Real Options: Theory Meets Practice

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REAL OPTION, FINANCIAL FRICTIONS AND COLLATERALIZED DEBT: THEORY AND EVIDENCE FROM REAL ESTATE COMPANIES

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This paper introduces financial frictions and the collateralized debt capacity of a company within an options theory framework. The financial constraints and frictions affect option value by forced suboptimal exercise or imposed finance cost. Yet the land and properties in the firm can be used as collateral to ease financial constraint and reduce finance costs. This financial flexibility, modelled as real option interacts with real flexibility and affects corporate investment. The firm with more assets in place to collateralize may imply larger financial flexibility due to the presence of available collateral. This financial flexibility functions to reduce the distortion of option exercise and increase corporate investment.

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1. Introduction and Background

The determinants of firm valuation is an interesting, rich and diverse research field in corporate finance, more so because it is not likely that a definitive, simple and widely agreed set of firm characteristics that is seen to drive firm valuation is ever expected to be agreed on. Pioneered by Berk, Green and Naik (Berk et al., 1999), a fairly recent and growing strand in this research has been the application of real options theory in the investigation of investment decisions of the firm and linking it to firm valuation and dynamic asset pricing. In their study, Berk, et. al. (1999) value assets in place and growth options in the firm separately and then sum them together to obtain the firm value; an approach which implicitly assumes that assets in place are independent of growth options the firm may have. While the concerns of real options theory, namely uncertainty, flexibility and irreversible investment, provide powerful tools to describe the investment behavior in the firm, the notion that the value of a firm's real options are independent of the entity that executes the options has always been a somewhat uneasy equilibrium assumption. Thus, in studies that followed Berk, et. al, (1999) investment frictions, caused by the degree of investment irreversibility and the adjustment cost of lumpy investment, were introduced into investment behavior and asset pricing models ((Kogan, 2004, Zhang, 2005). Similarly, Gomes, Yaron and Zhang (Gomes et al., 2006) propose an investment-based asset pricing model with the presence of financial constraints, and argue that financial constraints are important factors in asset pricing. These papers differ from Berk, et. al. (1999), however, in that they focus on asset pricing of the firm rather than the investment behavior of real options, or the two in combination.

Our paper investigates the real options and investment behavior of a firm with a growth opportunity as real options, with financial constraints and an external financing requirement. In particular, it studies the effects of financial flexibility generated by the firm's assets in place and its impacts on investment decisions. Overall, we explore whether financial frictions and external financing strategy influence the investment decisions in the firm, and through which channel financing policy interacts with investment policy. There is a rich body of research into financing the firm's activities, and this body of work directly influences the questions we address. Starting with a world with perfect and efficient capital markets, the Modigliani–Miller theorem argues that the value of a firm is independent with its financial structure, and that the investment decision is not affected by financing policies. However, taxes, bankruptcy and information asymmetry causes financial frictions in the use of external resources and in the adjustment of capital structure; while agency costs between professional managers, shareholders and debt holders give rise to the problems of under- or overinvestment. While the capital of a firm comes from three resources of capital, namely internal cash flow, debt and new equity, with financial frictions these three categories of capital have different opportunity costs. In this respect, financing hierarchies proposed in Fazzari, Hubbard, Blinder and Poterba (Fazzari et al., 1988) suggest that the costs of funds increase in the sequential order of internal funds, new debt and new equity (the so-called "pecking-order hypothesis"). Thus the financial status of the firm may influence its investment decisions through varying capital costs. Similarly, financial constraints and the varying costs of external funds potentially could affect optimal investment in real options and alter the exercise thresholds. So the investment decision may interact with financing decisions in the presence of uncertainty and financial frictions. Following the arguments of financial constraint and financing hierarchies, it is realized that classic real options theory ignores the capital cost of exercise price, through directly borrowing the idea from financial option pricing literature and assuming that the option holder can sell short risk free securities. The consideration of financial constraint and hierarchies addresses the gap between real options pricing and financial option pricing theory and literature.

Supposing a firm with investment opportunity and internal funds only, external financing has two direct effects on the investment if the internal funds cannot finance the investment. On the one hand, it relaxes the financial constraints in the firm and makes the development possible at the firm's will; or the constrained firm has to wait for its accumulated funds to be enough to meet the expenditure. The forced delay in the constrained firm reduces the value of a real options. On the other hand, although external financing can help mitigate the fund shortfall, the extra financing cost imposed by external funds may reduce the option value as well. As external funds are brought into the framework of real options theory, the expected profit is the price of the underlying asset net of exercise cost and additional financing cost, as the shareholder is the residual claimant for firm assets. The reduced profit induces underinvestment problem (debt overhang) as pointed out by Myers (Myers, 1977), which lowers the investment incentives as the net gains should be firstly accrued to the holders of external funds, and the outside investors would anticipate this agency problem. In addition, due to asymmetrical information between the firm and outside investors, the external funds cannot totally substitute for internal funds. Because external funds have higher opportunity costs, the incentive conflicts are more severe and it is more likely that profitable investment opportunities would be deferred when the firm confronts binding capital budget constraints and has to rely on expensive external funds. We develop a theoretical model to illustrate the effect of financial frictions on the investment decision.

We also investigate how the financial flexibility in the firm affects its investment decision, given that some firms can employ their advantages to alleviate the financial constraints. Financial flexibility may be simply defined as the ability to adjust capital structure with lower costs. Yet we broaden this definition to take financial flexibility as the ability to access sufficient funds for investment with lower cost. Then this flexibility may result from the ability to cut alternative investment, to cut dividends, to sell assets without large loss or to obtain debt or equity with lower costs. We emphasize the role of assets in place in the financing policy. The physical asset in the firm can be liquidated to gain funds immediately or be used as collateral for issue of loans. These collateralizable assets mitigate the information asymmetry and enhances debt capacity for the firm. The firm can use its fixed assets, land or properties, to collateralize low-risk loans, following the argument in Kiyotaki and Moore (Kiyotaki and Moore, 1997). This collateral channel provides the links between the assets in the place and growth options in the firm. The role of fixed assets like land and property as collateral for loans has been recognized in the literature and empirically confirmed to influence corporate investment decisions and household consumption in Gan (Gan, 2007, Gan, 2010); however, few studies have investigated the potential collateral channel theoretically at the firm level.

This paper proposes a theoretical model to value simultaneously real flexibility (real options embedded in the project) and financial flexibility (created by firm's collateral assets) and derives the firm value with investment decision and financing decision. The model is similar to the theoretical model in Boyle and Guthrie (Boyle and Guthrie, 2003). Their paper introduces the financial constraint into the real options model and finds that the financial constraints lower the option value and the risks of potential funds shortfalls accelerate the decisions of investment timing. As they argue, the model can explain the phenomenon that smaller firms invest more than big firms because they are subject to more severe financial constraints and have to accelerate option exercise. They further explore the relationship between investment and liquidity, and suggest different sensitivity of investment and cash flow for constrained and unconstrained firms. However, our paper, following the framework of real options model with financial constraint, investigates the role of external funds in relaxing the financial constraints, the effect of costly external capital and the collateral channel of assets in place. We follow similar logic in that firm fundamentals and financial constraints are seen to affect option value and exercise timing, but focus on the effect of external financing to provide additional funds to finance investment, but also cause agency problems in investment.

The theoretical model also involves the credit multiplier of collateral assets proposed by Kiyotaki and Moore (Kiyotaki and Moore, 1997). We argue that the assets in place in the firm provide financial flexibility through the collateral debt capacity or direct capital through asset sales. The state of assets in place can influence the investment decisions of growth options if it can generate an effect on internal funds or external financing. The flexibility to collateralize asset in place for low cost debt capacity (or sell assets without large loss) is analogous to a real options and priced in the theoretical model with investment timing. As we acknowledge, this is the first model to identify the interactions of asset in place and growth options through the collateral channel, and value dynamic investment decisions and financial decisions simultaneously.

The empirical tests in this paper use the data of real estate companies in the Hong Kong. There are some advantages to use this data sample. First, most real estate companies hold both investment properties and development properties, which can represent asset in place and growth option respectively in the firm. Second, real estate companies in Hong Kong have shown to distribute little dividends and rarely issue new equity[1]. Debt is the only significant way to obtain external capital. Third, real estate companies have realized that holding properties are important collateral to obtain loans from the banks. They always reveal the amount of collateral assets and available debt capacity as firm advantage. So we can use this data sample to confirm the effect of the collateral channel and debt financing on investment predicted by the theoretical model.

The paper is organized as follows. Section one is the introduction and background. Section two provides literature review on real options theory, financial constraint and collateral debt capacity. Section three presents a real options model with costly external funds and evolution of assets in place. A number of propositions are derived from the theoretical model. Section four introduces the data, variables and methodology for empirical tests. The empirical results are presented in the section five. Section six concludes this paper.

2. Literature Review

The first strand of related research is real options theory. The seminal research in real options implicitly assumes that the investment decision is independent of financing decisions and the investment is financed with all equity. Yet the difference between real options and financial option is that the option holder of a real asset confronts imperfect capital markets and relies on multiple resources of capital. In other words, the holder of a real options may not be able to execute the option with risk free capital as assumed with the holder of a financial option. A real option owned and executed by the firm, mainly financed with debt and equity, makes it necessary to study the real options at firm level and include the impact of capital structure on the option value and exercise strategy.

The integration of real options with financial imperfection gives rise to new implications. Boyle and Guthrie (Boyle and Guthrie, 2003) firstly introduce the financial frictions into real options model and place emphasis on the restrictions of investment timing by financial constraints. The financial frictions cause sub-optimal investment for projects and reduce the project value by forced delay or acceleration of investment. The additional capital cost imposed by constraints is weighed against the option value of optimal waiting. Obviously, the financial constraint and friction distort investment decisions and leads to lower option values. The investment decision is

[1] The descriptions of dividend and newly issued equity below give the evidences to this finding. For some firms, they seldom distribute earning to the investor. The possible reason is that these firms are largely controlled by some big families, so the dividend is not necessary to move from one pocket to another pocket.

not only determined by the payoff uncertainty of the project but also the availability and the capital cost of the firm to finance the project. Hirth and Uhrig-Homburg (Hirth and Uhrig-Homburg, 2010) extend the model of Boyle and Guthrie (2003) by including both liquidation constraint and external financing costs. They argue that the investment thresholds are non-monotonic with financing constraints, similar to the results of Boyle and Guthrie (2003). However, these two papers both focus on the sensitivity of cash flow and investment, rather than the effect of debt or equity on the investment decision.

The study of real options at firm level can enrich the literatures of both corporate investment and capital structure. The use of external funds relaxes the financial constraints and enables the firm to invest accordance with the exercise strategy of optional exercise, but on the other hand, it also creates additional dead loss for the firm. This argument is related to the capital structure theory. Myers (1984) asks the question, how do firms choose capital structure? He proposes a pecking order theory of financing choices as the firm would firstly use internal funds, followed by debt, and finally relying on equity issuance, based on financial hierarchy and information asymmetry. The various capital costs in the firm also may influence the investment timing of real options. The additional cost caused by market friction may lead to the tradeoff of opportunity cost of irreversible investment and the financing cost of the investment: the fear of high financing costs in the future may lead firms to make investments earlier through sacrificing waiting value.

