

CAPITAL STRUCTURE FOR MULTINATIONAL INTER- AND INTRA-FIRM INNOVATION COLLABORATIONS

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ABSTRACT

This study investigates how two competing capital structure theories: the pecking order and the static trade-off models, impact financing decisions in multinational inter- and intra-firm innovation collaborations. The results show that for the pecking order model, debt repayment, working capital, capital expenditure and operating cash flow are the main variables determining a deficiency in internal funds, as well as the key determinants of capital structure in multinational inter-firm innovation collaborations. Working capital is the main variable determining a deficiency in internal funds and the key determinant of capital structure in multinational intra-firm innovation collaborations. In contrast, for the static trade-off model, size and uniqueness are key variables determining capital structure in multinational inter-firm innovation collaborations. Growth and uniqueness are key variables determining capital structure in multinational intra-firm innovation collaborations. This study fills a gap in the existing research on the capital structure policy of multinational inter- and intra-firm innovation collaborations, and describes capital structure determinants in polar multinational business expansion models.

Keywords: Capital Structure, Pecking Order, Static Trade-off, Inter-firm, Intra-firm

1. INTRODUCTION

Given the strategic importance of overseas expansion to firm growth [5, 32, 55], the present study draws upon the resource-based view to argue that specific and unique resources play a pivotal role in determining the success of a firm's overseas expansion. Innovation is the most specific and unique resource in today's environment of dynamic international competition. Multinational firms require a multitude of innovation resources to achieve a sustainable competitive advantage.

However, multinational firms that invest in innovation resources development alone in different countries will incur high transaction costs and always surrounds multinational innovation activities information asymmetry. Furthermore, uncertainty [20]. Market transactions may help to redress a firm's lack of innovation resources, but in fact, such

transactions are difficult to organize. Collaborative agreements are a better option than pure market transactions; they also eliminate some of the information asymmetry and high transaction costs. Collaborative internalizing is relatively low cost and offers the benefits of flexibility and autonomous adaptation [61]. Firms that face pressure from competitors but lack internal innovation resources can rapidly gain such resources via collaboration; collaboration is an important means of acquiring innovation-specific resources [26] and the best way to use resources to accelerate innovation activities worldwide [4, 6, 8, 56]. Inter- and intra-firm collaborations enable multinational firms to overcome limitations in innovation resources, enter new markets and hedge against environmental uncertainties. Inter- and intra-firm collaborations allow individual firms to expand international growth and enhance their competitive position [2, 13]. Entering into inter- or intra-firm collaborations to

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rapidly acquire external innovation resources is a natural competitive response [37].

Investing in innovation is necessary in dynamic global markets, and in response to international competition. In fact, there is often a link between investing in innovation and financial distress. Multinational firms that invest in innovation development alone in overseas markets are usually burdened with high transaction costs [29] and face an enduring high risk of bankruptcy [3]. Inter- or intra-firm collaborations allow individual firms to combine innovation resources and specific knowledge to exploit complementarities and upgrade market power [11, 14, 18, 24, 28, 30]. They can also decrease transaction costs and reduce the risk of bankruptcy; therefore, inter- and intra-firm collaborations can offer firms in financial distress a fortuitous opportunity to invest in innovation. How inter- and intra-firm collaborations are employed to choose the optimal leveraging to efficiently develop or extend their innovation power to enhance competition in tumultuous international markets is always an important management issue. This issue, first discussed by Myers [44], is at the heart of capital structure policy. Subsequent studies have expanded this initial discussion to include agency problems, information asymmetry and pecking order considerations. This research has also identified a number of factors that help to explain variations in firms' capital structure policy. According to Modigliani and Miller's [42] static trade-off theory (STOT), the optimal capital structure policy depends on trade-offs between various costs and benefits; the primary advantage of debt is the tax deductibility of the interest. In contrast, according to Donaldson's [21] pecking order theory (POT) of information asymmetry, firms use debt in a hierarchical sequence: Firms choose a capital structure policy according to their internal financing, debt and equity, in that order. Myers [44] and Myers and Majluf [45] also argue that firms should avoid the threat of high information asymmetry and transaction cost. Thus, the most preferred source of funds is internal funds (e.g., retained earnings); if external financing is needed, a firm first seeks out low-risk debt (capital structure policy) and uses external equity financing only as a last resort.

