Corporate Financing and Investment Decisions
When Equity Issuance Reveals Managers’ Information to Investors

ABSTRACT
I study how a firm raises capital in a repeated game under dynamic adverse selection. The model considers a firm that must issue debt or equity to finance two sequentially arrived investment projects. An equity issuance is assumed to be more expensive than debt but can reveal managers’ information to potential investors and thus reduces the future’s information asymmetry between the firm and the capital market. In equilibrium, a firm will issue equity as a preferred choice if the incremental benefit from the future project outweighs today’s adverse selection cost. This finding suggests that empirically observed violations of the pecking order theory can nevertheless be consistent with information asymmetry being a main capital structure determinant. In support of model predictions, I find that seasoned equity offerings are less and less underpriced when firms conducting more and more SEOs. In addition, this underpricing reduction effect is stronger for firms going public in the cold market.
I. Introduction

How do firms finance their investment projects in a market with frictions? Since the first appearance of Myers and Majluf (1984), the capital structure literature has constantly debated about the validity of the pecking order theory. Despite the insightful argument about the adverse selection cost, much of the empirical evidence seems not in favor of the model prediction.\(^1\) Specifically, equity issuance activities are typically conducted during good times, e.g., high stock valuation, rather than under duress (Fama and French 2005). In this paper I propose an intertemporal financing model to reconcile the classical pecking order theory with the seemingly contradictory empirical evidence.

To start the benchmark model, consider a firm living in a two-stage economy, defined as today and the future, with each stage facing an investment project that requires external financing. The firm can raise capital through either debt or equity issuance. As in Myers and Majluf (1984), literature often treats the financing decision as a static game (i.e., as if a firm issues equity or debt just once). Yet practically, the typical corporation raises capital many times throughout its life, and the choice a firm makes in one financing round reveals information that can impact future issuances. Thus the problem of raising capital will be more accurately characterized by a repeated game with investors rationally update their pricing behaviors based on the gradually revealed private information. In this paper I model how a firm raises capital in a dynamic setting. An equity issuance today is assumed to be more expensive than debt but can reveal managers’ information to potential investors and thus reduces the future’s information asymmetry between the firm and the capital market. This information revealing mechanism rationalizes the incentive for a firm to pursue the more costly financing method, i.e., equity.

Imagine a simple scenario that the economy has one good firm, one lemon, and a sufficiently large number of average firms. The capital market initially does not know a firm’s

\(^1\)At best, the literature agrees that the evidence on testing the pecking order theory is inconclusive (Leary and Roberts 2010).
type and therefore prices all firms based on the average quality. As a result, the good firm has to distribute a large amount of proceeds to potential investors in order to raise capital. However, when the good firm is capable of overcoming today’s adverse selection cost and successfully raise capital from the equity market, the future investors will know it’s true productivity and in turn price it as a good firms. Formally, I consider the economy consists of a spectrum of firms with different profitability types. In the two-stage game, when an equity issuance today can reveal management’s information (i.e., a firm’s type) to potential investors, a firm will consider the intertemporal tradeoff when raising capital. If the incremental benefit generated from the future’s project is large enough to outweigh today’s adverse selection cost, a firm will issue equity today to maximize its two projects’ total payoff. In equilibrium, all firms above a threshold type will issue equity to lower their future’s financing cost, whereas firms with profitability type below this threshold will issue debt.

The model also captures the impact on a firm’s investment efficiency. As shown in Myers and Majluf (1984), the adverse selection problem caused by the lemons (Akerlof 1970) will make managers want to pass up some positive NPV projects. However, when issuing equity can reveal managers’ information to potential investors, it provides a possible path to overcome the lemons problem. Thus, the decision to issue equity is accompanied by an improvement in the investment efficiency. When financing with equity is available, some small NPV projects, which would have been forgone if there is no access to the equity market, can also receive funding.

The main implication of the model is that it predicts the financing patterns across time. Several other implications are in line with prior literature’s predictions. For instance, as in Myers (1977), equity issuances are more preferred when the growth opportunity is high. I test the role of asymmetric information in a repeated game by examining the evolvement of underpricing patterns of seasoned equity offerings (SEOs). Specifically, I pool SEO announcement cumulative abnormal returns (CARs) according to the announcement chronological order, i.e., a SEO announcement is marked as the \(n^{th}\) time in its history. This pooling can alle-
violate the impact of temporary market factors, like a temporary liquidity shock, and thus represents the more persistent determinant of information asymmetry. I find that the underpricing magnitude of SEOs becomes smaller and smaller as firms conducting more and more SEOs. For instance, a median firm is subject to a -2.35% CAR the first time announcing a SEO, whereas this underpricing reduces to -1.44% for the fifth time SEO announcement.