An alternative theory is the trade-off theory of capital structure. It argues that the firm would issue optimal debt and equity by weighing the benefit and cost of the securities; yet the cost or benefit of external capital are not involved with corporate investment, either. Jensen and Meckling (Jensen and Meckling, 1976) define the concept of "agency cost", which is caused by the interest conflict between manager, debt issuer and shareholder. Myers (Myers, 1977) shows that for growth options debt leads to underinvestment because the benefit from investment opportunity should be attributed to debt holders as a priority. Yet the default option on debt held by the firm may cause overinvestment. In both cases the agency problem originated by the debt issuance influences corporate investment. Our paper does not propose an alternative theory in capital structure but focuses on the effect of capital structure on corporate investment. It argues that financing policy, especially debt issuance, should match or influence the investment opportunities in the firm. The utilization of debt is to match the timing of financial flexibility with real flexibility so as to maximize the project value in the firm. The investment decision and financing choice should be considered in a dynamic and integrated framework.

Financial flexibility is demonstrated as the key factor in capital structure decision in the literature. In a comprehensive survey, Graham and Harvey (Graham and Harvey, 2001)show that the financial flexibility is the most important factor that influences the debt decision. They find that "firms that value financial flexibility are more likely to value real options in project valuation, and the difference is not significant". The financial flexibility is similar to real flexibility in that firms use some debt capacity for the investment but still preserve unused capacity for future opportunities. There is no theoretical study that explains the role of financial flexibility or the intuition of the similarity between financial and real flexibility. Our study aims to address this gap.

Debt capacity can be created by liquid assets. Shleifer and Vishny (Shleifer and Vishny, 1991) argue that more liquid asset indicates lower costs of financial distress in the firm and provides more corporate debt capacity. Liquid asset can support more debt. Debt capacity is related with liquidity cost of assets, which involves the potential participants and their abilities to pay in the asset market. If the asset sale is costly, it is not a good candidate for debt finance. They suggest the logic of asset liquidity to create debt capacity as "liquid assets are in effect better collateral". Asset liquidity varies across the industries and changes over time. This logic is similar in Kiyotaki and Moore (Kiyotaki and Moore, 1997), i.e. that land as a liquid asset can be used as collateral for loan. The credit multiplier in Kiyotaki and Moore (Kiyotaki and Moore, 1997) suggests that the collateral assets requirement amplifies the shock to investment opportunities and increases product fluctuation. In the process, the firm faces a negative productivity shock and its net worth reduces; because of credit constraints, it cannot borrow sufficient funds and has to decrease investment and collateral capital, causing net worth to drop further. The credit cycle continues and generates feedback effects on investment. They apply credit expansion through the collateral channel to explain the real business cycle. Campello and Hackbarth (Campello and Hackbarth, 2008)propose a firm-level credit multiplier to study the financing-investment interactions at firm level. Corporate investment enhance capital accumulation and tangible ability of the firm, which create more debt capacity; and the larger debt capacity allows the firm to invest more and quickly respond to newly arising opportunities in the market.

This literature confirms the existence of the collateral channel and that it plays an important role in investment. Some empirical studies have also demonstrated that corporate real estate influences debt capacity and investment strategy of the firm through this collateral channel. Using land market data in Japan, Gan (Gan, 2007)empirically shows that the decrease of collateral assets value significantly reduce corporate investment. Chaney, Sraer and Thesmar (Chaney et al., 2010)argue that the corporate investments are positively influenced by the value of the firm's real estate through collateralized debt in US corporations. These studies confirm the collateral channel and the important role of the real estate in creating debt capacity and increasing corporate investment.

Our paper differs from the cited literature in that it is concerned with the financial flexibility and debt capacity created by collateral assets and its impact on investment. It develops the intuition that financial flexibility, created by the collateral assets in the firm, is similar to real flexibility embedded in corporate investment. Thus we incorporate the real flexibility of real options and financial flexibility in the firm into a dynamic framework. The financial flexibility is analogous to real flexibility in real options: the firm should determine whether to employ the financial flexibility (use the debt capacity) to finance the investment in this period or to preserve the financial flexibility (keep the debt capacity) for the future investment. Our model investigates the interactions of investment and financing in a dynamic framework, following the argument in Trigeiogis (Trigeorgis, 1993) that the financial flexibility would interact with real flexibility. A closer study is Hennessy et al. (Hennessy et al., 2007), which argues that the earlier exercise of real options is to increase the collateral capital and generate additional debt capacity for future opportunities. But they do not provide a theoretical model to explain their findings.

Following the logics of collateral channel and real options investment threshold with financial constraints, the collateral assets have a U-Shape relationship with the investment threshold: when the assets are small, the available debt is also small and the firm may have to delay the investment due to the insufficient funds, which implies a high investment threshold for the forced delay; as the assets in place grows, the probability of insufficient funds decrease and the firm has incentive to delay the project to capture its option value, indicating a decreasing and following increasing thresholds; when the asset base is relatively large, the financial constraints disappear and the investment threshold approaches to the case in unconstrained firm. In the empirical part, we test the hypotheses that the investment increases with collateral assets in the firm.

Apart from the static analysis of collateral assets, debt capacity and corporate investment, their relationships may also change over time. The value of collateral assets changes over time, accompanied with the change of debt capacity. This point is also illustrated in Shleifer and Vishny (1991). When the market is good, the firm faces a large set of investment opportunity and also has sufficient funds internally and externally, because the assets in place would generate more internal cash flows and provide more debt capacity because of their rising values; while in a bad market, the falling values of assets in place further reduces investment as debt capacity reduces and less funds are available to support the investment decisions.

The dynamics of investment opportunity and financial flexibility may also explain the overbuilding phenomenon. As the market reach peak and start to fall, the firm may anticipate the binding constraints and large financial cost for investment in the future. To avoid the future financial cost and to “abuse” the debt capacity created by current still high value collateral assets, the firm may choose to overinvestment even it has expected the declining market in the future. This also reflects the agency problem and risk shift in the use of debt. However, we do not test this intuition.

3. Real options Model with External Funds and Collateral Channel

3.1 A General Firm Model

A firm holds the following assets and liability: asset in place with market value G, initial cash stock of X, the right to a real options project worth V and an existing perpetual debt D.

The value of underlying asset is assumed to follow the Geometric Brownian Motion as,

$$dV = (\mu - \delta)Vdt + \sigma Vdz$$

In the function, V is the underlying asset value, μ is the total expected return to the asset annually, δ is the payout rate of the asset, σ is annual volatility for the asset and dz is Brownian motion. Let I denotes the exercise cost and is constant in the all periods. The real options is a perpetual call option in which the only flexibility is the timing to invest. The firm can use the potential project value to issue project loan for the investment. This collateral debt with risk free interest rate is up to αV and $0 < \alpha < 1$[2].

The asset in place in the firm also has value varying with market[3]. It follows the Geometric Brownian Motion as,

$$dG = (\mu_G - \delta_G)Gdt + \sigma_G Gdw.$$

The physical asset generates income stream $\delta_G Gdt$. It has total expected annual return μ_G and annual volatility σ_G. The correlation of the Wiener processes z and w is assumed to be ρ. This physical asset can be used as collateral to issue risk-free credit for the firm operation. The potential maximum debt capacity created by the physical asset is some portion of its market value βG, $0 \le \beta \le 1$. The parameter β represents the market frictions or liquidation costs in asset sale. Even if outside investors can observe the market value of this asset, the asset transaction may involve some cost and loss as the asset is liquidated[4]. Also, some value of the asset may arise from firm-specific characteristic or human capital; the liquidation causes this part of value to be lost. If β equals to 1, it indicates no market frictions; if β equals to 0, the market frictions are so large that the asset cannot be utilized as collateral. The parameter value of β also depends on the quality of the asset and the timing of the market. The better asset quality leads to the larger

[2] See the discussions of market friction in Boyle and Guthrie (2003). The future benefit from the project can be used as collateral, but it is not good candidate for debt because the profit is not realized yet and suffers to large uncertainty. The asset in place is a better candidate for collateral.

[3] In Hirth and Uhrig-Homburg (2010), the asset in place is assumed to be constant over time. The income generated by the asset in place is stochastic. The difference between theirs and this paper is that we assume the value of asset in place changes over time. Hence the collateral debt capacity also evolves with the market. Our assumption is more realistic that the financial constraint and outside credit market are actually dynamic.

[4] The reason is that the asset may be firm specific or the potential buyers suffer to the same liquidation crisis as the seller and cannot access to credit market as well. See the discussions in Shleifer and Vishny (1991)..

parameter and potential debt capacity (see the discussion in (Liu and Liu, 2011)). If the asset is associated with existing debt, the collateral value is the asset value net of debt and the collateral debt capacity is the collateral value times liquidation cost. Notice that β should be larger than α . Also, the debt capacity created by the assets in place is more flexible than that from projects because it can be used for the whole firm and not only be constrained to the project.

The firm has existing debt D which requires periodic coupon payments. This existing debt occupies some debt capacity as the firm has to pay the coupon to ensure that it is not liquidated. The equity-hold can continue to own the firm as long as:

$$X + \alpha V + \beta G - D \geq 0 .$$

Beyond internal funds and collateral debt, the firm can also obtain external financing through risky debt or equity issuance. We do not distinguish these two kinds of financing, but argue that both funds are more costly than internal funds and collateral debt, involving issuance cost IC . This cost enters the option exercise condition and affects the investment threshold if the firm relies on risky debt. Also, the issuance of risky debt increases the probability of firm default.

The capital resources before investment are internal cash, rental income from assets in place and collateral debt capacity created by assets in place, net of existing debt. Assume the internal cash can earn interest rate by investing in risk-free securities before executing the project. The available capital resources (including internal funds and potential collateral debt) evolve as:

$$R = X + \delta_G G + \beta G - D ,$$

$$dR = rXdt - rDdt + (\delta_G + \beta)(\mu_G - \delta_G)Gdt + (\delta_G + \beta)\sigma_G Gdw ,$$

$$dR = [rX - rD + (\delta_G + \beta)(\mu_G - \delta_G)G]dt + (\delta_G + \beta)\sigma_G Gdw .$$

If $R \geq I$, the firm can make investment decision without any additional financing cost with its current available resources. If $I > R$, additional amount of capital need to be financed for the project. The firm can firstly use the debt capacity αV with low interest cost. Any other extra funds require extra financing cost. We use the same function of issuance cost in Hirth and Uhrig-Homburg (2010):

$$IC(\Delta, V, \alpha, k) = \left(\frac{\max\{\Delta, 0\}}{\alpha V}\right)^k (1-\alpha)V , \ \Delta = I - R , \ k \geq 1 .$$

The equity value before development is $X + G - D + F(R,V)$, in which $F(R,V)$ is the value of project development rights. The firm would adopt the optimal investment decision to maximize its equity value with consideration of capital spending. After investment, the market equity value can be written as $X + G - D + V - I - IC$.

