The Association between Finance Policy, Business Risk and Firm Growth Effect in Taiwan

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ABSTRACT

This study applies the panel smooth transition regression (PSTR) model to investigate the non-linear dynamic relationship between firm growth and firm size in the Taiwan electronic information industry. Our empirical results reveal that firm growth and firm size present a non-linear relationship. Firm growth is different under the size threshold value and the control variables of firm age, business risk, debt, R&D, and free cash flow (FCF). The different firm size attributes of firm growth produce completely different business risks. We recommend that firms should measure business risk and firm growth. High leverage risk does not necessarily mean one will get a higher firm growth. In sum, the business risk is an important index when looking at firm growth.

Keywords: PSTR model, business risk, firm size, firm growth, free cash flow

1. INTRODUCTION

In this paper, we address two questions related to free cash flow and firm growth. First, which firms a growth issue and free cash flow in domestic market? Second, what happens to business risk and firm growth? These questions have not previously been addressed using a broad panel of firms monitored over an extensive time period. We thus assess these questions by documenting several new patterns concerning free cash flow, firm growth, and the associated evolution of the threshold effect of firm size. Smith and Stulz (1985), examining the financial theory, suggest that corporate risk management can benefit shareholders. In particular, risk management can increase shareholder value by reducing cash flow uncertainty, and thus, the expected costs of financial distress and underinvestment. We also discuss how these findings relate and contribute to business risk and firm growth.

Most studies in the literature on the determinants of firm growth have focused on the relationship between initial firm-specific conditions and firm growth. For example, Singh and Whittington (1975) examined the relationship between the size of firms and their growth for nearly 2,000 British companies in 1948–1960 and found that firm size has a significant positive effect on firm growth. Based on the profit maximization problem, Jovanovic (1982) established a theoretical model of firm learning to analyze the survival of firms. He showed that firm age and size are important factors in determining the survival of firms. Smaller firms grow faster but are more likely to fail than large firms.

Evans (1987a, 1987b) applied Jovanovic's theoretical model (1982) to test the relationships among manufacturing firm growth, firm size, and firm age in the U.S. He presented that firm growth decreases with firm age and firm size. The inverse relationship between growth and age is consistent with Jovanovic (1982). Some studies on firm growth started to focus on the elements of innovation and R&D in the mid-1990s. For example, Audretsch (1995) showed that the post-entry performance of new firms and technological conditions were closely related. Specifically, they found that a higher innovative environment was associated with higher survival and growth. Audretsch and Mahmood (1995) also found that R&D intensity was positively correlated with a firm's survival. Lee and Shim (1995) showed that the relationship between firm growth and R&D expenditure was significantly positive using data from high-tech firms' from the U.S. and Japan. Griliches and Mairesse (1983), Hall and Mairesse (1995), Raut (1995) and Yang and Chen (2002) also examined the relationship between R&D and the productivity growth of firms.

The relationship between an outward finance policy and firm growth was has also under investigation. Given the significance of firm growth, a good number of empirical studies in the last few decades have focused on the financial barriers to growth as well as the relationship between growth and different sources of financing; however, the results of these studies are mixed and complicated. This might be because of the multiple and complex variables and different approaches that have been deployed to explain the relationship between firm growth and financial policy. For example, Cassar and Holmes (2003) and Hall, Hutchinson and Michaelas (2004) found positive associations between growth and both long-term and short-term debt ratios, while others present mixed evidence from this relationship. Paul, Machin and Walters (1997) found that the current period growth rates and a natural measure of changes in current expectations about long-run profitability are robustly positively correlated. Hall et al. (2004) expected that firm growth is positively related to the proportion of internal financial resources in terms of the retained profit used to finance a firm's assets. Hovakimian and Titman (2006) examined the relationship between proceeds from voluntary asset sales and investment expenditure, and their regressions show that cash obtained from asset sales is a significant determinant of corporate investment and that the sensitivity of investment to proceeds from asset sales is significantly stronger for firms that are likely to be financially constrained. If firm's risk underinvestment and their internal financial resources are insufficient, it would be reasonable for them to turn to short-term debt as a second financial alternative, such as short-term loans or trade credits, before choosing long-term loans as a financial source. Financial assets can quite easily be transformed into other types of resources. With access to sufficient financial assets, firms are able to develop their growth capacity in different ways.

Corporate finance theory suggests that market imperfections, as well as free cash flow (FCF) and incentive problems, raise the cost of external finance, especially due to underdeveloped financial markets l. Free cash flow is a measure of how much cash a business generates after accounting for capital expenditures such as buildings or equipment. It is also important to note that firms have some leeway about what items are or are not considered capital expenditures, and the managers should be aware of this when comparing the FCF of different companies. Beck et al. (2001) also showed that firm growth was primarily affected by internally generated funds and short-term debts, while it was less affected by the cost of external finance. There are a number of studies that investigate the free cash flow hypothesis. One line of empirical work examined the overinvestment problem by analysing the relation between growth opportunities and FCF on the one hand, and leverage on the other. The authors found the predicted negative relationship between debt and growth opportunities (Smith and Watts, 1992), and that changes in FCF lead to positive changes in leverage (Crutchley and Jensen, 1996). Another approach to the implications of the free cash flow hypothesis in corporate capital structure policy is to study specific events that take place after capital structure and show that in general the firms acted according to free cash flow theory (Blanchard, Silanes, and Shleifer, 1994; Denis and Denis, 1993).