Many multinational firms have started to pay increased attention to developing multinational innovation resources [35]. They see collaboration as much more efficient and a more fruitful source of resources; they rely on multinational inter- or intra-firm collaborations to combine or acquire various innovation resources from partners and use finances to effectively maximize firm value. Previous studies of capital structure, such as Teker et al. [57], find that return on assets and tangibility of assets positively affect a firm's leverage ratio;

Shanmugasundaram [51] shows that the growth rate of assets is positively related to a firm's capital structure. These findings do not seem consistent with the features of multinational innovation collaborations, which aim to decrease the expenditure of tangibility assets via collaborations. Furthermore, multinational innovation firms usually face the pressures of market competition, require continued investing in innovation activities, face high risk and growth uncertainty, and even receive a low return on their assets. That existing empirical findings seem ill-matched to the realities of multinational inter- and intra-firm innovation collaborations, and seem to ignore the determinants of capital structure among such collaborations, represents a gap in the capital structure policy research. The present paper attempts to address this gap by theoretically analyzing and empirically defining which of two capital structure policies: STOT or POT, is more applicable to multinational inter- and intra-firm innovation collaborations, and what determinants can explain variations in the optimal capital structure policy of such collaborations. Following Williamson [61], the authors define multinational inter-firm collaboration as being based on incentive and involving autonomous and contract law-based multinational cooperation and inequitable relationships between partners. The authors define multinational intra-firm collaboration as involving a high degree of administrative control; bilateral dependency; more formal, orchestrated organizations; and more equitable relationships.

2. THE RELATION BETWEEN CAPITAL STRUCTURE POLICY AND INNOVATION COLLABORATION

Modigliani and Miller [41] propose that under perfect market conditions, a firm's debt leveraging would have no influence on the value of the firm. In fact, information asymmetry and transaction costs characterize real market activities. The cost of financing is usually an outcome of information asymmetry, which leads to different payments of transaction costs. Hennart and Park [31] argue that pure market transactions involve adverse selection of ex-ante and moral hazard of ex-post; consequently, only internalized market transactions can address the problems of high information asymmetry and transaction costs. Multinational expansion may provide more growth opportunities, but it also involves greater information asymmetry and higher transaction costs. Furthermore, it is impossible for a single firm to possess all expensive innovation resources; yet in the face of pressure from

competitors, a firm can acquire the various innovation resources it lacks through collaboration relationships with other firms. Entering into an inter- or intra-firm collaboration is a good strategic option and a way to promote financial complementarity. Different collaborations lead to different agency behavior, information asymmetry and financing cost payments; these, in turn, lead to a different capital structure policy. However, this study is based on the premise of multinational inter- and intra-firm innovation collaboration, and still needing to issue new debt (financing activities) to cope with the needed of innovation activities to develop these hypotheses and validated.

2.1 Determinants of POT in Multinational Inter- and Intra-Firm Innovation Collaborations

Although Donaldson [21] was the first to address POT, Myers[44] and Myers and Majluf[45] provide a theoretical explanation for how firms choose to finance given different degrees of information asymmetry and transaction costs. Internal funds (e.g., retained earnings) are used when there is low information asymmetry and transaction costs because of fixed obligations. Firms that rely on external equity usually need to pay higher dividends to external investors; this frequently leads to high transaction costs. Thus, firms issue new debt when their internal funds are insufficient to pay for business expansion; debt typically increases when investments exceed retained earnings, or when investment earnings are less than retained earnings. The corresponding capital structure policy involves a firm issuing new debt instead of using retained earnings to finance its expansion. Consistent with POT, Fama and French [23] show that highly profitable firms are less leveraged and that firms with greater investment opportunities are more leveraged. Furthermore, Shyam-Sunder and Myers [53], focusing on key quantitative predictions of the pecking order, find a positive relation between leverage and expected investment by the POT model. Multinational inter- and intra-firm innovation collaborations result in more growth opportunities and expected investments (e.g., innovation activities), which frequently leads to a deficiency in internal funds. Therefore, in order to decrease information asymmetry and transaction costs, firms will rely on low-cost debt financing rather than issuing new shares to outside shareholders.

However, multinational expansion requires substantial funds, even in the context of inter- and intra-firm collaborations. Ahmed and Hisham[1] argue that an insufficiency of internal funds is the most important determinant for the issuance of new debt. Martin and Scott [39], Myers[44], Shyam-Sunder and Myers[45], and Frank and Goyal [25] find that dividend payment is an expensive use of

external funds. Making dividend payments obviously decreases the amount of internal funds and increases the need for debt financing; that is why a positive relationship between dividend payments and debt can be expected. Therefore, we propose the following hypothesis:

H1: There is a positive association between the issuance of new debt and dividend payment in multinational inter- and intra-firm innovation collaborations.

Multinational innovation collaboration involves complementary systems of resources. But investing in innovation development still requires substantial funds; this will result in a serious shortage of internal funds. Ahmed and Hisham[1], Frank and Goyal [25], and Liang and Bathala [38] use POT to examine firms' issuance of new debt as it relates debt repayment; they find that there is a positive association. Therefore, we propose the following hypothesis:

H2: There is a positive association between the issuance of new debt and debt repayment in multinational inter- and intra-firm innovation collaborations.

