC), Akaike's corrected information criterion (AICC), Bayesian information criterion (BIC), and Mallow's C_p[12].

THRESHOLD ESTIMATES

Following Hansen (1999), Model (18) was estimated using least squares estimation. The results are summarized in Table 5. The table shows that the threshold is 0.3536. Whited (1992) found that the mean of debt to total assets ratio was 0.339. The threshold indicates that there are two regimes, which are: below, and above the threshold. The first regime consists of low-debt firms, while the second regime consists of high-debt firms. The likelihood ratio statistics for the threshold is significant at one per cent significance level, which rejects the null hypothesis of no threshold model (Model 12). This implies that firms of different regimes behave differently with respect to investment behaviour. In addition, Model (18) has lower residual sum of squares (RSS), at 10.7081, as compared to non-threshold model, at 11.4735, in which that lower RSS represents better model specification.

Figure 1 shows the plot of threshold estimates against the likelihood ratio. The figure shows that the likelihood ratio falls and crosses the dotted line to hit the zero axis, where the threshold value is 0.3536. Once the likelihood ratio lies beneath the dotted line, the confidence intervals (0.354, 0.378) can be obtained. The confidence intervals are based on 95 per cent confidence level where the threshold lies within the range of the intervals. The figure also shows that there is no second major dip. This implies that there is no other threshold except 0.3536. This certifies that the regimes are only two.

The existence of the regimes confirms that generalization may not be carried out to imply firm behaviour to invest. Leverage threshold of 0.3536 shows that the behaviours of low-debt firms and high-debt firms may not be generalized as similar. This finding supports other firm's characteristics such as firm size, maturity and ownership types as mentioned in the literature. In particular, low-debt firms have different characteristics as compared to their high debt counterparts. Even more, they have different accesses to sources of fund. Thus, this will affect their investment strategies. On the other hand, the policy makers should consider this finding in formulating any policy that is directed by them. The details regarding investment and cash flow relationship for these categories of firms are elaborated in the next section.

TABLE 5. Threshold estimates

		Residual sum of squares (RSS)
Zero threshold model		11.4735
Single threshold model		10.7081
Threshold Estimate	0.3536	
Confidence Region	0.3536 0.3778	
Trimming Percentage	0.01	
LR Test for threshold effect	100.3591	
Bootstrap p-value	0.0067	
Critical Values	14.9703 (10 per cent)	
	22.2871 (5 per cent)	
	48.8938 (1 per cent)	

Note: Number of firms and years used in the estimation are 234 and 7 respectively with total observations of 1404 (after trimming process at 0.05 per cent). Number of Bootstrap replications and quantiles are 300 and 400, respectively. The confidence level is 0.95.