To further study the model implication, I separate firms into two groups based on whether they have conducted initial public offerings (IPOs) during hot or cold market (Alti 2006). Then I apply the same procedure to find the patterns for SEO underpricing. The results show that both groups experience the underpricing reduction effect. Especially, the underpricing magnitude for cold market IPO firms declines in a much sharper rate than hot market IPO firms. Thus, investors seem to reward a firm conducting IPO in the cold market by reducing its premium in the long run. This evidence suggests that signaling is more effective when there are less signals, which is in support of model predictions.2

This paper joins the voluminous development of the capital structure literature by studying the dynamic feature of information asymmetry.3 Since Akerlof (1970), many studies have investigated how information travels among economic agents, and how the uneven distribution of information has led to the deviation from the Modigliani and Miller’s (1958) world. For instance, Baker and Wurgler (2002) propose that firms issue equity to time the market. Dittmar and Thakor (2007) develop a model by considering the belief alignment between managers and investors. Fulghieri, Garcia and Hackbarth (2013) investigate the scenario

2This mechanism also provides an explanation for firms raising underpriced equity. Empirical evidence of underpricing in IPOs and SEOs can be traced back to early 1970s (e.g., Ibbotson 1975, Smith 1977, and Ritter 1984). Rock (1986) provides an information asymmetry model and proposes that issuing equity will suffer from the underpricing problem due to the additional compensation required by uninformed investors. Since then, the motivation for issuing underpriced equity has been a puzzle to academicians. A comprehensive review of IPO motives can be find in Ritter and Welch (2002).

3The repeated game setting has been well developed in areas like contract theory (Bolton and Dewatripont 2005). An example for early applications in the capital structure literature is Welch (1989), in which the author focuses on the equity market and models IPO and SEO underpricing patterns. Lucas and McDonald (1990) also extend the pecking order theory to infinite horizon and predict the stock price behavior around equity issues. Their model differs from this paper in that they rely on the assumption that firms have to use equity to finance the projects. More recent progresses like Bond and Zhong (2016) provide a unified framework in analyzing SEOs and repurchases.
in which assets in place and growth options have different exposure to information asymmetry. The assumption that an equity issuance today can reveal managers’ information to potential investors is more in line with the traditional signaling argument (e.g., Spence 1973, Townsend 1979, Welch 1989) and relies on the fact that the market constantly learn from the history and update its pricing behavior of securities.4,5

Aside from the information friction, other market frictions also contributes to the determinants of real world financing patterns. Numerous alternative explanations emerge to describe the discrepancy between Myers and Majluf (1984) and the empirical stylized facts. For instance, issuing equity can alleviate the debt overhang problem (Myers, 1977), reduce the bankruptcy cost (Myers 1984, Bradley, Jarrell and Kim 1984), mitigate the agency cost of debt (Jensen and Meckling 1976), enlarge a firm’s investor base (Merton 1987). Boot and Thakor (2011) develop a dynamic pecking order model by considering the agency problem between a firm’s initial owners and managers. While these explanations provide valuable insights in describing the observed financing behavior, the model in this paper explains the pecking order violation directly based on the adverse selection problem caused by information asymmetry.

This paper contributes to the long-lasting debate about the capital structure theories (e.g., Shyam-Sunder and Myers 1999, Frank and Goyal 2003, Fama and French 2005, Leary and Roberts 2010) as well as the progress on the security design problem (e.g., Nachman and Noe 1994, DeMarzo and Duffie 1999, DeMarzo 2004, Malenko and Tsoy 2018).6 As stated in Fama and French (2005), “...both the tradeoff model and the pecking order model have serious problems...Perhaps it is best to regard the two models as stable mates, with each