Not all innovation investing involves current assets; research and development (R&D) expenses, various costs, wages, royalty fees, and so on, are non-current assets but nevertheless necessary expenditures during innovation development. This huge outlay of working capital will lead to a deficiency in internal funds. Shyam-Sunder and Myers [53] examine long-term debt as a part of the financing deficit and its role in change in working capital. Ahmed and Hisham [1] argue that change in working capital is an important determinant of the issuance of new debt. Therefore, we propose the following hypothesis:

H3: There is a positive association between the issuance of new debt and change in working capital in multinational inter- and intra-firm innovation collaborations.

Investing in innovation is an expensive capital expenditure that requires many different resources, including technology, equipment and know-how. This huge capital expenditure will lead to a shortage of internal funds. Empirical results from Ahmed and Hisham [1] and Frank and Goyal [25] show that there is a positive association between the issuance of new debt and capital expenditure. Therefore, we propose the following hypothesis:

H4: There is a positive association between the issuance of new debt and capital expenditure in multinational inter- and intra-firm innovation collaborations.

Ahmed and Hisham [1], Myers [44], and Shyam-Sunder and Myers [45] argue that firms require external financing when operating cash flow is insufficient. Yet, opportunistic managers or owners may feel uncomfortable relinquishing control over the firm by issuing equity to outside investors when operating cash flow is insufficient. Therefore, the firm can issue debt securities rather than issue new shares to outside shareholders. This study extends Ahmed and Hisham's [1], Frank and Goyal's [25], and Liang and Bathala's [38] arguments that relate the issuance of new debt to a shortage of operating cash flow. Therefore, we propose the following hypothesis:

H5: There is a positive association between the issuance of new debt and operating cash flow in multinational inter- and intra-firm innovation collaborations.

2.2 Determinants of STOT in Multinational Inter-and Intra-Firm Innovation Collaborations

According to Myers's [44] STOT, a firm's optimal debt ratio is determined as a trade-off of the cost and benefits of borrowing. These costs include: bankruptcy costs [49], agency costs [34] and loss of debt tax shields [19], and are especially relevant in situations of financial distress. STOT has two important implications. First, firms with a greater proportion of tangible capital expenditures and innovation expenditures frequently have a large tax shield. Therefore, firms with more opportunities for growth (and thus a higher tax shield effect) are likely to have a higher debt ratio, and the cost of financing is likely to be lower. Second, high uncertainty in terms of innovation input usually leads to less certainty in terms of profits, which means a higher deadweight of bankruptcy and a higher cost of debt financing. Therefore, having greater growth or expansion opportunities counteracts the effect of debt tax shields. Because optimal STOT leveraging is determined by balancing the tax advantages of debt against the deadweight costs of bankruptcy, tax shield variables are key factors in capital structure decisions [23, 44, 57]. Therefore, the value of firms' financing depends on real variables that reflect differences in capital structure policy related to growth opportunities.

Frank and Goyal [25] argue that tangible assets constitute a form of secured collateral that has a positive effect on financing leveraging. Chittenden et al. [16], Stohs and Mauer [54] and Titman and Wessels [58] all find a positive relationship between

tangibility of assets and long-term debt. Having tangible assets may alleviate the agency costs associated with debt [34, 43]. STOT predicts that a higher proportion of fixed assets leads to a higher debt ratio because the fixed assets have high collateral value, which results in a lower risk of financial distress. Tangible R&D equipment is a natural component of the innovation exploitation process. This equipment acts as a tax shield, and is usually mortgaged to finance debt. Therefore, we propose the following hypothesis:

H6: There is a positive association between the issuance of new debt and the tangibility of assets (TA) in multinational inter- and intra-firm innovation collaborations.

Castanias [15] and Shapiro and Titman [52] believe that the main reason managers are unlikely to issue new debt is because of the risk of bankruptcy. They argue that larger firms have more chance of becoming diversified and thus have a relatively low risk of bankruptcy. Warner [60] finds that smaller firms always have higher bankruptcy costs. Barclay et al. [9], Crutchley and Hansen [17] and Rajan and Zingales [47] all find that size affects leveraging decisions. Multinational innovation collaborations can be considered a kind of expansion for the purpose of reducing bankruptcy risk, acquiring more innovation resources, acquiring financing resources, and so on. Hence, we propose the following hypothesis:

H7: There is a positive association between the issuance of new debt and firm size (SIZE) in multinational inter- and intra-firm innovation collaborations.

In addition to interest, which is tax deductible, multinational firms can usually acquire other tax reductions and local investment tax credits. Furthermore, firms that can claim other tax shields, such as tax deductions for depreciation, have less need to exploit debt tax shields. De Angelo and Masulis [19] argue that non-debt tax shields include all non-interest tax deductions made from a firm's taxable income, such as depreciation expenses for fixed assets or R&D investment and investment tax credits. Therefore, firms with higher non-debt tax shields are less likely to issue new debt, as one motivation for using debt securities is to obtain the tax shield benefit from debt financing. Consequently, non-debt tax shields should be inversely related to debt ratio. In line with Gajdka [27] we propose the following hypothesis:

H8: There is a negative association between the issuance of new debt and non-debt tax shields

(NDTS) in multinational inter- and intra-firm innovation collaborations.