Our paper provides evidence relevant to FCF and firm growth in firms. Although recent studies in international corporate finance predict a positive relation between firm growth and access to external financing, we actually know very little about how firms' perceptions conform to the conventional notions of what makes FCF efficient. Moreover, we do not know whether these conventional notions help predict the threshold effect of the firm size. In this paper, we address both of these issues.

This study applies the PSTR model developed by Gonzalez, Terasvirta and van Dijk (2005) to set firm size and age as the threshold variables and determines the relative influence of all variables on a firm's growth. The objectives of this present study are twofold: (1) To use the PSTR model to prove a non-linear relationship between firm size and firm growth; (2) To set up control variables of age, FCF, R&D, risk and debt ratio to explore the relationship between firm size, age and a firm's growth according to different ranges of firm size.

Our empirical study's data set consists of monthly FCF, R&D, and debt ratio, and the firm size and age. The sample period for the study covers ten years from January 2003 to June 2013, and comprises a total of 703 firms. We find strong evidence of the non-linear dynamic relationship between a firm's growth and its' size, age. Moreover, the different financial policy attributes of firms produce completely different firm growth.

In today's challenging environment firm growth and risks are constantly changing. The management of risk is not a single act of decision or action but a complex multi-staged process. In the functioning of a business in a fast-changing global environment, a static approach of examining and analyzing risks can contradict the principle of effectiveness. The management of risk is a dynamic process.

This means that the collecting and processing of information about risks, making and implementing decisions of the choice and application of methods of management, and the monitoring and analysis of the results of the application of the chosen method should be examined as a continuous process, a part of the general process of the management of business. As an important element of the general management of the company, the management of risk should correspond with the requirements of dynamics, flexibility, and adaptability of the adopted business decisions.

The corporate passion for firm growth has passed, and today strategic management groups activities around core businesses. This leaves firm growth mainly to the investor, who must attain their most preferred business risk–firm growth profile by constructing a suitable portfolio mix. Nonetheless, both the firm growth and business risk of investments as well as their relationship to one another continue to be important issues for strategic management. In the portfolio theory, risk is defined as the standard deviation of return in a certain period of time. The theory prescribes that both return and risk increase when the debt ratio increases. Numerous accounting measures of risk and return to evaluate that trade-off. Bettis and Mahajan (1985) showed that a trade-off existed between profitability and risk; in their findings, firms that diversified into unrelated businesses usually had lower returns on assets (ROA) than firms that did not do so. However, the ROAs of the unrelated diversifiers also had lower standard deviations of ROA, representing lower risk. The second motive for business-risk reduction derives from the effect of uncertainty about the operations of a firm on its cash flows. In stable environments, corporations' operations should be efficient and the volatility of their earnings should be low. A special case of this argument is a situation in which a risk-averse manager who is compensated on the basis of cash flows is willing to work for less compensation if cash flows are stable. In such a setting, it is in the interest of shareholders to reduce the business risk (Amihud, Dodd and Weinstein, 1986; Aron, 1988; Marshall, Yawitz and Greenberg, 1984). If industries are less than perfectly competitive, reduced business risk will enhance a firm's market value. According to this motive for business-risk reduction, a negative relation should exist between cash flows and business risk; that is, higher cash flows are associated with lower business risk. We refer to this motive as the firm growth and business risk motive. At each stage of the life cycle of the firm there is attrition. Most young firms fail to make it through early tests to become growth firms, and a large number of growth firms find that growth is short-lived and either go out of business or are acquired by larger firms. In this chapter, we will focus on the firms that survive these gruelling phases of competition and become mature firms: mature not only in terms of growth rates but also in terms of risk profiles and FCF characteristics. The current trends in the literature of business administration and strategic management define a difference in functional emphasis between Puschaver and Eccles (1996), who showed risk as an opportunity to be dealt with by strategic initiatives by top management, and risk as an operating uncertainty to be dealt with by line management.. As a dynamic process, the management of risk passes through several stages. In scientific literature there is no uniformly adopted opinion regarding the number and names of the stages. Models with different numbers and names of the stages have been proposed. Risk and firm growth could also have a converse relationship as opposed to the view that firm growth is in proportion to the measure of risk assumed. We will examine a conceptual model firm growth with risk management.

The remainder of the paper is organized as follows. Section 2 is a brief review of the PSTR model. Section 3 provides the empirical results. Section 4 is conclusion and remarks.