Applying the real options framework, the firm would immediately execute the real options project when the value of the underlying asset reaches the investment threshold as $V \geq V^{*}(R)$. The development profit is:

$$F^{c}(V,R) = V - I - IC .$$

The utilizing of costly external capitals involves additional financing cost. This cost reduces the project's profit. When it is optimal to delay, the option value is derived as[5]:

$$\frac{1}{2}\sigma^{2}V^{2}F_{VV}^{c} + \rho\sigma(\delta_{G}+\beta)\sigma_{G}GVF_{RV}^{c} + \frac{1}{2}(\delta_{G}+\beta)^{2}\sigma_{G}^{2}G^{2}F_{RR}^{c} + (r-\delta)VF_{V}^{c} +$$
$$[rX - rD + (\delta_{G}+\beta)(r-\delta_{G})G]F_{R}^{c} - rF^{c} = 0$$

The exercise decisions for the real option thus depends on both the value of underlying assets and the available capital resources, especially the collateral debt capacity. There are also some boundary conditions in determining the solution to the differential functions. If V approaches zero, the option has no value:

$$F^{c}(0,R) = 0 .$$

The firm would be liquidated if it cannot afford to the debt repayment as:

$$X + \delta_{G}G + \beta G + \alpha V < D .$$

Then the real options project is sold. It is worth:

$$F^{c}(V,R) = F^{u}(\alpha V) .$$

If the firm has sufficient capital resources, however, the option would be exercised without constraints. Its value is equal to the unconstrained option:

$$\lim_{R\to\infty} F^{c}(V,R) = F^{u}(V) .$$

According to the collateral channel, the firm with large collateral assets would generate large debt capacity that plays the equivalent role as internal free cash to relax financial constraints. It is natural that large firms with relatively more collateral assets would be less likely to suffer from financial constraints, and be able to gain the optimal option value.

In the following section, several cases in real estate development are introduced to investigate the effects of financial constraints and collateral debt.

[5] The differential equation in this paper differs from Boyle and Guthrie (2003). The value of asset in place is not constant but follows a Geometric Brownian Motion. We concern about the operating income and collateral debt capacity created by asset in place rather than the volatile cash flow generated by the physical asset.

3.2 Benchmark Case One: Unconstrained Firm

The first case is for the firm without financial constraints, even if it does not use collateral debt capacity. The issuance cost is zero. When $I \le X$, the firm chooses to exercise the development option at T and obtains the payoff $F(V) = \max_T[V_T - I, 0]$.

$$F(V,R) = F(V)$$

$$F_{RV} = 0$$

$$F_{RR} = 0$$

$$F_R = 0$$

This case is the classical real options model in McDonald and Siegel (1986). In the model, the financial constraints and frictions do not influence the exercise decision and option value. The investment decision is independent of capital structure. With option pricing techniques, the option value must satisfy the following second-order ordinary differential equation:

$$\frac{1}{2}\sigma^2 V^2 F_{VV}^u + (r-\delta)VF_V^u - rF^u = 0$$

It subject to three boundary conditions:

$$F^u(0) = 0\,,$$

$$F^u(V^*) = V^* - I\,,$$

$$F_V^u(V^*) = 1\,.$$

V^* is the investment threshold for option. Suppose the solution takes the form $F(V) = AV^\eta$. The partial differential equation and boundary conditions yield,

$$V^* = \frac{\eta}{\eta - 1} I\,,$$

$$A = \frac{V^* - I}{(V^*)^\eta}\,,$$

$$\eta = \frac{1}{2} - (r-\delta)/\sigma^2 + \sqrt{[(r-\delta)/\sigma^2 - \frac{1}{2}]^2 + 2r/\sigma^2}\,,$$

$F^u(V) = (\frac{I}{\eta - 1})^{1-\eta}(\frac{V}{\eta})^{\eta}$, for $V \le V^*$; $F^u(V) = V - I$ for $V > V^*$.

3.3 Benchmark Case Two: Constrained Firm with Costly External Financing

The second benchmark case is when $X < I$ and the firm cannot rely on collateral debt or it does not hold the physical asset[6]; the option would be exercised with additional capital cost IC. We can take it as $G = 0$ and $\beta = 0$.There is only one state variable for the option because the firm does not hold existing assets that can affect option exercise decisions indirectly. Similar to case one, we can obtain an analytical solution for the option value and investment threshold. The differential function is the same as:

$$\frac{1}{2}\sigma^2 V^2 F^c_{VV} + (r - \delta)VF^c_V - rF^c = 0$$

The value matching condition is:

$$F^c(V) = V - I - IC.$$

The investment threshold is now:

$$V^c = \frac{\eta}{\eta - 1}(I + IC).$$

And the investment option value is:

$$F^c(V) = (\frac{I + IC}{\eta - 1})^{1-\eta}(\frac{V}{\eta})^{\eta}$$

$$\eta = \frac{1}{2} - (r - \delta)/\sigma^2 + \sqrt{[(r - \delta)/\sigma^2 - \frac{1}{2}]^2 + 2r/\sigma^2}.$$

The effect of financial cost is to increase the exercise price of the option. However, the differential function and option elasticity for option value are the same in the benchmark case one. The financial cost actually increases investment threshold and lowers the option value.

It is also possible that the firm cannot access to the external capital market even if it is willing to pay for higher capital costs. In this scenario, the firm has to delay the development until it accumulates sufficient funds. It means that partial option value would not be captured because of this forced postponement. The constraints distorts the investment decisions through forced delay or higher capital costs.

3.4 Benchmark Case Three: Constrained Firm without Costly External Financing

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[6] The firm does not have assets in place and also original debt in this case.

The benchmark case three is the scenario that the firm can use the collateral debt capacity created by the asset in place. It is the case where $X < I \le R$. The firm can employ its financial flexibility to match the investment timing of real options and save the additional financial cost. The option value should be the same as the project in the unconstrained firm. The collateral debt capacity actually relaxes the financial constraint in the firm and plays a substitute role for internal funds. The interaction of real flexibility and financial flexibility enables the firm to exercise two call options simultaneously: to invest at optimal timing and to use the preserved debt capacity[7].

The project value satisfies the differential equation:

$$\frac{1}{2}\sigma^2 V^2 F^c_{VV} + \rho\sigma(\delta_G+\beta)\sigma_G G V F^c_{RV} + \frac{1}{2}(\delta_G+\beta)^2\sigma_G^2 G^2 F^c_{RR} + (r-\delta)VF^c_V + \\ [rX - rD + (\delta_G+\beta)(r-\delta_G)G]F^c_R - rF^c = 0 .$$

The value matching condition is:

$$F^c(V,R) = V - I \text{ .}$$

Two other boundary conditions are:

$$F^c(0,R) = 0 \text{ .}$$

$$F^c(V,R) = F^u(\alpha V) \text{, if } X + \delta_G G + \beta G + \alpha V < D \text{ .}$$

The collateral debt capacity is related to several factors: the asset in place, market friction, and correlation between underlying asset in growth option and asset in place. More assets in place and less market frictions increases debt capacity. The positive correlation between underlying assets of option projects and assets in place increases the option value because the financial flexibility negatively affects the exercise cost.

The asset in place and thus collateral debt capacity change dynamically with the market as well as the underlying assets of growth options. It indicates that the collateral debt capacity may have two effects on investment: firstly it helps mitigate the financial constraint which leads to lowers the investment threshold; and then because the delay is optimal, it would raise the investment threshold. These effects are similar as the investment-cash flow relationships discussed in Boyle and Guthrie (Boyle and Guthrie, 2003).

3.5 Propositions

[7] It should notice that the financial flexibility is not a proprietary option because the debt us granted by the bank or other debt providers. It is not necessary that the firm would always obtain the debt with collateral assets. but obviously the collateral assets makes the firm easier to access to credit market.

The focus of this paper is to study the effect of collateral assets (assets in place) on the investment in growth options through the collateral channel. We also investigate the effect of cash flow and existing debt on the investment decision. We derive some propositions from the theoretical models. In comparison with the benchmark case one and case two, we derive the following proposition:

<u>Proposition 1</u>: The utilization of external funds relaxes the financial constraints and induces investment in profitable opportunities given $I > X$; while the higher opportunity cost of external funds raises the investment threshold which reduces investment and lowers option value, in comparison with the unconstrained case.

<u>Proof</u>: it is obvious to see that $V^c > V^*$ and $F^c < F^u$.

Proposition 1 indicates that external funds may play dual roles in investment. They increase the probability of investment and creates the agency problem of underinvestment as long as the external funds are riskier than internal funds. The results also show that financial frictions should be included in the real options model, because it explicitly influences the investment threshold and option value.

The real options with financial frictions and collateral debt is in between the case one and case two. The collateral assets in the firm loosens the financial constraints and also mitigates the negative effect of financial cost, which both leads to more investment. We derive the propositions as:

<u>Proposition 2</u>: the firm with more collateral assets has lower investment thresholds in comparison with the firm relying on external capital with financial cost; the collateral assets provides financial flexibility which facilitates option value and increases investment.

Beside this proposition, some sub-propositions can be derived on the collateral assets.

<u>Sub-proposition 2.1</u>: the firm with more collateral assets would use more debt financing because the collateral assets creates low-risk debt capacity.

<u>Sub-proposition 2.1</u>: the firm with more collateral assets would gain more low-risk debt and pay less interest charge.

The papers of Boyle and Guthrie (Boyle and Guthrie, 2003) and Hirth and Uhrig-Homburg (Hirth and Uhrig-Homburg, 2010) discuss the relationship between cash flow and investment. Their main results are that the cash flow-investment is not non-monotonic; especially high liquidity decreases the investment threshold. We do not pay much attention to internal funds, but we do incorporate existing debt in the models. Existing debt can be viewed as negative cash flow. It reduces internal funds and erodes debt capacity created by the collateral assets. We derive a proposition about the effect of existing debt.

<u>Proposition 3</u>: the existing debt reduces the internal funds and debt capacity in the firm, leading to less investment and higher investment threshold.

In general, collateral debt capacity helps the firm to mitigate the threat of funds shortfall for investment and optimal delay; on the other hand, the low-risk debt from the collateral channel reduces the probability that the firm has to depend on costly external funds like risky debt and equity. From a static perspective, the firm with large collateral assets would have large potential debt capacity and its investment decision would be less distorted by constraints. The effect of existing debt is opposite because this debt erodes debt capacity: even if the firm can borrow the same amount in additional debt it may also cause agency problems and underinvestment. The existing debt increases the likelihood that to use costly funds for the project and decrease its value. Thus the firm should keep its debt-equity ratio at a reasonable level and adjust it in accordance with investment opportunities and financial flexibility. The low present period debt amount preserves the flexibility of collateral debt capacity and makes the firm respond to investment decisions appropriately to avoid high fund costs.