Growth represents a significant development in market operation and usually requires a great deal of investment in R&D. Jensen [33], Myers [44] and Titman and Wessels [58] all note that firms with more investment opportunities have less need for debt leveraging because of high interest rates or restrictive covenants, which discourage the taking on of debt. STOT suggests that firms with more investment opportunities are less leveraged because they have stronger incentives to avoid under-investment and asset substitution that can arise from stockholder–bondholder agency conflicts [22]. Therefore, we propose the following hypothesis:

H9: There is a negative association between the issuance of new debt and growth (GO) in multinational inter- and intra-firm innovation collaborations.

Risk is usually inversely related to debt ratio. In firms with more variable cash flows, higher business risk always leads to a higher probability of bankruptcy [40]. Furthermore, business risk involves a potential risk of default, thus leading to high earnings volatility. Thus, risk-averse managers tend to avoid excessive debt levels. Multinational innovation activities always involve potential risk, even when inter- or intra-firm collaborations are used to reduce this risk. In fact, multinational firms always have higher uncertainty business risk than traditional firms. Hence, we propose the following hypothesis:

H10: There is a negative association between the issuance of new debt and risk (RISK) in multinational inter- and intra-firm innovation collaborations.

Highly profitable firms always satisfy their demands for capital by investing their retained earnings. Therefore, profitability implies the high likelihood of having sufficient cash to decrease the need for leveraging. Jensen [33] argues that a negative relationship exists between the issuance of new debt and profitability in the case of an ineffective market for corporate control because, if firms have high profits but are under ineffective management, lenders may refuse to lend funds to these firms. Vasiliou et al. [59] also advocate a negative relationship between profitability and leveraging. Because the high degree of uncertainty in the multinational innovation exploitation process results in ineffective control of profits, we propose the following hypothesis:

H11: There is a negative association between the issuance of new debt and profitability (PT) in multinational inter- and intra-firm innovation collaborations.

According to STOT, unique products are connected to higher bankruptcy costs; thus, unique products should also carry a lower ratio of debt to equity. Gajdka [27] finds no significant relationship between uniqueness and debt level. However, Mazur [40] reports that firms with unique products invest significantly in R&D to stay competitive; Titman and Wessels [58] note that such firms are expected to advertise more and to spend more promoting and selling their products. Consequently, product uniqueness is related to bankruptcy cost. Therefore, we propose the following hypothesis:

H12: There is a negative association between the issuance of new debt and uniqueness (UNI) in multinational inter- and intra-firm innovation collaborations.

Ozkan [46] argues that a negative relationship may stem from conflicts between shareholders and bondholders because the greater a firm's liquidity, the more easily shareholders can manipulate the liquid assets at the expense of the bondholders. Nevertheless, liquidity can also have a positive effect, in that high liquidity eases the availability of debt. The majority of empirical evidence shows that being highly liquid (cash rich) reduces a firm's need to take on debt [12, 47, 57]. Therefore, we propose the following hypothesis:

H13: There is a negative association between the issuance of new debt and liquidity (LIQ) in multinational inter- and intra-firm innovation collaborations.

3. METHODS

3.1 Definition of the Variables

In line with POT, we argue that new debt increases as a result of dividend payment, debt repayment, change in working capital, capital expenditure and operating cash flow. Therefore, we propose a positive association between the issuance of new debt and dividend payment, debt repayment, change in working capital, capital expenditure and operating cash flow. The dependent variables included: dividend payment, debt repayment, change in working capital, capital expenditure, and operating cash flow. The independent variable was new debt. The variables in the POT model were defined following Ahmed and Hisham [1] as follows:

1. ΔD_{it} is the change in new debt issued for firm i at period t

2. DIV_{it} is the dividend paid at period t for firm i
3. R_{it} is the amount of repaid long-term debt at period t for firm i
4. ΔWC_{it} is the change in working capital at period t for firm i
5. X_{it} is capital expenditure at period t for firm i
6. CFO_{it} is operating cash flow at period t for firm i

The STOT explanatory variables studied here were selected based on alternative capital structure theories and previous empirical work. The STOT variables can be summarized as follows:

1. Tangibility of assets (TA) influences the issuance of new debt because fixed assets can serve as collateral. Having more collateral may alleviate agency costs of debt [34, 43]. STOT predicts that the greater the proportion of fixed assets, the higher the debt ratio, because fixed assets are high in collateral value, which results in a lower risk of financial distress. Therefore, tangibility of assets was measured as the proportion of gross fixed assets to total gross assets [51].
2. With regard to size (SIZE), larger firms have plentiful resources to more easily access the market and acquire market information; thus, they tend to be more diversified. Because information asymmetry is not as great, larger firms can more easily acquire revenue from market competition [45, 40]. In this study, size was measured as net revenue from total assets [40].
3. Non-debt tax shields (NDTS) include all non-interest tax deductions made from a firm's taxable income, such as depreciation expenses on fixed assets or R&D costs. Non-debt tax shields should be inversely related to debt ratio. This study adopted Teker et al.'s [57] use of the ratio of total depreciation to total assets (total depreciation/total assets) to measure non-debt tax shields.
4. Growth (GO) represents a significant development in business and revenue [1]. Three proxies commonly used to measure growth opportunities are: the average growth rate of total assets, the average growth rate of revenue from sales and the ratio of long-term investments to total assets. Given the high degree of market business risk and uncertainty in sales revenues in multinational innovation industries, this study adopted Mazur's [40] strategy of using the average growth rate of revenues from sales (revenues/sales income) to measure growth.
5. Risk (RISK) is usually reported in terms of variable cash flow and potentially high earnings volatility [40]. The high degree of uncertainty and market risk always leads to high earnings volatility. In the existing literature, standard deviation, variation and percent change in operating earnings are the most frequently used

measures of business risk. This study followed Mazur [40] and Shanmugasundaram [51] and used the standard deviation of the percent change in operating earnings to measure risk.

6. With regard to profitability (PT), firms usually face a high degree of uncertainty in the innovation exploitation process because the link between investing in innovation and profits is unpredictable. This study followed Bayless and Diltz [10] and Shanmugasundaram [51] and measured profitability as operating income as measured by total assets (earnings after taxes + interest expenses $[1 - \text{tax rate}]/\text{total assets}$).
7. With regard to uniqueness (UNI), firms that produce unique products have higher expenses and thus should have higher bankruptcy costs. Similarly, such firms usually need to invest in human resources and materials, which can lead to excessive overhead costs. This study thus followed Gajdka [27] and Titman and Wessels [58] and used the ratio of overhead and selling expenses to sales ($(\text{overhead} + \text{selling expenses})/\text{sales}$) to measure uniqueness.
8. Liquidity (LIQ) can be considered negative debt, as it reduces a firm's need to take on new debt [48]. Jensen [33] reports that when a firm is liquid (or cash rich), variation in cash flow is very low and the company's funds are ample. Therefore, this study adopted Jensen's [33] ratio of current average cash balance to total assets as a measure of liquidity.

3.2 Sample Selection

The authors examined the determinants of optimal capital structure in Taiwanese multinational inter- and intra-firm innovation collaborations. Taiwan is an appropriate setting for testing our hypotheses because Taiwan's exports are booming, especially in the high-tech innovation industry. High-tech innovation industry adopts Shanklin and Ryan's [50] definition following three criteria: a strong science and technology base, new technology to rapidly weed out existing technology and the application of new technologies can create market demand. The samples include: information technology (24%), electronics (21%), electrical engineering (19%), metals (15%), chemicals (11%), energy (6%) and light industry (4%). However, the authors sampled multinational high-tech innovation firms engaged in inter- or intra-firm collaborations with other high-tech firms. Following Williamson [61], the authors defined inter-firm innovation collaborations as being based on incentive and autonomous and contract law-based cooperation, and as being marked by inequitable and real collaboration (formal cooperation agreements and actual business transactions) between partners. The authors considered intra-firm innovation collaborations as

involving a high degree of administrative control; bilateral dependency; and more formal, orchestrated organization; moreover, the firms had to hold more than 20% of their own shares in order to have decision-making influence over their partner firms. The authors examined 201 inter-firm and 117 intra-firm collaborations from among 1,554 high-tech innovation firms in Taiwan.

3.3 Modeling Procedures

The statistical models covered an 8-year period from 2002 to 2009. We examined optimal capital structure using firm year as the unit of analysis, with firm-year records for our basis. Therefore, panel data were used in this study. We obtained the data from balance sheets, income statements and cash flow statements from the Taiwan Economic Journal database, Taiwan's largest and most detailed financial database. We used general linear squares

random-effects models to test the hypotheses. General linear squares models correct for the presence of autocorrelation and heteroscedasticity in pooled times series data [36]. Using the Hausman test [7], we compared our random-effects models to fixed-effects models; the random-effects models were preferred in POT cases, while the fixed-effects models were preferred in STOT cases.

4. RESULTS

4.1 POT Model

Correlations for the POT model for multinational inter- and intra-firm innovation collaborations are presented in Table 1 and Table 2. Results of the regression analysis are presented in Table 3.