2. METHODOLOGY

2.1 Brief Review of the Smooth Threshold Regression Model

Most economic variables change regimes in a smooth manner, with the transition from one regime to another taking some time. Testing parameter constancy in panel data models has not received much attention in the time series literature. One possible explanation for this is that in many applications the time dimension T is relatively small, making the assumption of parameter constancy a less interesting hypothesis to test. However, when the number of empirical panel data sets with a relatively large T increases, then testing for parameter constancy does become important.

In this study we propose a novel approach that can be used to examine the non-linear relationships between firm growth and amount of FCF, R&D, and debt ratio under different firm size and age scenarios. For this purpose, we use a panel smooth transition regression (PSTR) model that imposes a common regime-switching mechanism, while allowing for considerable heterogeneity in the timing of the regime changes across the series.

This approach has two main advantages. First, based on PSTR model specifications, we derive variable coefficients that vary not only among the Taiwan electronic information industry, but also with time. Thus, our work provides a simple parametric approach to capture both cross-firm heterogeneity and time variability of the variable correlations. Second, this approach allows for smooth changes in firm-specific correlations, depending on a threshold variable.

There are many empirical studies about the PSTR model in the literature, and some explore non-linear relationships. Some studies also examine the threshold effect in the PSTR model. For example, Chakroun (2009) uses the PSTR model to investigate the potential threshold effects in the relationship between national expenditures on health and national income for 17 OECD countries over the period 1975–2003. The results of their empirical study show that health care is a necessity rather than a luxury, in contrast to many previous analyses. Furthermore, the relationship between health expenditure and income seems rather non-linear, changing over time and across countries. Cheng, Kang and Chiang (2010) explore whether there exists an efficient investment regime for a panel of S&P100 companies over the period 1986–2007. By utilizing the PSTR model to examine the threshold effect of the one-year lagged market-to-book assets ratio on abnormal stock returns, this study finds that there exists an efficient investment regime between the threshold values of 0.4773 and 3.2728. Their results are robust enough to predict approximately 74.42% of the movement direction of abnormal stock returns in 2008.

We note two interpretations of the above models that are possible. On the one hand, the PSTR model can be thought of as a regime-switching model that allows for a small number of extreme regimes associated with the extreme value of a transition function, whereby the transition from one regime to another is smooth. On the other hand, the PSTR model allows for a continuum of regimes, with each one being characterized by a different value of the transition variable.

2.2 Panel Smooth Threshold Regression Model

We follow Gibrat (1931) and assume that lognormal distribution was a good description of the observed firm size distribution. According to Gibrat's law, a firm's proportionate rate of growth is:

$$(S_t - S_{t-1}) / S_t) = \varepsilon_t \tag{1}$$

where S_t is the firm size at time t, e.g. sales or trade assets and ε_t is a random variable that is distributed independently of S_{t-1}. Assuming that the initial size is S_0 and there are n steps before the final size S n is reached, then summing up gives:

$$\sum_{t=1}^{n} (S_t - S_{t-1}) / S_t) = \sum_{t=1}^{n} \varepsilon_t \tag{2}$$

For short-time intervals the value of ε_t is probably small, and (2) can be approximated as:

$$\sum_{t=1}^{n}(S_t - S_{t-1})/S_t) \approx \int_{S_o}^{S_n} ds/s \tag{3}$$

which gives:

$$\log S_n = S_o + \sum_{t=1}^{n}\varepsilon_t \tag{4}$$

Bearing in mind that the ε_t is relatively small and combining that with the exponential expansion, then equation (4) is approximately equivalent to

$$S_t = S_{t-1}(1+\varepsilon_t) = S_o(1+\varepsilon_1)(1+\varepsilon_2).....(1+\varepsilon_n) \tag{5}$$

Assuming that log S_o and S_t are identically distributed with mean μ and variance σ^2, using the central limit theorem, it follows that $\log S_t \sim N(\mu t, \sigma^2 t)$ as $t \to \infty$ Therefore, the distribution of S_t is lognormal, with the implication that the expected value and variance increase over time.

Taking into consideration all the above and the fact that there are usually more small firms than there are large firms, Gibrat (1931) assumed that lognormal distribution was a good description of the observed firm size distribution. As there are more small firms, the firm size distribution is skewed. In a graph of probability density function, the probability mass is concentrated closer to the origin of the axis due to the many small firms and there is a long right tail due to the few large firms. Evans' model: According to Evans's model, the firm growth relationship for firm i in period t+1 is a function of size and age:

$$S_{it+1} = \left[G(A_{it,}B_{it}\right]^d (S_t)e_{it} \tag{6}$$

where e_{it} is a lognormally distributed error term. Equation (6) suggests the following regression framework:

$$\log S_{it+1} = \log\{\left[G(A_{it,}S_{it})\right]^d (S_t)e_{it}\} = d\log G(A_{it,}S_{it}) + \log S_{it} + \log e_{it} = \log G(A_{it,}S_{it}) + u_{it}$$

where the d=(t+1)-1=1 so become:

$$\log S_{it+1} - \log S_{it} = \log G(A_{it,}S_{it}) + u_{it} \tag{7}$$

where u is distributed normally with zero mean and possibly a non-constant variance, and it is independent of size and age.