4More evidence on the information production and revelation can be found in Baron (1982), Welch (1989), Beveniste and Spindt (1989), Chemmanur (1993).
5Empirically, Pagano, Panetta and Zingales (1998) examine a panel of Italian firms and find that IPOs are followed by lower cost of credit. Kisgen (2006) shows that firms near a credit rating change are more likely to issue equity than debt, indicating that there exists cross impact between debt and equity financing.
6Malenko and Tsoy (2018) also focus on the asymmetric information problem and study optimal security design by an informed issuer when the investor faces Knightian uncertainty about the distribution of cash flows and demands robustness. Specifically, they includes investors’ preferences and investigate the scenario in which investors evaluate each security by the worst-case distribution. The model in this paper differs from their approach in that investors here are assumed to be risk neutral.
having elements of truth that help explain some aspects of financing decisions.” (p. 580-581). To resolve the inconsistency between the empirical evidence and the tradeoff theory, Hennessy and Whited (2005) develop a dynamic tradeoff model by endogenizing several factors like investment and leverage choices. Perhaps in complement to their approach, the model in this paper builds on the traditional pecking order theory and extends the setting to incorporate dynamic debt and equity issuing activities.

The rest of the paper proceeds as follows: Section II introduces assumptions and the model. Section III presents empirical results. Section IV discusses potential model variations. Section V concludes.

II. Model

A. Assumptions

Consider a firm living in a two-stage economy, defined as today \( (t = 1) \) and the future \( (t = 2) \), with each stage facing an investment project that may require external financing. There are no taxes or transaction costs. I assume that the manager of the firm acts on behalf of the old stakeholders so that there is no managerial distortions.

If the project requires outside financing, the manager can choose in between equity or debt issuance. As in Myers and Majluf (1984), when firms have information that investors do not have, security issuances are priced based on the average quality of all firms. This generates adverse selection problem and investors may interpret equity issuance as a bad signal of a firm’s quality. On the other hand, debt issuances may suffer less from this adverse selection problem. For instance, banks may have private information and can closely monitor the firm’s progress. Nevertheless, the terms equity and debt in this paper are more symbolic of securities that suffer from different levels of adverse selection problem rather than a strict definition. For example, private equity might be more similar to debt than equity in this paper.
To incorporate the feature of the classical pecking order theory, I first assume that issuing debt is always cheaper than issuing equity contemporaneously. As a result of this first assumption, if the raising capital problem is a single-stage game, firms will always choose debt. The second assumption is that equity issuance in the first stage \( t = 1 \) can reveal a firm’s type to investors. This assumption relies on the fact that the security market constantly updates its pricing behavior based on the observed history of a firm’s performance. For instance, an equity issuance for a good firm in the first stage may increase its exposure to a broader audience, attract more analysts and sophisticated investors to analyze it’s asset value. These impacts are very likely to reduce the information asymmetry between firms and investors and in turn make the second stage raising capital less costly. In Appendix A I provide a simplified example for the below benchmark model.

B. Benchmark Model

This is a three-date two-stage model. In each stage the firm faces an investment project that requires \( I_t \) amount of investment. Assume that all projects’ returns are realized at the end of the model \( t = 3 \) and no intermediate return is available. The firm (i.e., old stakeholders) can choose either equity or debt financing at \( t = 1 \) and \( t = 2 \).

Assume that the economy consists of firms with a type \( \rho_i \) that falls in between \([\rho_L, \rho_H]\), with \( \rho_L < \rho_H \). This type represents a firm’s profitability on its investment projects. If this firm could use internal cash to finance the investment projects, these projects would generate \( R_1 \rho_i \) and \( R_2 \rho_i \) for each project at \( t = 3 \). Under the scenario of outside financing, the realized proceeds will be divided between old stakeholders and new investors. I use \( \delta_t \) to represent the discount of external financing for old stakeholders. Specifically, denote \( \delta_d \) and \( \delta_e \) as the discount multiplier with respect to debt and equity financing, and \( \delta_t \in \{\delta_d, \delta_e\} \). Thus, one could interpret these discount multipliers as the contract between old stakeholders and new investors. Specifically, if investors know a firm’s true type, the contract between them is: Old stakeholders receive \( R_t \delta_t \rho_i - I_t \), and new investors receive \( R_t(1 - \delta_t)\rho_i \). As in Myers and
Majluf (1984), the cost of equity is assumed to be greater than the cost of debt. Assumption A1 summarizes this statement. Adopting this rule of notation, the final proceed for project $I_t$ would be $R_t \delta_t \rho_i$ for the old stakeholders if the capital market has a perfect knowledge of $\rho_i$. The timeline is illustrated in Figure 1.