In empirical studies, we test the hypotheses of investment, debt and related financial flexibility. According to the theoretical model, the investment increases with internal funds and yet decreases with existing debt. The utilization of debt firstly increases investment but may depress investment due to the financial frictions. Additionally, the investment decisions are positively affected by the financial flexibility, which is generated by the collateral assets in the firm. It is expected that the investment is positively related to the collateral assets.

The debt capacity in the firm is unobservable. In the model, it is affected by the value of collateral assets: the collateral assets enhances the debt capacity. It is expected that, after controlling investment opportunities and other resources of funds, the firm with more collateral assets can use more long term debt to invest as it has larger debt capacity and cheaper financial funds. We directly test the relationships between the long term debt and collateral assets.

The role of collateral assets in investment is equivalent with the internal funds in some degree. As the amount of collateral assets increases, the firm would be less likely to suffer financial constraints. On the other hand, the firm without financial constraints may not rely substantially on collateral debt. We split the data sample into two categories of financial constrained and unconstrained firms. It is expected that the investment in financially constrained firms would be more sensitive to collateral assets.

4. Data, Empirical Specifications and Methodology

This section describes the data, variables, model specifications and methodology in the empirical studies. The empirical model connects the corporate investment with collateral assets, debt and internal funds to illustrate the collateral channel. The general hypothesis is that the firm's investment is positively related to collateral assets and this collateral channel works through the debt capacity.

We use real estate companies to test the implications from general theoretical models. Real estate development is viewed as a real options that is exercised at construction cost and with the underlying value of the built property (Titman, 1985, Williams, 1991). Real options theory predicts that the developers should wait to invest until the property value is sufficiently larger than the construction cost, and the uncertainty of property value increases this waiting value and encourages the deferment of development. Nevertheless, traditional real options theory always assumes that the firm with development options only has equity and it finances the construction cost with its internal cash flow. It is obvious that the developer does not always fully depend on its own funds due to the fact that real estate development requires large expenditure and debt finance is normal in the real estate industry. Financial frictions, which are substantial in practical real estate development, should be integrated with real options frameworks as shown in the theoretical models in previous section.

Real estate in typical non-real estate sector companies plays the role of factor input, but it is the product in the real estate firm. The tangible capital in real estate firms, land or properties, typically occupies a more prominent role in the balance sheet than firms in other industries. It is natural that real estate industry may rely heavier on the debt financing through the collateral channel. That is the reason we select the real estate industry as object to investigate the collateral channel. Further, we select real estate companies in Hong Kong as data sample for empirical tests. On the one hand, the real estate industry is highly concentrated in that that only a limited of companies dominate property development and investment but hold a large number of existing properties and developable land; and on the other hand, property development and investment requires large capital expenditure and the banking system plays an important role in the real estate industry.

The data sample consists of real estate companies listed in Hong Kong Exchange (the real estate sector of DataStream). We delete the firms that operate their core business outside Hong Kong[8] and the firms with too much missing data in the database. Finally the sample includes 51 firms over the 1980-2010 periods. The variables for the empirical testing are capital expenditure, cash flow, net tangible asset, total asset, market value, plant, property and equipment, and others. The firm list and the definitions of firm variables are in the Appendix.

4.1 Investment and Collateral Assets

Following the investment literature, we include the market-to-book ratio (act as Tobin Q) and cash flow in the empirical model. We incorporate the measures of collateral assets as additional explanation factor for the investment behavior. The basic model can be written as:

$$Investment = a + bq + cCashFlow + dCollateralAsset + eDebt + fCollateralAsset * Debt + error$$

The dependent variable, $Investment$, is the capital expenditure normalized by the total asset at the beginning of the period. q is the ratio of market to book value of equity, which measures the

[8] Many real estate firms come to list in Hong Kong Exchange. Our sample does not include these firms because the properties markets of Hong Kong and mainland China have different cycle and are affected by different macro-economic environments. The institutional arrangement and regulations also cause difference in real estate development and investment behavior.

investment opportunity of the firm. $CashFlow$ is the sum of incomes before extraordinary items and depreciation normalized by the beginning-of- period total asset. $CollateralAsset$ is the asset that the firm own and use as collaterals to obtain external financing. The measures of collateral assets are discussed in next paragraph. It is expected that the coefficient of collaterals is positive. The $Debt$ is the long term debt divided by total asset. If corporate investment relies on the external financing, it is expected that the debt can mitigate financial constraint and increase investment. The interaction term, $CollateralAsset * Debt$, is included to directly illustrate the collateral channel. It is because the collateral assets may influence the investment decision through other effects, like generating rental income.

The value of collateral assets is difficult to measure because the liquidation value of these assets cannot be observed unless these assets are sold in the market. Almeida and Campello (Almeida and Campello, 2007)measure the liquidation value from the Receivables, Inventory and Capital in the firm following the study of Berger et al. (Berger et al., 1996). They find that the firm with more tangible assets has larger debt capacity and suffers less financial constraints. But their study only considers manufacturing firms. As we focus on real estate companies, the "hard" assets like land and properties reflect a substantial portion of total asset in these firms. We use the Plant, Property and Equipment and Net Tangible Asset as main proxies for collateral assets because the land and properties are the core part in these two variables. The variable of PPE proxy for collateral assets in the regression may lead to serious endogeneity problem because the lagged PPE may cause positive current investment due to the duration of large scale projects and persistent capital commitment. To solve this problem, we also use the Buildings in the Plant, Property and Equipment to directly represent the collateral assets, because the Building represents existing properties in the firm that may not require for further investment. The lagged variable of Net Tangible Asset does not contain under progress projects in the firm and thus may be a suitable variable for collateral assets. All these measures are book value rather than market value of collateral assets which is the amount of value used to obtain external funds. It is argued that the book value of collateral assets, however, can also represent the quantity of land and property in the firm, although it is not so precise. The market value of total asset may be a closer proxy for liquidation value of properties and land, but it includes the value of intangible asset and growth opportunity in the firm. We use all these measures to represent the value of collateral assets.

The previous empirical studies in investment literature always divide the firms into groups of financially constrained or unconstrained through using KZ or WW indices. They argue that the two groups of firms would respond differently to investment because of financial costs in constrained firms to raise investment, see the studies in Almeida and Campello (Almeida and Campello, 2007), Hennessy, Levy and Whited (Hennessy et al., 2007), Livdan, Sapriza and Zhang (Livdan et al., 2009) and others. It is reasonable that the tangibility of firms' asset substantially influence investment behavior of constrained firms rather than unconstrained because unconstrained firms do not rely on the collateral channel to save high cost of external financing (Almeida and Campello, 2007). However, we argue that financial flexibility and debt capacity through collateral assets are important to all real estate companies as the real estate properties require a large block of lumpy sum capital and the investment opportunities in the market may disappear soon if the firm cannot assemble financial resources quickly. In robustness tests, we also divide the sample to two categories as financially constrained firms and unconstrained firms by asset size and leverage, to investigate whether the collateral assets have larger effects on constrained firms.

Several problems are raised with the use of Q as proxy for investment opportunity in the firm. The first problem is to use average Q rather unobservable marginal Q, which may result in measurement errors and estimate bias (Erickson and Whited, 2000). Second, the average Q may not capture the investment threshold in the option-like investment because of the option value. Third, due to typical discount to net asset value in REIT and real estate companies, the market-to-book value and Q are usually lower than 1. In addition to using the market to book ratio, we include the property returns in the market to measure the investment opportunities for the firm. The direct property return is a good instrumental variable for market to book value because it is substantially correlated with investment opportunities in the real estate market and the firm, but it cannot be determined or directly related to the individual firm behavior (thus it is not related with observable factors in the firm).

To avoid endogeneity bias in the regression, we include last period of collateral assets at the right hand side of regression function. The investment literature is always to control year and firm effects as many factors in the firm and period generate fixed effects. Hausman tests confirm the usefulness of the fixed effect method.

4.2 Debt and Collateral Assets

Apart from the direct regressions of corporate investment and collateral assets, we also investigate the effect of collateral assets on the debt financing, explained as the collateral channel in the theoretical model. The collateral assets provides financial flexibility to the firm as it creates lower cost debt capacity. The collateral assets would increase the debt amount after controlling the investment opportunity and other sources of capital.

Financial flexibility includes the suspension of investment, the suspension of dividends, maintaining cash balances, asset sale and preserving unused debt capacity. Daniel, Denis and Naveen (Daniel et al., 2008) find that “debt capacity is the primary source of financial flexibility for firms facing cash flow shortfalls while other potential sources of flexibility are empirically unimportant”. Similarly, our theoretical model emphasizes the role of debt capacity in the investment and financing decisions. We further point out that the collateral assets in the firm may impact the debt capacity and thus investment. To investigate this effect, we control for other sources of financial flexibility, like the internal cash flow, the dividend payment, the issuance of equity and the asset sale[9].

The ideal dependent variable is debt capacity in the firm, yet it is unobservable. We use the variables, Long Term Debt and the Change of Long Term Debt, to represent the utilization of

[9] From the sample, we find that the dividend payment and new issued equity is rate and small compared to the amount of debt. These two ways of financing are not as important as debt. This circumstance helps us to focus on the role of collateral assets. As the model shows, the firm may sell the asset or use it as collateral for debt. To separate these two effects, we add the variable, Disposed Fixed Asset, to control the effect of asset sale.

debt capacity. However, the utilization of debt may not directly reflect the debt capacity because the firm would not exhaust the debt capacity as to preserve this financial flexibility for unanticipated capital need and investment opportunity (DeAngelo and DeAngelo, 2007). So the relationship between used debt and collateral assets may not straightforward and significant. We test the intuition that the firm may use more debt corresponding to more collateral assets when it faces good investment opportunities.

The regression model for the relationships of debt capacity and collateral assets is:

$$Lending = a + bq + cCashFlow + dCollateralAsset + eAssetSale + fDividend + gNewEquity + error$$

The dependent variable is Long Term Debt and the Change of Long Term Debt. In the regressions, we use the present dependent variable and independent variables, unlike the previous testing in investment. The reason is that the debt decision should correspond to the current investment decision, cash balances, or other financial resources. This decision would not be significantly related the corporate fundamentals in lagged 1 period. The endogeneity problem in the investment literature may not appear in the debt regressions because measurement errors of Tobin Q and cash flow are not critical in this regression. The Long Term Debt and the Change of Long Term Debt are normalized by the total asset in the current period, following the usual definition of leverage. To be consistent, all the independent variables are also normalized by the total asset in current period.