Evans' extended model: The empirical model used in this study is an extensive model of Evans (1987a, b). Taking into account the stock market and firms, we reference Beck and Levine (2002) to examine the relationship between finance and industrial growth and Fama and French (1973, 1995), using a second order logarithmic expansion of ln G (Size, Age) and adding the natural logarithms and squared term of measure for Growth, Size, Age, BE/ME and Volume to the following extensive model:

$$\begin{aligned} GR_{it} &= \beta_0 + \beta_1 \log Age_{it-1} + \beta_2 \log Size_{it-1} + \beta_3 \log R\&D_{it-1} + \beta_4 \log FCF_{it-1} \\ &+ \beta_5 \log Debt_{it-1} + \beta_6 \log Risk_{it-1} + u_{it} \end{aligned} \quad (8)$$

In Eq.(8) where the growth rate of total assets(GR_{it}), the firm operating period(Age_{it}), the total of firm assets ($Size_{it}$), research investment of firm ($R\&D_{it}$), and the free cash flow of firm (FCF_{it}) and the loan of firm ($Debt_{it}$) and the business risk of firm ($Risk_{it}$) in logarithmic terms. When Gibrat's law holds, this simple hypothesis asserts that the firm size is uncorrelated with firm growth. Age is measured in years since the firm became incorporated and is also in logarithmic form.

In this study we propose a novel approach to examine the non-linear relationship between investor flows and amount of assets, fees, and the Sharpe ratio under different volatility scenarios. For this purpose, we use the PSTR[1] model, which imposes a common regime-switching mechanism while allowing for considerable heterogeneity in the timing of the regime changes across a series. We first briefly review the PSTR model as follows.

The basic PSTR model with two extreme regimes is defined as:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it}; \gamma, c) + u_{it} \quad (9)$$

Here, i = 1, . . . , N, and t = 1, . . . , T, where N and T denote the cross-section and time dimensions of the panel, respectively. The dependent variable y_{it} is scalar, x_{it} is a k-dimensional vector of time-varying exogenous variables, μ_i represents the fixed individual effect, and u_{it} are the errors. Transition function $g(q_{it};\gamma,c)$ is a continuous function of the observable variable q_{it} and is normalized to be bounded

[1] For more details, please see Gonzàlez et al. (2005) and Colletaz and Hurlin (2006).

between 0 and 1, and these extreme values are associated with regression coefficients β_0 and $\beta_0 + \beta_1$. More generally, the value of q_{it} determines the value of $g(q_{it};\gamma,c)$ and thus the effective regression coefficients $\beta_0 + \beta_1 g(q_{it};\gamma,c)$ for individual i at time t. We now demonstrate that the widely used transition function is a logistic specification:

$$g(q_{it};\gamma,c) = \left(1 + \exp\left(-\gamma\prod_{j=1}^{m}(q_{it} - c_j)\right)\right)^{-1}$$
$$with\ \gamma > 0\ \ and\ \ c_1 \leq c_2 \leq \cdots \leq c_m \qquad (10)$$

Here, c = (c1, . . ., c_m)' is an m-dimensional vector of location parameters, and the slope parameter γ determines the smoothness of the transitions. The restrictions $\gamma > 0$ and c1≤ . . . ≤ cm are imposed for identification purposes. In practice, it is usually sufficient to consider m = 1 or m = 2, as these values allow for commonly encountered types of variation in the parameters.

For m = 1, the model implies that the two extreme regimes are associated with low and high values of q_{it} with a single monotonic transition of the coefficients from β_0 to $\beta_0 + \beta_1$ as qit increases, where the change is centred around c1. When $\gamma \to \infty$, $g(q_{it};\gamma,c)$ becomes an indicator function $I[q_{it} > c_1]$, defined as I [A] = 1 when event A occurs and 0 otherwise. In that case the PSTR model in equation (9) reduces to the two-regime panel threshold model of Hansen (1999).

For m = 2, the transition function has its minimum at (c1 + c2)/2 and attains the value 1 both at low and high values of qit. When $\gamma \to \infty$, the model becomes a three-regime threshold model whose outer regimes are identical and different from the middle regime. In general, when m > 1 and $\gamma \to \infty$, the number of distinct regimes remains at two, with the transition function switching back and forth between zero and one at c1, . . ., c_m. Finally, for any value of m, the transition function becomes constant when $\gamma \to 0$, in which case the model collapses into a homogeneous or linear panel regression model with fixed effects.