![Figure 1. Timeline of events.](image)

Because of the information asymmetry problem between firms and investors, the capital market will initially estimate a firm’s type according to the average quality of all firms. I use $\bar{\rho}_t$ to denote this average type for time $t$, with $\bar{\rho}_t \in (\rho_L, \rho_H)$. Thus, the potential investors are only willing to sign the following contract: Old stakeholders receive $R_t \delta_t \bar{\rho}_t - I_t$, and new investors receive $R_t \rho_i - R_t \delta_t \bar{\rho}_t$.

The impact of equity financing to the future cost of capital is represented by the change of the perceived type by the equity market. Specifically, in the first stage, all firms will be considered as type $\bar{\rho}_1$. If the firm decides to issue equity in the first stage, its real type will be revealed to investors and at the second stage it will be correctly perceived as type $\rho_i$. On the other hand, if the firm decides to use debt to finance its first project, the capital market will not know its true type and thus continues to consider it to be type $\bar{\rho}_2$ at the second stage. Assumption A2 summarizes this process.

Finally, I impose a restriction of no internal financing, as stated in assumption A3. A discussion of this assumption is in section IV. In addition, I also temporarily assume that all projects are profitable enough so that the firm will always raise capital (assumption A4). The
discussion of small NPV projects and the impact on investment is deferred to section II.C.

**Assumption 1:** (A1) The contemporaneous cost of debt is always smaller than the cost of equity, i.e. $\delta_d > \delta_e$.

**Assumption 2:** (A2) Equity financing reveals managers’ information (i.e., a firm’s type) to investors, i.e. equity issuance changes $\bar{\rho}_1$ to $\rho_i$ in the second stage, while debt issuance changes $\bar{\rho}_1$ to $\bar{\rho}_2$.

**Assumption 3:** (A3) There is no financial slack.

**Assumption 4:** (A4) All projects are sufficiently profitable, i.e., $R_t \delta_t \rho_i > I_t, \forall t \in \{1, 2\}, \delta_t \in \{\delta_d, \delta_e\}, \rho_i \in [\rho_L, \rho_H]$.

Since all investment profits are realized at the end of the model we can further omit the discussion of the time discount. Because of assumption A4, we can temporarily ignore the amount of initial investment and focus on analyzing the payoffs of these investment projects. Figure 2 illustrates the payoff structure for old stakeholders under the combination of different financing decisions at both stages. For instance, if the firm chooses debt financing for both stages, it would have $R_1 \delta_d \bar{\rho}_1 + R_2 \delta_d \bar{\rho}_2$ at time $t = 3$. If the firm chooses equity financing in the first stage and debt financing in the second stage, its payoff is $R_1 \delta_e \bar{\rho}_1 + R_2 \delta_d \rho_i$.

In this paper I assume that the average profitability type $\bar{\rho}_t$ to be exogenous in order to obtain the partial equilibrium solution. This simplification translates into that the marginal firm conducting equity issuance does not change the average perception of the capital market.\footnote{A general equilibrium model would first assume a distribution of $\rho_i$ and then express $\bar{\rho}_t$ by using this distribution. This approach is mathematically more rigorous but less flexible to incorporate discussions of other market frictions. Especially, the average perception $\bar{\rho}_t$ can be affected by both rational and irrational factors. For instance, in reality, the types of firms would not always stay inside $[\rho_L, \rho_H]$.}

The following proposition 1 summarizes the equilibrium results.

**Proposition 1:** Under Assumptions A1-A4, firms with $\rho_i \in (\rho_L^*, \rho_H]$ will choose equity financing in the first stage, whereas firms with $\rho_i \in [\rho_L, \rho_L^*)$ will choose debt financing, with $\rho_i^* = \bar{\rho}_2 + \frac{R_1 (\delta_d - \delta_e)}{R_2 \delta_d} \bar{\rho}_1$ to be the indifference cutoff point.
Equity