For other sources of financial flexibility, the coefficients for Cash Flow and Disposed Fixed Asset are expected to be negative as the capital from internal funds and asset sale would reduce the need to issue debt; however, the coefficients for Dividend should be negative because the dividend payment reduces the available capital resources. The coefficient sign for new issued equity is ambiguous because on the one hand the new equity can reduce the needs of debt issuance but on the other hand the more equity supports more debt as well. Other than some studies that view Market to Book ratio as proxy for intangible asset, we use this variable to control the investment opportunity which represents the capital demand. Thus it coefficient is expected to be positive as more capital demand causes more debt utilization.

We employ the Hausman test which rejects the null hypothesis for a random effect in the cross-section effect. Thus we control for the fixed effect in the cross section for the regressions. We report all results with fixed effect or random effect of cross section and period. For all regressions, we report the heteroskedasticity -consistent standard errors by the approach of White (White, 1980). In the additional regressions, we also correct the standard errors from pooled OLS through clustered standard errors. The results show that standard errors and t statistics are the same after correcting the clustered errors of the cross section and period. Thus we only report the heteroskedasticity -consistent standard errors.

5. Findings and Analysis

5.1 Description Results.

This section presents the descriptions of the data samples for testing the propositions from the theoretical models. Table 1 gives a summary statistics for the sample and its subsamples. Table 2 shows the results to detect whether there are collinear relationships between regression variables. Table 3 describes the variables in the regressions for debt decisions.

Table 1: Summary statistics

The full sample includes all firm-year data of 51 firms and 30 years from 1980-2010. The subsamples are divided by the median of the full sample by the leverage and firm size. The boom and bust samples are set by the year accordance with the real estate cycle in Hong Kong.

Sample	Investment	Market to Book	Leverage	Long Term Debt	Cash Flow	Net Tangible Asset	Plant, Property and Equipment	Asset
Full Sample								
Mean	0.6135608	0.7123135	0.1984453	0.1716358	0.0483884	0.844402	0.6133571	15.47061
High Leverage								
Mean	0.6332229	0.6314213	0.3392035	0.2979494	0.024854	0.671897	0.6330211	15.77256
Low Leverage								
Mean	0.5990042	0.7723352	0.0944969	0.0784155	0.0661611	0.97203	0.5988086	15.24706
Large Firm								
Mean	0.5630066	0.7501364	0.204446	0.1772311	0.0640256	0.765395	0.5630066	17.0944
Small Firm								
Mean	0.6577957	0.678	0.1931843	0.1667106	0.0347608	0.913808	0.6575892	14.04979
Bust(1998-2003)								
Mean	0.5138774	0.4778966	0.2574176	0.1547922	-0.0094575	0.548361	0.5138774	15.46505
Boom(2004-2010)								
Mean	0.5373245	0.7139776	0.1898706	0.1946754	0.0601506	0.901435	0.5373245	15.46053

From Table 1, we see that the firms with different financial structure, firm size and in different markets, would exhibit various investment and financing behavior. The full sample is used to investigate the overall effect of collateral assets on investment and debt decisions; the subsamples are used to investigate the effects of collateral assets in financially constrained and unconstrained firms, and in the market expansion and contraction ("boom" and "bust") phases of the market cycle.

We conduct the correlation analysis to detect potential collinearity in the regressions. The Table 2 shows the correlations among variables. The Plant, Property and Equipment have larger correlation with investment even in the lag term. It is not surprising because in each year the capital expenditure (investment) is added to Plant, Property and Equipment. For the projects lasting for several years, the investment in last year would be closely related to the investment this year. Yet we argue that the Plant, Property and Equipment in the firm include complete properties and land which can be used as collateral, which are additional factors that may impact the investment behavior. To disaggregate the effect of the collateral channel from endogenous investment trend, we use the variables of Buildings and Land which are included in Plant, Property and Equipment in last period. It is reasonable to argue that the variable Buildings in the last period would never be directly correlated with investment in next period.

Table 2 : Correlations for the corporate investment regressions

	Investment	Market to Book (Lag)	Leverage	Long Term Debt	Cash Flow	Net Tangible Asset (Lag)	Plant, Property and Equipment (Lag)
Investment	1						
Market to Book (Lag)	0.0093	1					
Leverage	-0.0402	-0.1199	1				
Long Term Debt	0.1123	0.0363	0.5937	1			
Cash Flow	0.1396	0.1493	-0.4549	-0.0003	1		
Net Tangible Asset (Lag)	0.2742	0.0641	-0.257	-0.0078	0.2678	1	
Plant, Property and Equipment (Lag)	0.5913	-0.0913	-0.0267	0.007	0.0895	0.5966	1

Table 3 is the description for the dataset sample for the regressions of debt decisions.

Table 3: The Variable Descriptions for Debt Financing Regressions

All variables are normalized by the book asset in the ending of the year except the variable AST. The firm size, which is the book asset, is deflated by the GDP of that year to 1981. LTDC is the change of long term debt; LTD is long term debt; CF is cash flow; MTB is the market to book ratio; PPE is plant, property and equipment; NTA is net tangible asset; BLD is the buildings; DIV is the dividend; NIE is newly issued equity; DFA is disposed fixed asset; and AST is deflated book asset.

	LTDC	LTD	CF	MTB	PPE	NTA	BLD	DIV	NIE	DFA	AST
Mean	0.010903	0.146435	0.029145	0.729312	0.534384	0.728583	0.15649	0.022299	0.023934	0.030459	14.46396
Median	0	0.118436	0.035764	0.56	0.517919	0.692522	0.005907	0.008622	0	0.000874	14.35757
Maximum	4.14898	4.14898	5.022918	9.58	9.524105	9.68865	1.455022	2.916963	1.477779	3.966655	18.2559
Minimum	-1.72863	0	-5.17927	-7.6	0	-3.84833	0	0	-0.00016	-0.11564	9.787071
Std. Dev.	0.198614	0.193159	0.290936	0.825328	0.517893	0.525058	0.279839	0.106961	0.09598	0.172732	1.869962
Observations	961	999	978	1003	994	1008	419	996	941	928	1005
Cross sections	51	51	51	51	51	51	51	51	51	51	51

5.2 The effect of Collateral Assets on Corporate Investment

This section gives the regression results of the effect of collateral assets on corporate investment. In accordance with the Proposition 2 that collateral assets facilitates corporate investment by providing low-risk debt capacity; it lowers the investment threshold and increase corporate investments.

Table 4 shows that the collateral assets in the last year significantly increases the fixed investment in the current year after controlling for the investment opportunity, cash flow and leverage. In all regressions, the coefficients for collateral assets, measured by Net Tangible Asset, PPE or Buildings, are positive and significant at least at 5% level. It is obvious that the assets-in-place in the firm affect the investment patterns. From the theoretical model, the liquidity asset may act two roles to obtain the funds for the firm: one is through liquidation and the other is to use it as collateral to obtain external financing. Our test is concerned with the latter effect as collateral channel. The income of asset sale is included in the Cash Flow. In the unreported regression results, the variable Disposed Fixed Asset is used to estimate the effect of asset sale on investment. However, the coefficient for this variable is ambiguous and not significant in some regressions. It is noticeable that, after controlling the funds from selling fixed asset, the collateral assets still significantly increases the investment in next year. This effect may be attributed to the collateral channel that collateral assets enhances debt capacity for the firm. This channel is further examined in regressions below.

Contrary to standard investment literature, the coefficients for Market to Book ratio are negative. A potential reason is that the Tobin Q or Market to Book is not so effective variable to measure investment opportunity as we can see from the statistical description that the market to book ratio is always less than 1 in the real estate companies. To avoid the criticisms on Market to Book value (or Tobin Q), we use the Property Return to proxy for the investment opportunity in the market. This proxy is reasonable because the direct real estate market determines the investment opportunities the firm faces and the firm may depend on past property returns to make investment. This variable is not correlated with the unobservable factors in the individual firm which may help solve the potential endogeneity problem. The coefficients for Property Return are positive and significant at 1% level except in column (6). The regressions in column (4), (5) and (6) show similar results for the coefficients of other independent variables. It may indicate that the return in the direct market is a good substitute for Market to Book ratio to control for investment opportunity. The coefficients of Property Return in column (6) are positive but insignificant. A possible reason is that by including Buildings the sample is relatively small and irregular with much data missing.

The cash flow-investment sensitivity literature argues that this sensitivity represents financial constraints for the firm that cannot access to perfect capital markets. The theories and evidences are still ambiguous in the literature. In our regressions, the coefficients for Cash Flow are positive but only significant in column (1). It may indicate that for real estate companies it is difficult to only depend on internal funds because real estate projects need large sums for investment and expenditure. They have to rely on external financing to execute the projects.

The effect of debt financing on corporate investment is ambiguous in the theory. The tradeoff theory argues that the debt generates benefits like interest tax shield and cost like agency problem and financial distress. The empirical evidences are also contradictory. Aivazian, Ge and Qiu (Aivazian et al., 2005)show that leverage is negative with corporate investment due to the agency problems of the debt. Yet Korteweg (Korteweg, 2010)identifies the net benefits of leverage in the market value of firm, indicating that leverage would not always have negative effects. In our model, the debt actually benefits corporate investment firstly by relaxing financial constrains; and then it decreases investment due to increasing capital cost. In the regressions, the coefficients for Long Term Debt are positive and significant at 1% level in the regression (1) and (4). But the coefficients are negative and significant in the repressions (2) and (5). The coefficients are positive but not significant for regressions (3) and (6). In our theoretical model with financial constraint and friction, the debt plays role to provide funds for investment but may also reduce investment due to high cost of capital. On the other hand, the leverage may reflect lending relationships that give the firm more financial resources by borrowing or firm quality because the firm has good investment opportunity and thus wants to use more debt.

The theoretical model predicts that the debt-investment relationship exhibits an inverse U-Shape that the debt increases the investment first and then decreases it (The below empirical tests will investigate this relationship). However, the dominate effect may be positive as the real estate industry depends heavily on debt financing. The regressions with PPE have negative and significant coefficients that seem to contradict these predictions. However, for the interaction term LTD*PPE the coefficients are positive and very large with the significance at the 1% level. If this interaction term is removed from the regressions, the coefficients for Long Term Debt turn positive and significant.

In addition to the direct regression with collateral assets on the investment, the interaction term provides more evidence to support the collateral channel, i.e. that the collateral assets provides debt capacity. For the interaction term, the coefficients in all regressions are positive which is consistent with the predictions of Proposition 2. It indicates that with more collateral assets, the firm can make more investments through employing more long term debt. Yet the coefficients for this variable in column (1), (4) and (6) are not significant (although it is positive). We will make future investigation in following studies.