A generalization of the PSTR model to allow for more than two different regimes is the additive model of:

$$y_{it} = \mu_i + \beta_0^{'} x_{it} + \sum_{j=1}^{r} \beta_j^{'} x_{it} g_j(q_{it}^{(j)};\gamma_j, c_j) + u_{it} \tag{11}$$

Here, the transition functions $g_j(q_{it}^{(j)};\gamma_j, c_j)$, j = 1, . . ., r, are of the logistic type. If m = 1, $q_{it}^{(j)} = q_{it}$ and $\gamma_j \to \infty$, for all j = 1, . . . , r, then the model in equation (10) becomes the PSTR model with r + 1 regimes. Consequently, the additive PSTR model can be viewed as a generalization of the multiple regime panel threshold model in Hansen (1999). Additionally, when the largest model that one is willing to consider is the two-regime PSTR model with r = 1 and m = 1 or m = 2, then equation (10) plays an important role in evaluating the estimated model. In particular, the multiple regime equation (11) is an obvious alternative in the diagnostic tests for no remaining heterogeneity.

The set-up of the PSTR model consists of specification, estimation, and evaluation stages. Specification includes testing homogeneity, selecting the transition variable yit, and if homogeneity is rejected, then determining the appropriate form of the transition function – that is, choosing the proper value of m in equation (9). Statistically, the PSTR model is not identified if the data-generating process is homogeneous, and a homogeneity test is necessary to avoid the estimation of unidentified models. The estimation of parameters $\theta = (\beta_0^{'}, \beta_1^{'}, \gamma, c^{'})^{'}$ in the PSTR model is a relatively straightforward application of the fixed effects estimator and non-linear least squares. The evaluation of an estimated PSTR model is an essential part of the model-building procedure, including the tests of parameter constancy over time and of no remaining non-linearity.

3. EMPIRICAL RESULTS ANALYSIS

For the purpose of comparison, the sample period for the study covers ten years from January 2003 to June 2013 and comprises 703 electronic and information firms. The data were obtained from the Taiwan Economic Journal (TEJ) database.

Table 1 reports the descriptive statistics of the electronic and information firms' average ratios of the variables firm growth, size, age, debt, R&D, and FCF. The firm growth is between -97.86% to 17094% and the mean is 22.528%, showing that the firms have great differences in terms of revenue growth. We see that size is between 9.7953 (NT$ million) and 21.562 (NT$ million), which demonstrates a great size difference among the firms. Here, age is between 1 and 59 years, which explains which reveals/demonstrates a great size difference among the firms. Risk is between 0% and 118%, which denotes whether a firm issued a high- or low-business risk with the intention of increasing the firm's value. The debt is between 0% and 118%, and its mean is 40.662%, which explains the great difference between the high and low indicators and implies that the firm's overall operating performances had different financial policies. The R&D is between 0% and 233.25%, and its mean is 5.4127%, which implies manufacturers for R&D has a different degree, highlighting the fact that manufacturers do not give the same degree of attention to research and development. The FCF is between 141.68 and -119.77, and its mean is 3.989, which explains the great difference in FCF and implies that the firms' operating businesses have different financial policies too. In addition, all Jarque-Bera (J-B) statistics reject the null hypotheses of normality distribution.

Table 1. Summary statistics of electronic and information firms

	firm growth (%)	size (NT$ million)	age (year)	risk (%)	debt (%)	R&D (%)	FCF (NT$ million)
Mean	22.528	14.945	18	182.38	40.662	5.4127	3.9894
Std	238.40	1.4395	0.1026	356.24	17.460	8.8352	5.9236
Max	17094	21.562	59	8898.1	118.18	233.25	141.68
Min	-97.86	9.7953	1	0.000	0.000	0.00000	-119.77
Skewness	53.203	0.8014	0.0117	7.9879	0.19544	7.5470	223.736
Kurtosis	3534.1	1.3686	0.5619	108.35	-0.26744	30947	10192.3
J-B	8.169***	716.21**	1113.92***	69929.9***	99.3075***	578***	578***

Note: P-value is the probability that the data come with a normal distribution, according to the Jarque-Bera normality test.

In the empirical design, we set the size as the threshold variable and the control variables include age, research, FCF, debt, and risk. Table 2 presents the test of linearity results between the size and the firm growth. The LM, Fisher, and LRT linearity tests clearly lead to the rejection of the null hypothesis of linearity for the model. This result implies there is strong evidence that the relationship between size and the firm growth is non-linear.

We next apply a sequence of tests to determine the order m of the logistic function. In practice, it is usually sufficient to consider m = 1 (monotonically increasing with two regimes) or m = 2 (symmetric or exponential with three regimes) for the transition function, as these values allow for commonly encountered types of variation in the parameters. The results of the specification test sequence are shown in Table 3. We select m = 2 if the rejection of H_{02} is the strongest one. We find that the values are monotonically increasing in Figure 1.