Debt

$R_{1}d\bar{\rho}_{1} + R_{2}d\bar{\rho}_{2}$

$R_{1}d\bar{\rho}_{1} + R_{2}d\bar{\rho}_{2}$

$R_{2}d\bar{\rho}_{1} + R_{2}d\bar{\rho}_{2}$

$R_{1}d\bar{\rho}_{1} + R_{2}d\bar{\rho}_{1}$

$R_{1}d\bar{\rho}_{1} + R_{2}d\bar{\rho}_{2}$

Figure 2. Benchmark model decision tree. This figure shows the payoffs structure for a firm with a profitability type $\bar{\rho}_{i} \in [\rho_{L}, \rho_{H}]$ under different financing combinations. There are two investment projects that arrive sequentially, which could yield final proceeds $R_{1}\rho_{i}$ and $R_{2}\rho_{i}$ at the end of the model. However, because the capital market initially cannot tell the true type, the firm will be considered as type $\bar{\rho}_{1}$ at the first stage. Under assumption A2, if the firm chooses equity financing, the market will be able to know its true type $\rho_{i}$ at the second stage. On the other hand, if the firm chooses debt financing, the market will continue to perceive it as the average type $\bar{\rho}_{2}$. Each branch of the above figure lists the total payoff to old stakeholders.

Proof. With backward induction and assumption A1 ($\delta_{d} > \delta_{e}$), the firm will always choose debt financing at the second stage (observe from Figure 2). Then the problem reduces to choose equity financing in the first stage and receive $R_{1}\delta_{e}\bar{\rho}_{1} + R_{2}\delta_{d}\bar{\rho}_{i}$, or choose debt financing and receive $R_{1}\delta_{d}\bar{\rho}_{1} + R_{2}\delta_{d}\bar{\rho}_{2}$. Thus, an equity issuance decision would be preferable if $R_{1}\delta_{e}\bar{\rho}_{1} + R_{2}\delta_{d}\rho_{i} > R_{1}\delta_{d}\bar{\rho}_{1} + R_{2}\delta_{d}\bar{\rho}_{2}$. Rearranging and collecting terms yield the equilibrium cutoff point $\rho^{\ast}_{i} = \bar{\rho}_{2} + \frac{R_{1}(\delta_{d} - \delta_{e})}{R_{2}\delta_{d}}\bar{\rho}_{1}$. $^{8}$

Proposition 1 can be interpreted from two directions. The first direction is to interpret from a firm’s perspective. Observe from Figure 2 that given $\delta_{d} > \delta_{e}$ (assumption A1), the firm will always choose debt financing at the second stage. This second stage financing is designed to be in line with the prediction of the traditional pecking order theory. Define $\Delta \rho := \rho_{i} - \bar{\rho}_{2}$. Proposition 1 shows that a firm has incentive to issue equity if the incremental benefit generated from the second project (left hand side of equation (1)) outweighs the

$^{8}$Here I focus on the interior solution as it simplifies notation without losing model flavor. Alternatively, one could also include a boundary scenario in proposition 1 and define $\rho^{\ast}_{i} = \min(\bar{\rho}_{2} + \frac{R_{1}(\delta_{d} - \delta_{e})}{R_{2}\delta_{d}}\bar{\rho}_{1}, \rho_{H})$. 

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incremental cost of financing the first project with equity (right hand side of equation (1)).

\[
\Delta \rho R_2 \delta_d > R_1 (\delta_d - \delta_e) \bar{\rho}_1 \tag{1}
\]

Equation (1) shows that even if equity financing is more costly for the first stage, firms still have incentive to issue equity if the benefit from the future investments is large enough to outweigh the temporary cost. Equation (1) can also be rearranged into the following:

\[\frac{\Delta \rho}{\bar{\rho}_1} > \frac{R_1 (\delta_d - \delta_e)}{R_2 \delta_d} \tag{2}\]

where \(R_1/R_2\) is akin to a measure of the inverse of growth opportunities. Thus, a firm is more likely to issue equity if there are more growth opportunities, consistent with the traditional view by Myers (1977).

The second direction is to interpret the cutoff point \(\rho_1^* = \bar{\rho}_2 + \frac{R_1 (\delta_d - \delta_e)}{R_2 \delta_d} \bar{\rho}_1\) from the aggregate level. Since a firm’s profitability type \(\rho_i\) falls in between \(\rho_L\) and \(\rho_H\), proposition 1 states that the entire spectrum of firms can be cut into two parts, with the right side willing to issue equity and the left side always use debt. Thus, the proportion of firms issue equity in equilibrium, \(\frac{\rho_H - \rho_1^*}{\rho_H - \rho_L}\), is affect by three factors: the average quality of firms in the market \(\bar{\rho}_1\), the difference between cost of debt and equity \(\frac{\delta_d - \delta_e}{\delta_d}\), and the growth opportunities \(\frac{R_2}{R_1}\).