Table 1: Correlations for the pecking order model of multinational inter-firm innovation

	D_{it}	DIV_{it}	R_{it}	ΔWC_{it}	X_{it}	CFO_{it}
D_{it}	1.000 (—)					
DIV_{it}	.223*** (.000)	1.000 (—)				
R_{it}	.498*** (.000)	-.048 (.250)	1.000 (—)			
ΔWC_{it}	.524 (.078)	.427*** (.000)	.455*** (.000)	1.000 (—)		
X_{it}	.506 (.089)	.098 (.083)	.490 (.107)	.415*** (.000)	1.000 (—)	
CFO_{it}	.396 (.103)	.542*** (.000)	.151 (.016)	.517 (.082)	.323*** (.000)	1.000 (—)

Note1: *** $p < 0.05$

Note2: D_{it} , new debt issued for firm i at period t ; DIV_{it} , dividend paid at period t for firm i ; R_{it} , amount of repaid long-term debt at period t for firm i ; ΔWC_{it} , change in working capital at period t for firm i ; X_{it} , capital expenditure at period t for firm i ; CFO_{it} , operating cash flow at period t for firm i .

Table 2: Correlations for the pecking order model of multinational intra-firm innovation collaborations

	D_{it}	DIV_{it}	R_{it}	ΔWC_{it}	X_{it}	CFO_{it}
D_{it}	1.000 (—)					
DIV_{it}	.597 (.807)	1.000 (—)				
R_{it}	.552 (.067)	.562*** (.000)	1.000 (—)			
ΔWC_{it}	.459*** (.000)	.330 (.091)	.575 (.120)	1.000 (—)		
X_{it}	.446 (.059)	.586*** (.000)	.571 (.091)	.399*** (.000)	1.000 (—)	
CFO_{it}	.430*** (.000)	.548 (.406)	.568*** (.000)	.431 (.078)	.439 (.401)	1.000 (—)

Note1: *** $p < 0.05$

Note2: D_{it} , new debt issued for firm i at period t ; DIV_{it} , dividend paid at period t for firm i ; R_{it} , amount of repaid long-term debt at period t for firm i ; ΔWC_{it} , change in working capital at period t for firm i ; X_{it} , capital expenditure at period t for firm i ; CFO_{it} , operating cash flow at period t for firm i .

The regression results for the POT model reveal significant evidence for the possible explanation of the issuance of new debt, with an adjusted R-squared of 87.8% and a significant Wald test on the inclusion of variables for inter-firm collaborations, and an adjusted R-squared of 85.4% and a significant Wald test on the inclusion of variables for intra-firm collaborations. Debt repayment, change in working capital, capital expenditure, and operating cash flow are positively associated with the issuance of new debt at the 5% level for inter-firm collaborations. Furthermore, working capital is positively associated with the

issuance of new debt at the 5% level for intra-firm collaborations. Therefore, H2, H3, H4, and H5 are supported for inter-firm collaborations, and H3 is supported for intra-firm collaborations.

4.2 STOT Model

Correlations for the STOT model for multinational inter- and intra-firm innovation collaborations are presented in Tables 4 and 5.

Results of the regression analysis are presented in Table 6.

Table 3: Regression results for the pecking order model of multinational innovation collaborations

Variable	Inter-firm		Intra-firm	
	Coefficient	P-value	Coefficient	P-value
DIV_{it}	-.256	.276	-.549	.027***
R_{it}	.768	.000***	-.164	.204
ΔWC_{it}	.743	.000***	.241	.000***
X_{it}	.304	.004***	.052	.489
CFO_{it}	.451	.001***	.043	.714
Adjusted R-squared	.878		.854	
Wald X^2	165.64***		61.76***	

Note1: ***p<0.05 (two-tailed tests)

Note2: DIV_{it} , dividend paid at period t for firm i; R_{it} , amount of repaid long-term debt at period t for firm i; ΔWC_{it} , change in working capital at period t for firm i; X_{it} , capital expenditure at period t for firm i; CFO_{it} , operating cash flow at period t for firm i.

Table 4: Correlations for the static trade-off model of multinational inter-firm innovation collaborations

	D_{it}	TA	SIZE	NDTS	GO	RISK	PT	UNI	LIQ
D_{it}	1.000 (—)								
TA	.007 (.463)	1.000 (—)							
SIZE	.407*** (.000)	-.539 (.089)	1.000 (—)						
NDTS	.059 (.201)	.801 (.903)	-.420*** (.000)	1.000 (—)					
GO	-.303*** (.000)	-.065 (.180)	.015 (.414)	-.015 (.417)	1.000 (—)				
RISK	.014 (.420)	-.012 (.434)	-.085 (.116)	-.020 (.388)	-.074 (.147)	1.000 (—)			
PT	-.468 (.078)	-.211*** (.001)	.084 (.119)	-.193 (.065)	.649 (.105)	-.176 (.066)	1.000 (—)		
UNI	-.282*** (.000)	.043 (.273)	-.355*** (.000)	-.066 (.178)	-.561*** (.000)	-.010 (.443)	-.200 (.064)	1.000 (—)	
LIQ	-.455 (.105)	-.381*** (.000)	-.013 (.428)	-.248*** (.000)	.192 (.071)	-.077 (.138)	.418*** (.000)	.175 (.077)	1.000 (—)

Note1: ***p<0.05

Note2: D_{it} , new debt issued for firm i at period t; TA, tangibility of assets; SIZE, firm size; NDTS, non-debt tax shield; GO, growth; RISK, risk; PT, profitability; UNI, uniqueness; LIQ, liquidity.