Table 2. Test of linearity

H_0: linear model against H1: PSTR model with at least one threshold variable ($r \geq 1$)		
	Statistics	P-value
Wald Tests (LM)	92.145	0.000*

Fisher Tests (LM_F)	5.564	0.000*
LRT Tests (LRT)	92.715	0.000*

Notes: * denotes significant at the 5% level. The LM and pseudo LRT statistics have a chi-square distribution with mK degrees of freedom, whereas the F statistics have F (mK; TN – N- K (m + r + 1)) distribution. LM_F is its F-version. Pseudo LRT can be computed according to the same definitions by adjusting the number of degrees of freedom. For details, please see also Colletaz and Hurlin (2006).

Table 3. Sequence of homogeneity tests for selecting m

Select m=2 if the rejection of H02 is the strongest one; otherwise select m=1.		
	Statistics	P-value
H_{03}: B3=0	F3 = 1.450	0.115
H_{02}: B2=0|B3=0	F2 = 0.841	0.632
H_{01}: B1=0|B2=B3=0	F1 = 3.319	0.000*

Final model m=2

The next step is to determine the number of transitions in the model. Table 4 presents the test for no remaining non-linearity, which consists of checking whether there are two transition functions (H_0: $r = 1$) or whether there are at least three transition functions (H_1: $r = 2$). The testing results show that the reasonable number of thresholds is is r =2, which means that there are two regions. Each region has three regimes.

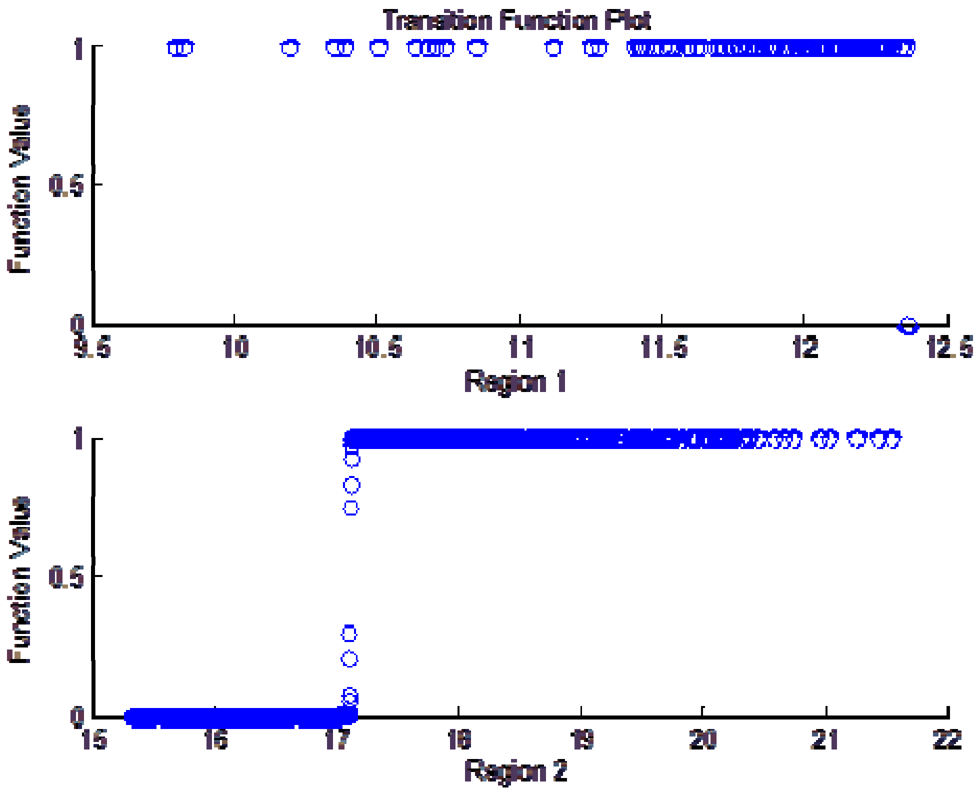

Figure 1. Transition function with m = 2.

Given the choices of rmax = 3 and m = 2, the optimal (LMF criterion) number of threshold functions is r = 1.

Table 4. Testing the number of regimes: Test of no remaining non-linearity

H0: PSTR with r = 1 against H1: PSTR with at least r = 2		
	Statistics	P-value
Wald Tests (LM)	24.20	0.000
Fisher Tests (LMF)	4.504	0.000
LRT Tests (LRT)	24.861	0.000
H0: PSTR with r = 2 against H1: PSTR with at least r = 3		
	Statistics	P-value
Wald Tests (LM)	5.842	0.322
Fisher Tests (LMF)	1.057	0.382
LRT Tests (LRT)	8.544	0.322

Notes: 1. * denotes significance at the 5% level.
2. max r=3, m=1, and the reasonable number of threshold is r=1.