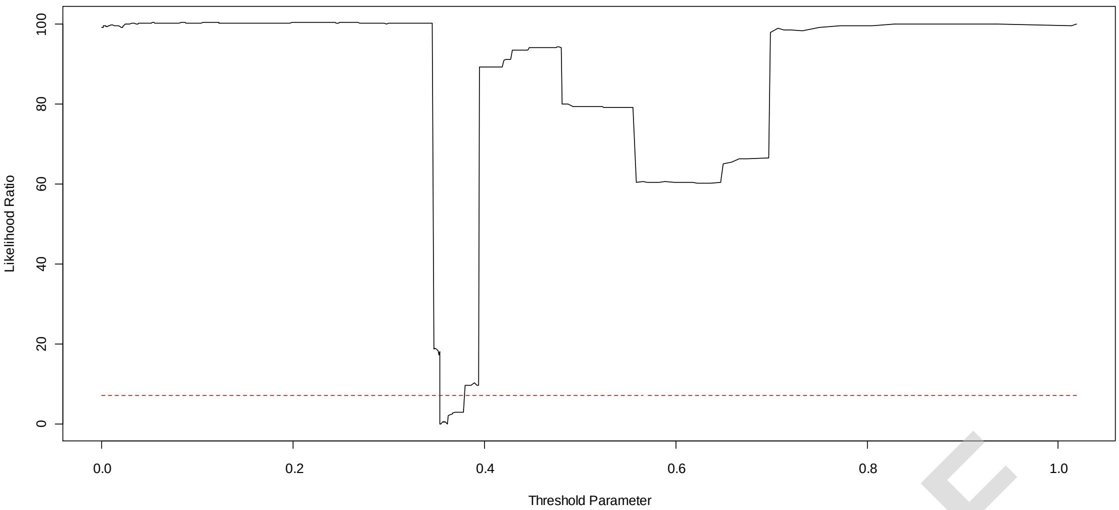

FIGURE 1. Confidence interval construction in single threshold model

REGRESSION ESTIMATES

Table 6 demonstrates slope estimate for the least squares regression. There are two types of variables. First, the regime-independent variables, which are: Q_{it}, Q_{it}^2, D_{it}, D_{it}^2, D_{it}^3 and Q □ D_{it}. Second, the regime-dependent variable, which is $\frac{CF}{K}_{it}$. The results show that Q is positively correlated with investment. Previous studies such as Kadapakkam et al. (1998), Koo and Maeng (2005), Ismail et al. (2010a; 2010b) and Aivazian et al. (2005) also reported similar finding. The finding is in line with Q theory. The positive relationship indicates high value of Q (represents high profitability of firms); i.e. for every Ringgit spent for investment, firm value will increase by 2.9 per cent.

The squared Q indicates nonlinear relationship with investment. The result shows an inverse relationship between the variables. On the other hand, the debt ratio is not significant except for the squared debt ratio. The sign is negative. This implies that firm debt is nonlinearly related with investment, in which the indebtedness restricts firms from having more debts to finance investment. It indicates that too much debt is not good for investment. Aivazian et al. (2005) found that increase in leverage level reduces investment. High level of debt increases default risk and overall risk of running a firm.

Using the debt ratio as the threshold variable to examine the effects of different regimes to investment, this study found that low debt firms are financially constrained, while statistically, high debt firms are not financially constrained. This finding confirms the first hypothesis of pecking-order that asymmetric information reduces firm's ability to access external financing. As a result, firms retained their earnings to finance future profitable investments.

On the other hand, the high debt firms are able to gain access to external financing in order to carry out other investments. Although the coefficient is not significant, the sign is negative. This negative sign indicates the existence of agency problem among high debt firms; whereby insiders of the firms tend to invest in projects that provide them with more benefits but at the expense of outside investors. This finding supports the free-cash flow hypothesis explained in Vogt (1994). The finding also supports Hackbarth and Mauer (2012) whereby financially unconstrained firms tend to use senior unsecured debt claims, while constrained firms tend to preserve priority for future debt issues using junior secured debt. Tangible assets possession is important to increase debt capacity (Ameer 2014).

TABLE 6. Regression estimates

	Coefficients	Standard errors	Hetero-corrected standard errors
Regime-independent			
α_1	0.0288**	0.0124	0.0113
α_2	-0.0021*	0.0016	0.0012
α_3	0.0675	0.0395	0.0527
α_4	-0.0433*	0.0213	0.0268
α_5	0.0036	0.0018	0.0022
α_6	0.0101	0.0125	0.0202
Regime-dependent			
γ_1	0.0338***	0.0036	0.0110
γ_2	-0.0032	0.0022	0.0024

Note: *, ** and *** denote 10, five and one per cent of significance levels.

In addition, the above result also shows the importance of debt at signalling good reputation to outsiders; thus, outweighing the negative impact of debt to investment. A debt ratio that is higher than the threshold level is useful for firms. This allows better access to external funds by firms. However, if the debt ratio is too high, it will reverse the positive impact of debt and impede investment as shown by the squared debt ratio. Therefore, it is very crucial for firm to have an optimal level of capital structure; with leverage higher than 0.3536 of debt to total assets.