Table 5: Correlations for the static trade-off model of multinational intra-firm innovation collaborations

	D_{it}	TA	SIZE	NDTS	GO	RISK	PT	UNI	LIQ
D_{it}	1.000 (—)								
TA	-.042 (.327)	1.000 (—)							
SIZE	.471*** (.000)	-.330*** (.000)	1.000 (—)						
NDTS	-.041 (.329)	.829 (.201)	-.471 (.113)	1.000 (—)					
GO	-.372*** (.000)	.073 (.216)	-.239 (.005)	-.037 (.344)	1.000 (—)				
RISK	-.013 (.433)	-.028 (.384)	.001 (.494)	.055 (.278)	-.005 (.478)	1.000 (—)			
PT	-.323 (.105)	-.231*** (.006)	.094 (.157)	-.291 (.056)	.772*** (.000)	.017 (.427)	1.000 (—)		
UNI	-.304*** (.000)	-.018 (.424)	-.355*** (.000)	-.094 (.156)	-.255 (.063)	-.009 (.463)	-.255 (.063)	1.000 (—)	
LIQ	-.327 (.065)	-.446*** (.000)	.074 (.214)	-.337*** (.000)	.131 (.079)	-.050 (.295)	.241 (.054)	.093 (.161)	1.000 (—)

Note1: *** $p < 0.05$

Note2: D_{it} , new debt issued for firm i at period t ; TA, tangibility of assets; SIZE, firm size; NDTS, non-debt tax shield; GO, growth; RISK, risk; PT, profitability; UNI, uniqueness; LIQ, liquidity.

The regression results for the STOT model reveal significant evidence for the possible explanation of the issuance of new debt, with an adjusted R-squared of 74.6% and a significant F test on the inclusion of variables for inter-firm collaborations, and an adjusted R-squared of 80.0% and a significant F test on the inclusion of variables for intra-firm collaborations. As expected, firm size is

positively related to the issuance of new debt at the 5% level, and uniqueness is negatively related to the issuance of new debt at the 5% level for inter-firm collaborations, supporting H7 and H12. Growth and uniqueness are negatively associated with the issuance of new debt at the 5% level for intra-firm collaborations, supporting H9 and H12.

Table 6: Regression results for the static trade-off model of multinational innovation collaborations

Variable	Inter-firm		Intra-firm	
	Coefficient	P-value	Coefficient	P-value
TA	.069	.216	-.209	.000***
SIZE	.022	.039***	.022	.089
NDTS	.009	.961	-.247	.251
GO	-.032	.219	-.614	.000***
Variable	Inter-firm		Intra-firm	
	Coefficient	P-value	Coefficient	P-value
RISK	-.004	.923	.138	.114
PT	-.003	.896	.268	.000***
UNI	-.272	.000***	-.417	.000***
LIQ	.671	.190	-.655	.784
Adjusted R-squared	.721		.800	
F-statistic	8.3***		26.49***	

Note1: *** $p < 0.05$ (two-tailed tests)

Note2: TA, tangibility of assets; SIZE, firm size; NDTS, non-debt tax shield; GO, growth; RISK, risk; PT, profitability; UNI, uniqueness; LIQ, liquidity.

5. CONCLUSIONS AND IMPLICATIONS FOR MANAGEMENT

This paper draws on research on capital structure policy to revisit the POT and STOT hypotheses in the context of multinational inter- and intra-firm innovation collaborations. Data come from a sample of 201 inter-firm and 117 intra-firm

collaborations over an 8-year time frame (2002–2009). The study has several main findings.

First, POT describes firm financing given different degrees of information asymmetry and transaction costs. Internal funds (e.g., retained earnings) are a lower cost due to low information asymmetry and transaction costs due to fixed obligations. Multinational innovation firms usually face a high degree of uncertainty and unpredictable profits; firms issue new debt when their internal funds are insufficient to pay for business expansion or when investments exceed retained earnings. Because multinational innovation firms are usually viewed as high risk by risk-averse lenders, they rely on external equity and usually need to pay higher dividends to external investors; this frequently leads to high transaction costs. Furthermore, innovation development requires investing in technology, equipment, R&D, human resources, and so forth; these resources represent a kind of financial cost. To reduce high transaction costs and information asymmetry for multinational operations, firms eschew external equity financing and instead rely on internal market transactions, such as entering into relatively less expensive inter- and intra-firm innovation collaborations to offset the risk of business expansion. Therefore, this study supports a capital structure policy that involves a firm issuing new debt instead of using retained earnings to finance its expansion. The findings show that a deficiency in internal funds is the main reason for issuing new debt, and that it is relatively less expensive to issue new debt in inter- and intra-firm collaborations.