Specifically, when the average quality of firms is high (\(\bar{\rho}_1\) is high), firms have less incentive to use an equity issuance as a costly way to reduce the information asymmetry between the firm and the capital market. Second, when equity becomes relatively cheaper (\(\delta_e\) higher or \(\delta_d\) lower), more high quality firms would want to reveal its type to the capital market. Third, when the growth rate is higher (\(\frac{R_2}{R_1}\) higher), a larger portion of firms would want to issue equity.\(^9\)

\(^9\)Traditional approach in the capital structure literature often includes the discussion of asset in place and growth opportunities (e.g., Myers 1977, Myers and Majluf 1984, Fulghieri, Garcia and Hackbarth 2013, Bond and Zhong 2016). Voluminous amount of papers have extended this idea to different fronts (Tirole 2006). For instance, higher portion of fixed assets can be considered as easier to collateralize, which lower the contracting cost. In this paper, although the separation of asset in place and growth opportunities is not
C. The Impact on Investment

As shown in Akerlof (1970) and Myers and Majluf (1984), the asymmetric information between firms and investors could lead the firm to pass up positive NPV projects in the scenario of outside financing. In this section, I relax assumption A4 and investigate the investment efficiency when equity issuance reveals a firm’s type to investors (assumption A2).

To study the potential influence of assumption A2, I construct two scenarios: X and Y, with only assumptions A1 and A3 hold true in Scenario X, and assumptions A1, A2, and A3 hold true in Scenario Y. Thus, equity issuance does not reveal any additional information under Scenario X, which means that the firm will only seek debt financing (due to assumption A1). The impact of assumption A2 on the investment efficiency can then be summarized into the comparison between Scenario X and Y. For each scenario, the firm can choose to finance either or both projects (or not finance any projects such that the NPV is zero). The NPVs under these two scenarios are listed below:

**Scenario X: Assumptions A1 and A3 hold (⇒ the firm will not finance with equity)**

X1. Invest in Both: \[R_1\delta_d\bar{\rho}_1 + R_2\delta_d\bar{\rho}_2 - I_1 - I_2.\]

X2. Only invest in \(I_1\): \[R_1\delta_d\bar{\rho}_1 - I_1.\]

X3. Only invest in \(I_2\): \[R_2\delta_d\bar{\rho}_2 - I_2.\]

**Scenario Y: Assumptions A1, A2 and A3 hold (⇒ the firm might finance with equity)**

Y1. Invest in Both, Debt + Debt: \[R_1\delta_d\bar{\rho}_1 + R_2\delta_d\bar{\rho}_2 - I_1 - I_2.\]

Y2. Invest in Both, Equity + Debt: \[R_1\delta_e\bar{\rho}_1 + R_2\delta_d\bar{\rho}_2 - I_1 - I_2.\]

Y3. Only invest in \(I_1\): \[R_1\delta_d\bar{\rho}_1 - I_1.\]

Y4. Only invest in \(I_2\): \[R_2\delta_d\bar{\rho}_2 - I_2.\]

For Scenario X it is straight forward to see that a project \(I_t\) will receive financing if and explicitly discussed, the impacts are embedded inside the model parameters \((\delta_d, \delta_e, \rho_i, \text{etc.})\). For instance, high asset-in-place could translate into a higher \(\delta_d\) or higher \(\rho_i\). This simplification helps to concentrate our focus on studying how assumption A2 (equity issuance reveals a firm’s type to the capital market) alters the financing patterns.
only if $R_t\delta_t\hat{\rho}_t > I_t$. For Scenario Y, whether to forgo a project depends on the comparison between $Y1$ to $Y4$ and zero. The following proposition first augments proposition 1, then describes the impact of assumption A2 on the investment efficiency:

**Proposition 2:** (1) Under Assumptions A1-A3, firms with $\rho_i \in (\rho_i^*, \rho_H]$ will choose equity financing in the first stage, whereas firms with $\rho_i \in [\rho_L, \rho_i^*)$ will choose debt financing, with $\rho_i^* = \max(\bar{\rho}_2 + \max(\frac{R_1(\delta_d-\delta_e)\hat{\rho}_t}{R_2\delta_d}, \frac{I_1-R_2\delta_d\hat{\rho}_t}{R_2\delta_d})$ to be the indifference cutoff point; (2) when equity issuance can reveal managers’ information to potential investors (assumption A2), the investment efficiency is improved and more small NPV projects can get financed.