The significance of the threshold also indicates different cash flow-investment relationship among high and low debt firms; thus, showing the importance of firms' characteristics in analyzing their behaviours in investment decisions. In this article, the different levels of debt ratio exhibit different tendency of firms, whereby low debt firms are highly dependent on internal funds, while high debt firms do not significantly depend on them. In this case, for unconstrained high debt firms, external funds are more favourable and cheaper, but not for constrained low debt firms. Thus, high-debt firms are able expand their investments beyond their current capacities through external funds.

CONCLUSION

The financial constraints and firm investment have been widely studied. However, previous studies did not take into account the issue of dynamic characteristics of firms while deciding a splitting criterion. This article employs Hansen's (1999) threshold regression method of non-dynamic panel data. In this article, the debt ratio is used as the threshold variable to analyse the importance of debt levels for firms. A sample of balanced panel data of listed companies from Bursa Malaysia is chosen. The sample is comprised of 234 companies from 2004 to 2010. The results show that debts have significant effects, in which low debt firms exhibit significant support for the financial constraints hypothesis while the high debt firms demonstrate support for the free-cash flow hypothesis.

The significance of the threshold level indicates the presence of firm regime and validates the importance of firm's debt level. The finding is crucial because it provides both firms and policy makers more reliable information regarding firm investment and its relationship with cash flow availability as compared to the traditional method that is based on sample splits. The results indicate that debt level produces different signals to investors; in which low debt firms are less accessible to external fund, while high debt firms have better access. To ensure that a proper signal is used when firms access the external funds, the firms have to decide on their capital structures as to signify internal strength and the ability to fulfil liability obligations. The capital structure should be consisted of debt ratio that is higher than the threshold, but the leverage level cannot be too high. This is because extreme level of debt increases default risk. This strategy guarantees future investment planning of the firms.

Similarly, the policy makers may make use of the finding to formulate appropriate policies to intervene in the market as to ease the financial constraints among the low debt firms. Using this directed policy approach, the policy makers are able to reduce the cost of intervention. At the same time, only the affected firms benefit from the policy measures, while the rest of firms are not worse-off with the policy implementation. According to Agung (2000), appropriate policy implementation is important as wrong measure may worsen the financial constraints faced by the firms. For instance in India, the financial liberalization benefited only middle-sized firms, while small firms suffered more severe financial constraints (Bhaduri 2005). Karim et al. (2013) found that in Malaysia, financially constrained firms are more affected by domestic monetary policy shock with respect to their equity returns.

ENDNOTES

[1] Under a perfect capital market, asymmetric information, transaction costs, and agency problem are assumed absent. Therefore, firms that operate in the perfect capital markets behave homogenously. They also issue perfectly substitutable equities and bonds.

[2] We consider the year of 1988 as the timeline, when Fazzari et al. (1988) published the first article that studies the financial constraints and their relationships to firm investment.

[3] No cash flow-investment sensitivity implies that Modigliani and Miller's theorem holds.

[4] The adjustment cost increases with an increase in investment.

[5] The expectation operator is omitted through rational expectation assumption in which expected values are replaced by realised values plus an expectational error (Ismail et al. 2010a).

[6] For derivational details, please see Ismail et al. (2010a).

[7] Hansen produced many articles on threshold regressions. For further details, see his website at http://www.ssc.wisc.edu/~bhansen/progs/progs_threshold.html

[8] *NT* is the number firms multiplied by number of time periods.

[9] The required period ranges from 2004 to 2010. The sample was not randomly selected.

[10] The sample distribution is informative but the analysis did not analyse sectors.

[11] With regard to structural break, it does not affect the analysis since the data period is short and the trend shift will be insignificant. In contrast, the unit root tests employed in this article consider cross sectional dependence which is a common issue in panel data.

[12] The model is selected if the model has the highest adjusted R^2, lowest statistics of AIC, AICC and BIC, and closest statistic of Mallow's C_p to one. If the statistics produce contradictory results, the result of Mallow's C_p will be preferred. The results may be reproduced upon request to the author.

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