Table 4: The effects of collateral assets on capital expenditures: basic results

Investment regressions: ordinary least squares estimates. The sample is an unbalanced panel data of real estate companies in Hong Kong between 1980 and 2010 from DataStream. The dependent variable Investment is the capital expenditures normalized by the beginning-of-period book asset value. The independent variables, Cash Flow, Net Tangible Asset, PPE (Plant, Property and Equipment) and Buildings are all normalized by the beginning-of-period book asset value. Property Return is calculated from the price indices of private domestic by all class published Hong Kong Government. The Long Term Asset is the ratio between long term debt and total asset. Firm Size is the log of book asset value of the firm which is deflated by GDP. The proxies for collateral assets are Net Tangible Asset, PPE and Buildings. Their coefficients are expected to be positive. White standard errors are presented in parentheses. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively

	(1)	(2)	(3)	(4)	(5)	(6)
Market to Book	-0.10854**	-0.044199	-0.19079			
	(0.046904)	(0.032764)	(0.117765)			
Property Return				0.30135***	0.283984***	0.009901
				(0.076021)	(0.050961)	(0.183732)
Cash Flow	0.33999**	0.114585	0.238482	0.232046	0.057269	0.70867
	(0.180873)	(0.126712)	(0.381922)	(0.21758)	(0.104492)	(0.429311)
Long Term Debt	0.7413***	-0.303981*	0.015944	0.64302***	-0.391485**	0.537294
	(0.214108)	(0.173103)	(0.409545)	(0.235168)	(0.172399)	(0.727158)
Net Tangible Asset(-1)	0.17015**			0.180948**		
	(0.085987)			(0.08844)		
PPE(-1)		0.228774**			0.244437**	
		(0.099657)			(0.106192)	
Buildings(-1)			0.2498***			0.247384**
			(0.079431)			(0.095502)
NTA*LTD	0.13187			0.124567		
	(0.085121)			(0.097455)		
PPE*LTD		2.30154***			2.349593***	
		(0.20315)			(0.201728)	
Buildings*LTD			1.364124**			0.609729
			(0.599713)			(1.013395)
Firm Size	0.068582	-0.005904	0.24267**	0.06106*	0.018175	0.258355
	(0.046764)	(0.037156)	(0.094973)	(0.035127)	(0.031982)	(0.205673)
Constant	-0.600967	0.409559	-2.93966**	-0.568191	0.014728	-3.345186
	(0.69702)	(0.537206)	(1.360346)	(0.521415)	(0.445904)	(2.933646)
Firm Effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year Effect	Fixed	Fixed	Fixed	None	None	None
No. of Observations	875	869	172	890	883	176
R-squared	0.484895	0.687044	0.733134	0.409178	0.661935	0.526167
Adjusted R-squared	0.430124	0.653513	0.581338	0.369459	0.639016	0.381189

In sum, the regressions results support the Proposition 2 that collateral assets do influence the corporate investment and this effect works through the collateral debt capacity. Although the investment thresholds for projects are unobservable, collateral assets increase corporate investment at significant level. The debt financing generates ambiguous effects on the investment; yet the interaction effect of debt and collateral assets is positive with corporate investment. The increasing incorporate investment works though debt financing with collateral assets.

5.3 Investment and Collateral Debt

The Modigliani–Miller theorem argues that the firm value is independent from firm's financial structure in perfect and efficient capital market; while bankruptcy, information asymmetries, agency cost and others cause frictions to raise debt. As our theoretical model predicts, with the presence of financial constraints, the debt financing firstly mitigates the binding constraints and makes the firm invest more. Yet the mitigated financial constraints lead to riskless waiting and lower investment thresholds; the increasing debt then gives rise to high financial costs, together with optimal waiting which reduces investment. The investment-debt relationship is inverse U sharp. We will test the Proposition 1 and this hypothesis in the regressions. In addition, we argue that the firm can use collateral assets to decrease finance costs and enhance debt capacity. The firm with more collateral assets has larger debt capacity and is able to employ the debt financing to make more investment due to the lower capital costs, following the argument in Proposition 2.

Similar to the results in the previous table, the coefficients in Table 5 for market to book value and cash flow are negative and positive respectively. In all regressions, both coefficients are significant at least at 10% level. The additional variable, disposed fixed asset has positive and significant coefficient at 1% level for all regressions. This result confirms that the investment in real estate firm substantially depends on the internal funds through asset sales. After controlling for this asset sale effect, the firm still depends on debt to finance its investment.

The current debt level may be not be the amount of available credit to the firm because the firm would not always exhaust its debt capacity in each period. We test the effects of current long term debt and the change of long term debt on the fixed investment. Three variables are used to measure the debt decisions. The first one is the Long Term Debt. This variable measures the financial state in the firm over time and may not be good proxy for the current debt capacity or potential usable debt amount. Thus two other variables are used in the regressions. They are constructed to measure the firm ability to employ "additional" debt over the normal level. The Change of Long Term Debt denotes the debt utilization in contrast with previous level; the Debt Over Industry Average is concerned with debt utilization in comparison with other firms in the industry. Corporate investment, in accordance with our theoretical model, has an inverse U-shape relationship with debt utilization. Therefore the regressions include the terms of these three variables and their square terms.

The results in Table 5 confirm the inverse U shape relationship between investment and debt in the presence of financial constraint and financial friction, predicted by our theoretical model. The coefficients for the long term debt or the increase of debt are positive and significant at 1% level.

This means that financial structure is related with investment decision as the external debt increases the fixed investment by providing extra funds. These results are new in the empirical investment literature. For most studies, the debt variable does not enter into the regressions, and our results may show that debt financing is also an important tool to relax financial constraints, similar to the role of cash flow.

However, as more debt is used, the increasing capital cost caused by the potential bankruptcy or information asymmetry depresses the further investment. The coefficients for the square terms are negative and significant for the Change of Long Term Debt and Debt over Industry Average. Because the variable Long Term Debt denotes the total amount of the long term debt in the firm, it may not measure the use of long term debt in the period for investment. Thus the coefficient for its square term is not significant. But in general, we can argue that the negative effect of debt financing actually influences corporate investment.

The columns (4), (5) and (6) tests the interaction effect of collateral assets and debt on the investment. We use a dummy variable to describe whether or not the firm has more net tangible assets than the average amount in the whole sample. The firm with more collateral assets has a higher level of debt capacity and lower cost for debt. The same unit of long term debt in use would facilitate more investment as the collateral assets reduces financial frictions. In all three regressions, the interaction terms are positive and significant at least at 5% level. These coefficients for the interaction term confirm that the firm with more tangible assets would invest more through the use of long term debt.

Table 5: The effects of debt and collateral assets on fixed investment

Investment regressions: ordinary least squares estimates. The sample and dependent variables are basically the same with Table 3. To investigate the effects of debt, the variables Long Term Debt are used in the regressions to measure financial structure. Two new variables, Change of Long Term Debt and Debt over Industry Average are constructed through Long Term Debt. The Change of Long Term Debt is the difference of Long Term Debt between this year and last year. Debt over Industry is the Long Term Debt subtracted by average Long Term Debt of all firms of that year in the sample. They are to measure whether the firm utilizations "extra" long term debt. A dummy is created by Net Tangible Asset in which 1 represents that the firm has higher Net Tangible Asset than average amount in the sample, and 0 for otherwise. The interaction term is the Dummy time Long Term debt to estimate whether the firm with more tangible assets use more long term debt to invest. The coefficients are expected to be positive. Robustness standard errors are presented in parentheses. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Market to Book	-0.1319**	-0.1158**	-0.11115*	-0.2582***	-0.1828***	-0.2274***
	(0.05604)	(0.04767)	(0.05816)	(0.05961)	(0.051224)	(0.059431)
Cash Flow	0.52916**	0.33447**	0.4959***	0.53149**	0.54829**	0.679157**
	(0.209092)	(0.137459)	(0.144164)	(0.215841)	(0.235188)	(0.263305)
Deposed Fixed Asset	0.7281***	0.7504***	0.7027***	0.6850***	0.76633***	0.67285***
	(0.157592)	(0.137221)	(0.172882)	(0.171453)	(0.120749)	(0.187556)
Long Term Debt	0.6799***			1.0382***		
	(0.255225)			(0.38211)		
Square of Long Term Debt	-0.067429			-0.99976**		
	(0.081368)			(0.425656)		
Change of Long Term Debt		0.52737**			-0.075138	
		(0.227966)			(0.252954)	
Square of Change of Long Term Debt		-0.13497*			-0.3276***	
		(0.080629)			(0.097337)	
Debt over Industry Average			1.3781***			0.92842***
			(0.310203)			(0.242604)
Square of Debt over Industry Average			-0.3614***			-0.4624***
			(0.073668)			(0.094153)
NTA*LTD				1.2578***		
				(0.2897)		
NTA*LTDC					1.04616***	
					(0.324123)	
NTA*DOIA						0.842413**
						(0.339891)
Firm Size	0.048929	0.060614	-0.01935	0.038341	0.076345	-0.013162
	(0.052622)	(0.049886)	(0.051726)	(0.054114)	(0.049811)	(0.051196)
Constant	-0.144801	-0.233426	0.958998	0.034916	-0.425844	0.953766
	(0.762565)	(0.733867)	(0.767634)	(0.775472)	(0.731738)	(0.759664)

Firm Effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year Effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
No. of Observations	874	869	874	868	863	868
R-squared	0.44795	0.464695	0.499733	0.48429	0.485177	0.523332
Adjusted R-squared	0.389176	0.407341	0.446473	0.428235	0.428858	0.47152

5.4 Debt and Collateral Assets

In this section, we directly search for evidence of the collateral channel, by the regressions of the long term debt with collateral assets. We do not test capital structure theory, but are concerned with the relationships of debt utilization, financial flexibility and collateral assets.

Similar to the previous regressions, collateral assets is represented by Plant, Property and Equipment, Net Tangible Asset and Buildings respectively. It is expected that the collateral assets has a positive effect on the corporate borrowing as it lowers the capital cost, according to the Proposition 2.1. The dependent variables for debt decision are Long Term Debt and Change of Long Term Debt. As discussed before, these two variables measure the financial state and the increasing debt utilization respectively.

Table 6 presents the results for the regressions of collateral assets over corporate lending. Unlike the studies in capital structure, for instance, Faulkender and Peterson(Faulkender and Petersen, 2006)), the coefficients for Market to Book ratio are positive except the one in column (4). It is consistent with the intuition that when the firm faces more investment opportunities, it would rely on more long term debt to finance the investment. The coefficients for Cash Flow are consistently negative but not significant.

In accordance with Proposition 3, the existing debt (debt in previous period) would erode the debt capacity for current corporate investment, which leads to less utilization of debt. The coefficient of variables for previous debt should be negative in the regressions. However, in regressions (1), (2), (3) and (4), the coefficients of Long Term Debt in previous period are positive and significant at least at 10% level. Yet the regression results with Change of Long Term Debt are consistent with the predictions of theoretical models and the coefficients of lagged Change of Long Term Debt are negative and significant at 1% level. The Long Term Debt in lagged period has opposite effects on the Long Term Debt and the Change of Long Term Debt in this period. As the long term debt always lasts for several years, the debt in last year would be positively related to the amount of debt in this year. However, when there exist a large amount of long term debt in last period, the current debt capacity is small and thus the increase of long term debt should be lower. These contradictory results are reasonable as Long Term Debt and Change of Long Term Debt represent different debt amounts.