Second, STOT argues that a firm's optimal debt ratio is determined by a trade-off in the costs and benefits of borrowing. Costs include bankruptcy costs [49] and loss of non-debt tax shields [19]. The findings of this study show that optimal STOT leveraging is determined by balancing the tax shield advantages of debt against the deadweight costs of bankruptcy, and that tax shield variables are significant determinants in the capital structure decisions of both multinational inter- and intra-firm innovation collaborations. Multinational innovation firms are marked by high volatility and fierce competition, and must put a great deal of funds into innovation activities to enhance their market position. These firms usually have a greater proportion of tangible capital expenditures and innovation expenditures and thus a large tax shield effect. Firms with a higher tax shield effect are likely to have a higher debt ratio, and the cost of financing is likely to be lower. Furthermore, high uncertainty level in terms of innovation input usually leads to less certainty in terms of profits, which means a higher deadweight of bankruptcy and a higher cost of debt financing. However, this study shows that having greater growth

or expansion opportunities (such as a higher deadweight of bankruptcy) counteracts the effect of more debt tax shields.

Third, evidence shows that, in line with the POT model, long-term debt repayment, working capital, capital expenditure and cash flow are the main variables determining a deficiency in internal funds, and are key determinants in the issuance of new debt in multinational inter-firm collaborations. Inter-firm innovation collaborations are based on incentive and autonomous and contract law-based relationships. Partners in inter-firm collaborations have independent financial systems, and the complementary effect of financial resources is less obvious. Therefore, long-term debt repayment, working capital, capital expenditure and cash flow are the main determinants of a deficiency in funds and the issuance of new debt. In contrast, working capital is the key determinant of the issuance of new debt in multinational intra-firm collaborations. Intra-firm collaborations involve a high degree of administrative control; bilateral dependency; more formal, orchestrated organization; and more equitable relationships between partners. Partners in such collaborations support each other financially. In these collaborations, working capital is the only variable determining the issuance of new debt.

Fourth, evidence shows that, in line with the STOT model, size is positively associated with the issuance of new debt in multinational inter-firm innovation collaborations. Past studies [15, 52] also show that larger firms have more of a chance to become diversified and have a lower bankruptcy risk. Multinational inter-firm innovation collaboration can be considered a kind of expansion for the purpose of reducing bankruptcy risk and acquiring more innovation resources. Therefore, larger size means a low bankruptcy risk and possibilities of issuing new debt. Growth represents a significant opportunity for market operation and expansion, but may involve uncertainty in terms of real income or profits, and may trigger a chain reaction of bankruptcy in intra-firm collaborations. Thus, growth entails high business risk and is negatively associated with multinational intra-firm innovation collaborations. Finally, making available unique products, services, and so on, always means that firms need to put more funds into advertising, promoting and selling their products or services. Thus, uniqueness is connected with higher bankruptcy costs and is negatively associated with the issuance of new debt.

Multinational inter- and intra-firm collaborations represent polar international expansion models and the most important types of international cooperation in today's high-velocity, dynamic business environment. These collaborations are frequently used to exploit new products, new markets and even new locations. Yet past studies on capital

structure policy have neglected the determinants of capital structure in such collaborations. This study focused on these determinants and analyzed and compared the applicability of two capital structure policies: STOT and POT, to multinational inter- and intra-firm innovation collaborations. We believe that these findings highlight the optimal operating capital structure policies for multinational inter- and intra-firm innovation collaborations.

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跨國 INTER-及 INTRA-FIRM 創新合作資本結構

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摘要

本研究實證調查兩個對立資本結構理論：融資順位理論(pecking order)與靜態抵換理論(static trade-off)，何者較能解釋影響多國企業inter- and intra-firm 創新合作之融資決策。研究結果顯示在融資順位理論(pecking order)情境下，負債付款、營運資本、資本支出、營運現金流量是多國企業inter-firm創新合作之資金不足(融資決策)的主要決定變數；而營運資本是多國企業intra-firm創新合作之資金不足(融資決策)的主要決定變數。相對的，在靜態抵換理論(static trade-off)情境下，公司規模大小、獨特性是多國企業inter-firm創新合作之融資決策之主要決定變數；而成長性、獨特性是多國企業intra-firm創新合作之融資決策的主要決定變數。本研究結果可以填補多國企業inter- and intra-firm創新合作資本結構文獻上的空缺，且提供多國企業inter- and intra-firm創新合作資本結構操作之參考。

關鍵詞：資本結構、融資順位理論、靜態抵換理論、Inter-firm、Intra-firm

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