Table 5 shows the parameters' estimate results of the PSTR models. The transition function is a logistic specification (m=2 with two regimes), C is the location parameters in the region, and the value is 12.3618 and 17.1112. The above result shows that there are structure changes at the point (see also Figure 1).

With regard to the age and firm growth, firm age is correlated and younger firms tend to grow faster than older ones. More detailed empirical analysis on the determinants of growth going beyond the traditional size–age growth relationship should be of great importance both for firm value and policymakers. For instance, Evans (1987a and b) examined the effect of firm size and age on growth, using data on manufacturing firms in the United States. It was found that younger and small-sized firms tend to grow. Haltiwanger, Jarmin and Miranda (2013) firm age does not fully explain our results. maller, developing/newly established firms grow faster than larger ones across the different age groups.. Liu, Tsou and Hammit (1999) find a negative relationship between the growth, age and size of firms. Almus and Nerlinger (2000), and Davidsson et al. (2002) all find an inverse relationship between firm age and growth, suggesting that older firms grow less rapidly than younger firms.

Our finding that small-scale firms are positively related to age (17.3393), implies that small-scale firm age and firm growth is a positive relationship, but not significant; the middle-scale firm age and firm growth is a negative relationship (-26.0179), but not significant. However, large-scale firm age and firm growth is a significant negative relationship (-61.5861), indicating that belong to younger firms that the impact on firm growth is large. From the practical insights, large and younger electronic firms have growth potential, due to their being more likely to be flexible organizations, and therefore it is more possible for them to make a contribution to revenue growth.

With regard to the finance policy and firm growth, most empirical literature supports the former view. For instance, Audretsch and Elston's (2002) empirical studied regarded a lack of financial resources as an important barrier to growth Lang, Ofek and Stulz (1996) and Ahn, Denis and Denis. (2006) all report a negative relation between investment and leverage and that the correlation is much stronger for firms with low growth. Firth, Lin and Wong (2008) obtain a negative relationship between leverage and investment among listed firms in China, and find that the connection is weaker in firms with low growth opportunities and poor operating performance.

Our study shows that there is a negative relationship between debt ratio and firm growth regarding small-scale firms, indicating that small-scale firms have more conservative financial policies to reduce the debt structure and enhance revenue growth. We also found that the middle-scale and large-scale firms have a positive relationship between debt ratio and firm growth, and in particular the large-scale firm's debt ratio coefficient (5.0227) is greater than that of the middle-scale (1.5360) firm and has a moresignificant relationship, therefore, we believe that the middle-scale firm and the large-scale firm raise the/their debt ratio and enhance revenue growth. In terms of FCF, we observed belong to small-scale firm have a positive relationship between free cash flow with firm growth, indicating that free cash flow for small-scale firm with good management, we think that the small-scale firm may be more difficult for external financing, therefore retain good free cash flow management, to meet the needs of external capital.

However, the middle-scale firm and large-scale firm that have a negative relationship between free cash flow with firm growth, on behalf of the middle-scale firm and large-scale firm are less good free cash flow management, may be they have more easier financing pipeline, so free cash flow does not have the benefit of management, especially in the middle-scale firm of the free cash flow's coefficient have very significant relationship.

Therefore, the goal of middle-scale firms and large-scale firms should strive to create value of free cash flow, combined with a good investment plan and professional management of free cash flow will help vendors more revenue growth.

With regard to the R&D and firm growth, a more detailed empirical analysis on the determinants of firm growth going beyond the traditional size–age growth relationship should be of great importance for R&D. Hall (1987) found that growth is positively related to R&D investments, and Harhoff, Stahl and Woywode (1998), in West Germany, examined the effect of diversification and financial structure on growth. Yasuda (2005) investigates the relationship between firm growth and firm size and firm behaviour, such as R&D and subcontracting. Audretsch and Mahmood (1995) also found that R&D intensity was positively correlated with a firm's survival.

The results show a significantly positive relationship between firm growth and R&D for all firms. In particular, a middle-scale firm's R&D coefficient (11.3717) is greater than that of the large-scale and small-scale firm, showing that middle-scale firms have the most-effective R&D coefficient (8.4340) revenue growth for the maximum benefit. We think that the firm has entered the scale of the organization, it will be able to pay attention to the benefits of R&D. In particular, the electronic information industry establishes its core competitiveness through paying more attention to its R&D. Establishing a market advantage, therefore, to maintain an efficiency of R&D is important. From a risk perspective, we found that the large-scale firm's R&D is less efficient than that of the middle-scale firm, and this may increase the business risk for the large-scale firm.With regard to the business risk and growth, the main contribution of this paper is the consideration of a large set of potential determinants of firm growth, such as business risk. Business risks have different origins and natures, and that is why the management of such a portfolio should be complex, taking the specific characteristics of the internal connections between the risks in the portfolio into account. Risk strategy researchers have paid considerable attention to the risk–return trade-off when assessing corporate strategy (Bowman,

1980) and have used numerous accounting measures of risk and return to evaluate that trade-off. For example, Bettis and Mahajan (1985) showed that a trade-off exists between profitability and risk; in their findings, firms that diversified into unrelated businesses usually had lower returns on assets (ROA) than firms that did not do so. However, the ROAs of the unrelated diversifiers also had lower standard deviations of ROA, representing lower risk. Although many have used accounting measures of return and risk, other authors have questioned the measures' applicability to strategy evaluation because they reflect past investment decisions and do not appropriately capture the expected future cash flows a firm's stock of assets could generate.