We also investigate the effects of alternative capital resources on the debt financing. The Disposed Fixed Asset gives internal capital for the firm which plays a substitute role to external debt financing. The coefficients are consistently negative. The coefficients of Dividend in the regressions of Long Term Debt are positive, which may indicate that to pay the dividend the firm would issue more long term debt (not generally considered a wise financial management option). But in the regressions of the Change of Long Term Debt, the coefficients are basically negative. These results are consistent with the argument that the flexibility of cutting dividend payment plays a similar role in firm investment as using more debt. The New Issued Equity has positive relationships with long term debt and its change. It may mean that with more equity, the firm may have a larger debt capacity and thus use more long term debt. In our study, the firm size does not significantly affect the long term debt and its change.

We focus on the effect of collateral assets on corporate lending to test Proposition 2.1, that the firm with more collateral assets would use more debt. The Property, Plant and Equipment have positive and significant effect on the long term debt. Previous studies have confirmed that the tangibility of assets increases firm leverage. But our study differs in that we use the long term debt and its change rather than total debt to assess the tangibility effect. The asset that can be used as collaterals directly increases the long term debt and more importantly, the potential debt capacity, as the change of long term debt. It should be noticed that here there may be an endogeneity problem as the investment in the firm increase the PPE and long term debt simultaneously; but this problem may not be severe if the dependent variable is the Change of Long Term Debt as the investment may not be directly related to the ability to use more debt.

Additional tests are run by using the Net Tangible Asset to denote the collateral assets. The variable Net Tangible Asset has negative but insignificantly coefficients in the regressions, which is inconsistent with our proposition. To investigate potential implications, we include the square term of NTA and interaction term of NTA*MTB. After including the square term of NTA or the interaction term, the adjusted R-squared increases significantly for each regression. The coefficients for NTA are negative and significant at 5% level; while the coefficients for square term are positive and also significant at 5% level. It indicates that the firm with more tangible assets would have lower ratio of long term debt and use less debt capacity; with the increasing of the tangible asset, the trend of lower long term debt and less utilization of debt capacity is mitigated. The possible explanation is that other effects of net tangible assets, for instance that the tangible assets generates more internal cash, dominate its collateral effect to issue lower cost of debt. The interaction term of Net Tangible Asset and Market to Book value has positive and significant coefficients at 1% level. It means that when facing investment opportunities, the Net Tangible Asset plays positive role in the use of long term debt and debt capacity to finance for the investment. This result is consistent with our predictions.

Table 6: The effects of collateral assets on corporate lending

Financing decisions regressions: ordinary least squares estimates. The sample and dependent variables are basically the same with Table 4. Long Term Debt and Change of Long Term Debt are the dependent variables to measure the corporate lending in the firm. Still Net Tangible Asset and PPE are the independent variables to proxy for collateral assets in the firms. It is expected that the coefficients of collateral assets are positive. The square term and interaction term are also included in the regressions. White standard errors are presented in parentheses. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively.

	Long Term Debt				Change of Long Term Debt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Market to Book	0.017277	0.019389	0.023564**	-0.019382	0.050704***	0.052465***	0.057259***	0.010869
	(0.011003)	(0.011921)	(0.010441)	(0.020691)	(0.018159)	(0.019322)	(0.015973)	(0.028103)
Cash Flow	-0.248794	-0.296032	-0.151044	-0.230191	-0.246734	-0.285492	-0.144808	-0.226519
	(0.161462)	(0.186638)	(0.103782)	(0.144339)	(0.164599)	(0.1897)	(0.100389)	(0.14527)
Net Tangible Asset	-0.091992		-0.249812**	-0.122581*	-0.075152		-0.239714**	-0.10839
	(0.068971)		(0.113461)	(0.068155)	(0.069352)		(0.114512)	(0.06785)
Square of NTA			0.057224**				0.059669**	
			(0.024756)				0.0257	
NTA*MTB				0.110579***				0.120157***
				(0.033582)				(0.030251)
PPE		0.089004***				0.073952***		
		(0.031151)				(0.025115)		
Long Term Debt (-1)	0.186479*	0.195325*	0.161435*	0.236717**	-0.55591***	-0.54889***	-0.58202***	-0.50132***
	(0.102377)	(0.102537)	(0.081894)	(0.094983)	(0.137353)	(0.137861)	(0.115973)	(0.132559)
Disposed Fixed Asset	-0.068899**	-0.12136***	-0.037337	-0.063615**	-0.048037	-0.0916***	-0.015127	-0.042295
	(0.027472)	(0.038436)	(0.028512)	(0.030326)	(0.030737)	(0.029773)	(0.028182)	(0.028402)
Dividend	0.11707**	0.128268**	0.011955	0.083719*	-0.002658	0.006889	-0.112263*	-0.038897
	(0.05297)	(0.056032)	(0.052784)	(0.042785)	(0.054749)	(0.052941)	(0.065023)	(0.045382)
New Issued Equity	0.580032***	0.472278***	0.604109***	0.279811	0.37899**	0.290785	0.404096***	0.052766

	(0.1372)	(0.172092)	(0.134637)	(0.213049)	(0.169647)	(0.190592)	(0.147665)	(0.145573)
Firm Size	-0.009008	0.015706	-0.00501	0.001389	0.016582	0.036805**	0.02075	0.027879
	(0.020386)	(0.172092)	(0.016669)	(0.017823)	(0.021741)	(0.015435)	(0.018342)	(0.01912)
Constant	0.300584	0.015706	0.311724	0.137011	-0.129891	-0.51618	-0.118274	-0.307631
	(0.345623)	(0.012764)	(0.302695)	(0.301013)	(0.362138)	(0.220623)	(0.320083)	(0.313052)
Firm Effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Year Effect	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
No. of Observations	864	864	864	864	864	864	864	864
R-squared	0.480325	0.47499	0.590896	0.551813	0.371823	0.368674	0.49084	0.455386
Adjusted R-squared	0.422807	0.416881	0.54503	0.501566	0.302295	0.298798	0.433756	0.394327

5.5 Interest Coverage and Interest Payment

This section tests the effect of collateral assets on the interest payment of total debt in the firm. Following the logic in the theoretical model, if the firm has financial flexibility in collateral assets, it can obtain external debt financing with lower capital cost. As the model argues, the debt capacity created by the collateral assets provides to the firm cheap resources, which lower down the investment threshold of investment. If it is true, we could observe that the firm with more collateral would pay less cost for the debt. We use the Interest Coverage and Interest Payment to test this hypothesis. Due to the lower capital cost of collateral debt, the collateral assets is expected to relate to Interest Coverage positively and to Interest Payment negatively, in accordance with the Proposition 2.2.

Interest Coverage is calculated by operating earnings before depreciation over interest expense. And the Interest Payment is measured as interest expense divided by total debt. The problem for Interest Coverage is that the earning may be negative and interest expense may be zero. We set the value of earning over interest expense to be zero if the earning is negative and to be 10000 if the interest expense is zero. Following the study of Faulkender and Petersen (2006), the log of 1 plus the value of earning over interest expense is taken the variable Interest Coverage. We use a Tobit model to estimate the effect of collateral assets on interest coverage with a lower and upper limit. For the regressions with Interest Payment, the pooled panel regressions are conducted similarly to previous studies.

If the collateral channel works, the collateral assets reduces the capital cost of debt and the unit interest expense for debt. Because we cannot separate out the collateral debt and common debt, the total interest expense is used in the regressions to measure the cost of external debt. The amount of total interest expense may not precisely show whether the capital is cheap or expensive: the firm with financial flexibility accesses to lower unit cost of capital and also employs more of this category of capital, which actually may increases the total capital cost. To control for the quantity effect of capital, the Long Term Debt in previous period is included in the regressions[10].

The results in the Table 7 partially confirm our arguments that the collateral assets provides lower cost capital for the firm. In the regressions of dependent variable Interest Coverage, the coefficients for Net Tangible Asset and Buildings are positive and significant at 1% level. The coefficient is also positive for the variable PPE but it is not significant. These results may indicate that the collateral assets plays a positive role in reducing the interest expense, which leads to higher interest coverage. In the regressions of dependent variable Interest Payment, the coefficients for Net Tangible Asset and Buildings are negative and significant at least at a 5% level. The coefficient for PPE, however, is positive but not significant. When the lagged term of PPE is included in the regression, the coefficient turns negative and significant at 1% level.

[10] We also use the dependent variable of Leverage, which is the total debt over total asset, to replace with Long Term Debt, and also use the Long Term Debt in current period rather than previous period. All the regression results are similar and have the same signs and t statistics as the reports in Table 7.

Table 7: The effects of collateral assets on interest expense

The sample and dependent variables are basically the same with Table 6. The dependent variables are Interest Coverage and Interest Payment. Still Net Tangible Asset, PPE and Buildings are the independent variables to proxy for collateral assets in the firms. For the Tobit model, the lower and upper limits are 0 and 9.21. White standard errors are presented in parentheses for the regressions with pooled least square. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively

	Interest Coverage (Tobit Model)			Interest Payment (Pooled Least Square)		
	(1)	(2)	(3)	(4)	(5)	(6)
Market to Book	0.2171634**	0.2311972**	0.6271832***	-0.00215***	-0.00211***	-0.00438***
	(0.0995714)	(0.0989837)	(0.1452797)	(0.000646)	(0.000802)	(0.000745)
Cash Flow	0.3477411	0.6039237**	0.0012611	-0.01207***	-0.01512***	-0.01428**
	(0.2591134)	(0.2354105)	(0.2547997)	(0.004731)	(0.005718)	(0.006653)
Net Tangible Asset	0.9738468***			-0.007104**		
	(0.2057105)			(0.0024)		
PPE		0.0091373			0.00226	
		(0.2257347)			0.001705	
Buildings			1.204029***			-0.0067***
			(0.4209577)			(0.002462)
Long Term Debt (-1)	-2.95075***	-3.38223***	-4.1147***	0.035845***	0.037271***	0.041007***
	(0.5073472)	(0.502514)	(0.6629144)	(0.005859)	(0.00585)	(0.006376)
Disposed Fixed Asset	0.0287974	0.1397602	1.760861	0.011305***	0.00989***	-0.024906*
	(0.4270873)	(0.4554742)	(1.44175)	(0.004294)	(0.003668)	(0.012879)
Dividend	1.726942**	1.594931**	9.020158**	-0.008649*	-0.009269**	0.010329
	(0.731026)	(0.7463153)	(5.207717)	(0.004518)	(0.003623)	(0.031123)
New Issued Equity	-1.863666**	-0.8707838	-4.22596***	0.016147	0.008467	0.021543*
	(0.7908193)	(0.7602552)	(1.022494)	(0.011644)	(0.012407)	(0.01191)
Firm Size	0.0569134	-0.0594167	-0.2874855**	-0.00379***	-0.002018*	-0.00475***
	(0.0903606)	(0.0863627)	(0.116813)	(0.00121)	(0.001163)	(0.001184)
Constant	0.8531466	3.226138**	6.46203***	0.069633***	0.037596**	0.079132***
	(1.364923)	(1.2637)	(1.724787)	(0.018235)	(0.016788)	(0.017648)
Firm Effect	Random	Random	Random	Fixed	Fixed	Fixed
Year Effect	None	None	None	Fixed	Fixed	Fixed
No. of Observations	862	862	374	865	865	376
R-squared				0.548542	0.529726	0.749626
Adjusted R-squared				0.498638	0.477742	0.679556

As the dependent variables Interest coverage and Interest Payment are calculated by interest expense in the denominator and numerator respectively, it is reasonable to have opposing results of coefficient signs in two types of regressions. An interesting result is that more previous Long Term Debt decreases the interest coverage ratio and increases the interest payment. This finding is consistent with the Proposition 3 that existing debt has a negative effect on debt capacity and makes the firm more likely to depend on the risker debt financing.