Furthermore, for companies who own small-scale firms (firm size less than 12.3618), there is a significantly decreasing relationship between business risk and firm growth, which implies that small firms will have a more conservative approach to firm management, such as having lower debt ratio financial management policies, or will make effective investment in R&D, and it may be that the small-scale firm has less external resource conditions than the large firms, so the manager will manage the firm with a more conservative approach. But when the firm size is greater than 12.3618, the relationship between business risk and firm growth turns out to be significantly positive. We further show that this implies that a middle-scale and large-scale firm will adopt a positive attitude in their firm management. For example, they may have a higher debt ratio financial management policy, or the operator adopts a more high risk approach to financial operations in order to gain more revenue growth. However, the middle-scale and large-scale firm usually lack a risk management department and/or risk management professionals, so they often create financial risk by taking risks with orders and so on..

The Taiwan electronic and information industry's firm growth and firm size present a non-linear relationship. The different firm size attributes of firm produce completely different firm growth. To investigate whether the firm's growth theory is different from the past, we added business risk under different sized firms in an attempt to understand the structure of the relationship between firm growth and business risk. We observed that business risks differ between different-sized firms, and that large-scale firms in particular face a higher risk in the pursuit of revenue growth.

However, business risks represent uncertainty for a firm and so are often overlooked. When a firm enters the large-scale stage it should ensure that it has risk management expertise. In addition, we also explore the relationship between FCF and revenue growth. Although we recognize the importance of FCF, we find, in our empirical results, that the large-scale firm lacks in management in this regard. Therefore, large-scale firms should strive for a strengthening in the management of FCF in order to develop.

Table 5. Parameter estimation results for the PSTR model

	small-scale firm	middle-scale firm	large-scale firm
age	17.3393 (30.5500)	-26.0179 (68.1274)	61.5861*** (21.1538)
risk	-0.0378 *** (0.0099)	0.0874*** (0.0602)	0.2192 *** (0.2651)
debt	-0.0941 (0.1893)	1.5360 (3.6709)	5.0227 *** (2.7805)
R&D	1.2908*** (0.6149)	11.3717*** (3.9320)	8.4340 (9.1013)
FCF	0.0005 (0.0005)	-0.0010*** (0.0007)	-0.0015 (0.0005)
(C1)	(12.3618) (17.1112)		
(γ1)	(-4.6481) (0.0040)		
SSE	354906436.730		

Notes: 1. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
2. C is location parameters; γ is slope parameter (smooth parameter or transition speed).

4. CONCLUSION AND REMARKS

In this article, we have used the PSTR model to re-examine the non-linear dynamic relationships between firm growth and firm size in the Taiwan electronic and information industry. We find strong evidence that the relationship between firm size and firm growth is non-linear and that there is a trade-off correlation between these values and firm growth. Our empirical results show that the Taiwan electronic and information industry will be different under the firm size threshold value and the control variables of age, FCF, R&D, risk and debt ratio. Moreover, the different firm size attributes of the electronic and information industry produce completely different firm growth.

As to the firm growth, we conclude that companies who own small-scale firms (firm size less than 12.3618) will prefer to control the firm at a low business risk. We also find that these firms do not choose to expand their loans in comparison with middle-scale and large-scale firms. These small-scale firms may think that they have less external resource conditions than the middle-scale and large-scale firms. Conversely, the electronic and information industry who own middle-scale and large-scale firms (firm size is greater than 12.3618) will prefer to operate taking ahigh business risk.

In order to observe the financial policy in the series, we study the relationship between debt ratio, FCF and firm growth. We find a non-significant relationship between low-debt ratio and firm growth in firms with a low debt ratio (firm size is less than 12.3618), indicating that small-scale firms tend to work with a low-debt ratio for firm growth.

Furthermore, companies who own middle-scale and large-scale firms (firm size is greater than 12.3618) in the electronic and information industry do not perform well in the management of FCF and consequently there is a decreasing relationship between FCF and firm growth. But for companies who own small-scale firms (firm size is less than 12.3618), the relationship between FCF and firm growth turns out to be significantly positive. We further show that no matter the size of the firm, the higher the FCF the more appropriate will the debt ratio be to firm growth.

We recommend that firms should measure business risk and firm growth. High leverage risk does not necessarily mean a higher firm growth. In sum, business risk is an important index when looking at firm growth.

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