In sum, the results show that collateral assets would increase the interest coverage ratio and decrease interest charge ratio on the debt. These findings lend strong support to the collateral channel and explain why the asset tangibility increases leverage. The Proposition 2.2 in the theoretical model is consistent with the findings. Additionally, the Proposition 3 is also confirmed in the tests, as the lagged long term debt decreases interest coverage ratio and increase interest payment on the total debt.

4.5 Robustness Tests on Financial Constraint and Collateral Channel

The literature on financial constraints always splits the sample into financial constrained and unconstrained firms. The investment behavior and financing decisions may differ in these two categories. Following the previous studies, we divide the full sample into two sub samples as constrained and unconstrained by the financial leverage at the end of previous year. If the leverage of the firm is higher than the median leverage of the whole sample at the beginning of the year, this firm is assigned into the constrained group; otherwise is in the unconstrained group. The unconstrained firm has sufficient internal funds or can borrow risk less capital; and it does not rely on expensive external financing. Thus the collateral effect may not be as substantial as the one in the constrained group. It is expected that the coefficient for collateral assets in the regression of fixed investment and debt utilization is larger in the constrained group than the unconstrained group.

Table 8 and Table 9 report the regression results of corporate investment and debt financing respectively. In the Table 8, the coefficients for Long Term Debt for the constrained group (column 1 and 3) are negative and significant; while the coefficients for the unconstrained group (column 2 and 4) are positive although only significant in the column 2. These results confirm the inverse U-Shape between the investment and long term debt. For the unconstrained firm, external debt financing provides funds to finance investment without much more capital cost; yet for the constrained firm, the external debt financing may impose large capital cost which then reduces investment. The results are similar if the variable the change of long term debt is used to replace the variable long term debt.

Our theoretical models argue that the collateral assets can be used to obtain lower cost of capital. When the firm is unconstrained, it has sufficient internal funds and also large debt capacity for lower cost capital. Thus it may not rely on collateral assets to issue loans to make investment. The situation is opposite to that for the constrained firm: it is difficult to access the external capital market and it has to depend heavily on collateral assets to guarantee the external debt. The regressions results are consistent with these findings. The coefficient for lagged Net Tangible Asset in constrained firms is larger than the one in unconstrained firms, although the coefficients in lagged PPE are similar in the two groups. When it comes to the interaction term of collateral assets and long term debt, it is obvious that the constrained firm rely more on collateral assets to issue debt for the investment, as the coefficient in column 3 is 3.043244, much larger than 2.088605 in column 4.

Table 8: The effects of collateral assets on fixed investment: constrained and unconstrained groups

Investment regressions: ordinary least squares estimates. The dependent variable Investment is the capital expenditures normalized by the beginning-of-period book asset value. The independent variables are the same in the previous regressions, except that the sample is divided into constrained and unconstrained groups according to the leverage in the ending of last year. Robustness standard errors adjusted for clusters for firm are presented in parentheses. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively

	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	-4
Market to Book	-0.058529*	-0.1142637**	-0.0118898	-0.0784184
	(0.0295951)	(0.0534746)	(0.0090191)	(0.0549695)
Cash Flow	-0.083134	0.7447544	0.1189593*	0.3420384
	(0.2221885)	(0.4682616)	(0.0607237)	(0.3310065)
Long Term Debt	-0.6643118*	0.7825417**	-1.52003***	0.0678676
	(0.3934484)	(0.3824972)	(0.2625489)	(0.3260746)
Net Tangible Asset(-1)	0.2341951**	0.1752485**		
	(0.1084484)	(0.0832908)		
PPE(-1)			0.2272961***	0.2298204*
			(0.0696152)	(0.1145531)
NTA*LTD	1.355443	-0.0227337		
	(0.8745275)	(0.1068835)		
PPE*LTD			3.043244***	2.088605***
			(0.2178971)	(0.361858)
Firm Size	0.0000962	0.0578672	0.041546	-0.0047316
	(0.0609208)	(0.0736715)	(0.0265797)	(0.0788443)
Constant	0.4459963	-0.4436463	-0.2138772	0.4299202
	(0.8800868)	(1.006791)	(0.3630304)	(1.086415)
Firm Effect	Fixed	Fixed	Fixed	Fixed
No. of Observations	433	442	428	441
R-squared	0.1734	0.1085	0.8104	0.3841

Table 9 reports the results of the collateral effect on the change of long term debt. The long term debt in the last period has more severe effect on the current debt decision for the constrained firm, as seen by the coefficients for lagged Long Term Debt being negative and smaller for column 1 and 3 than column 2 and 4. Because the constrained firm has already more restricted debt capacity, the existing past debt erodes this debt capacity and would limit the ability to issue more debt in this period. Also, the results show that the constrained firm would sell fixed assets more to finance investment rather than issue long term debt (note the absolute values of the coefficients for the constrained group are much larger than the ones in unconstrained group).

Similar to the logic introduced in the last table, the constrained firm has to depend substantially on the collateral assets to issue more long term debt. The results in Table 9 again confirm this prediction. The coefficient for Net Tangible is positive in the constrained firms but negative for the unconstrained firms although both coefficients are not significant. The coefficients for PPE are both positive and significant for the two groups. The coefficient for constrained firms has a larger value than the one in unconstrained firms. It indicates that the same unit of collateral assets can support the issue of more debt in constrained firms because the unconstrained firms may not use the debt capacity backed by collateral assets.

Table 9: The effects of collateral assets on debt financing: constrained and unconstrained groups

Investment regressions: ordinary least squares estimates. The dependent variable is the change of long term debt. Robustness standard errors adjusted for clusters for firm are presented in parentheses. Significance at the 1%, 5% and 10% level is indicated by ***, ** and *, respectively

	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)
Market to Book	0.0496047***	0.0204381	0.04977***	0.0278684
	(0.009653)	(0.0202549)	(0.009093)	(0.0192201)
Cash Flow	-0.0125775	-0.3383726	-0.0163112	-0.3869733
	(0.0811636)	(0.2421007)	(0.078957)	(0.2629059)
Net Tangible Asset	0.0150158	-0.0921915		
	(0.0292326)	(0.0879254)		
PPE			0.0764668**	0.0607448*
			(0.0365771)	(0.0327954)
Long Term Debt (-1)	-0.500156***	-0.4020349	-0.49554***	-0.453421***
	(0.1125109)	(0.130537)	(0.1126167)	(0.1072317)
Disposed Fixed Asset	-0.3052502*	-0.0562908	-0.2653068*	-0.09147***
	(0.1596079)	(0.0362702)	(0.1563157)	(0.033416)
Dividend	1.326981	0.002912	1.111169	0.0105716
	(0.9361751)	(0.0527679)	(0.91055)	(0.0472982)
New Issued Equity	0.301157**	0.5425604**	0.3120152**	0.3798491*
	(0.1351824)	(0.2546626)	(0.1360339)	(0.2246739)
Firm Size	0.074453***	-0.0167834	0.077941***	0.0055156
	(0.0256846)	(0.027621)	(0.0265162)	(0.0161708)
Constant	-1.054725	0.3572217	-1.14045***	-0.0621495
	(0.3797114)	(0.4535965)	(0.400213)	(0.2307346)
Firm Effect	Fixed	Fixed	Fixed	Fixed
No. of Observations	427	437	427	437
Adjusted R-squared	0.0982	0.4247	0.0986	0.4115
F	14.31	10.1	22.7	42.18

6. Conclusion

In a comprehensive survey, Graham and Harvey (Graham and Harvey, 2001)show that the financial flexibility is the most important factor that influences the debt decision. They find that "firms that value financial flexibility are more likely to value real options in project valuation, and the difference is not significant". Financial flexibility is similar to real flexibility, in that firms use some debt capacity for investment but still preserve unused capacity for future opportunities. There is no theoretical study that explains the finding of financial flexibility in the survey and the intuition of the similarity between financial and real flexibility. Our study addresses this gap. We construct a theoretical model that values both real flexibility and financial flexibility dynamically and simultaneously. The interaction of real and financial flexibility enhances the firm value. The results show that the financial decision affects the investment decision. The firm makes decisions to issue the debt in responding to its current and future investment opportunities.

In addition, we propose a category of financial flexibility, as the firm can use its collateral assets, for instance land or property, to issue debt. This collateral channel has been identified at the level of the real business cycle (Kiyotaki and Moore, 1997). We investigate the collateral effect of tangible assets in corporate investment, which links assets in place with growth opportunities in the firm. Collateral assets plays the role to facilitate investment through its collateral debt capacity. The firm may choose to liquidate assets or use it as base to obtain lower capital cost for the investment. We emphasize the importance of collateral assets and find that it can affect the investment and financing decisions theoretically and empirically.

Data from real estate firms in Hong Kong are used to test the implications from the theoretical model. The results can be summarized as follows: (1) debt influences investment decision, in which the debt firstly releases the financial constraint for investment and then imposes financial frictions; (2) collateral assets increase the investment through its role to enhance debt capacity if the firm faces financial constraints; (3) the firm has ability to use more long term debt if it owns more collateral assets; (4) the interest charge for long term debt lowers in the firm with more collateral assets; (5) financially constrained firms have to depend substantially on collateral assets to invest and issue debt. In sum, we confirm the collateral channel in the firm level. Financial flexibility in the firm is important to determine debt decision and also investment decision.

In future studies, the proxy for collateral assets should be investigated as fixed assets or tangible assets may not be fully used to collateralize debt. A more precise variable to measure the collateral assets is needed. In our study, we do not distinguish firm decisions to sell the collateral assets or to use it to issue debt. We do not consider the conditions under which the firm would sell assets or use loans to fund investment. In the empirical study, the real estate firms which have a large portion of collateral assets and rely heavily on external debt financing are used to confirm the collateral channel, Future research may also test financial flexibility and the collateral channel in traditional industries like manufacturing.

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