While a formal proof of proposition 2 is provided in Appendix B, I use Figure 3 and Figure 4 to interpret proposition 2 as well as the difference between proposition 1 and 2. Recall that in the previous section $\rho_i$ denotes a firm’s profitability type, which ranges from $\rho_L$ to $\rho_H$, as shown in the figures. Figure 3 illustrates a case in which all projects are sufficiently profitable, whereas Figure 4 illustrates a case in which all projects would have negative NPVs (from the old stakeholders’ perspective) without assumption A2. Observe that among all the NPVs from Scenario X and Y, only payoff under Y2 (invest in both projects and finance the first one with equity) is a linear increasing function of $\rho_i$. These NPVs are drawn as straight lines in Figure 3 and Figure 4. The two cutoff points $\rho^*$ and $\rho^{**}$ are also depicted in Figure 4.

From Figure 3 and Figure 4 we can see that assumption A2 (equity issuance reveals managers’ information to investors) levers up the NPVs for $\rho_i > \rho_i^*$. Specifically, Figure 4 indicates that even if both projects would have negative NPVs to the old stakeholders due to the high adverse selection cost, they can jointly produce a positive NPV if the issuance decision in the first stage can reduce next stage’s information asymmetry.
Figure 3. **NPV of projects.** This figure draws the NPVs of different investment choices under Scenario X and Y. Specifically, this figure draws the case in which all projects are sufficiently profitable. Y1 (and X1) represents a firm chooses to invest in both projects with debt financing. Y2 represents a firm invests in both projects and finances the first project with equity. Y3 (and X2) and Y4 (and X3) denote a firm only invests in one of the two projects. The x-axis (\(\rho_i\)) denotes a firm’s profitability type, which ranges from \(\rho_L\) to \(\rho_H\). \(\rho^*\) denotes the equilibrium cutoff point from proposition 1.

Figure 4. **NPV of projects.** This figure draws the NPVs of different investment choices under Scenario X and Y. Specifically, this figure draws the case in which all projects will have negative NPVs initially. Y1 (and X1) represents a firm chooses to invest in both projects with debt financing. Y2 represents a firm invests in both projects and finances the first project with equity. Y3 (and X2) and Y4 (and X3) denote a firm only invests in one of the two projects. The x-axis (\(\rho_i\)) denotes a firm’s profitability type, which ranges from \(\rho_L\) to \(\rho_H\). \(\rho^*\) and \(\rho^{**}\) denote the equilibrium cutoff points from proposition 1 and proposition 2, respectively.
III. Empirical Evidence

A. Testing Asymmetric Information in a Repeated Game

In this section, I test the role of asymmetric information in a repeated game. While initial public offering (IPO) is a singular event that happen only once throughout a firm’s life time, seasoned equity offerings (SEOs) are likely to happen multiple times and are thus suited to test the repeated game feature. Figure 7 plots the time series of the 3-month moving average of IPO and SEO volumes from 1970 to 2017. We can see that the total number of SEOs is around the same magnitude as the total number of IPOs before the 2007 financial crisis. After the crisis, SEO volume often doubles the IPO volume.

SEO announcement return (namely, SEO underpricing) has been used as a proxy for the adverse selection cost (Choe, Masulis and Nanda 1993). Especially, although majority theoretical models deal with IPOs (e.g., Rock 1986), most of the implications can be naturally extended to SEOs (Loderer, Sheehan and Kadlec 1991). Figure 8 plots the time trend of SEO announcement returns from 1983 to 2017. Specifically, I draw the median value of the cumulative abnormal returns (CARs) over the event days [-2,2], where event day 0 is defined as the SEO filing date obtained from the Thompson Financials SDC database. Figure 8 shows the SEO underpricing for both the full sample and the subsample for NYSE listed firms. It can be seen that the average announcement effect is around -2% and NYSE listed firms are subject to less underpricing for most of the time, consistent with findings in the traditional SEO literature (e.g., Loderer, Sheehan and Kadlec 1991, Altinkılıç and Hansen 2003, and Corwin 2003).  

10While the SEO issuance date is available in the earlier time period, SEO filing date started to be available from SDC database since late 1982.
11Daily abnormal return is defined as return minus the value-weighted CRSP market return.
12Kim and Purnanandam (2013) manually search the announcement date over 1993-2006 through Factiva to check whether filing date coincides with the announcement date. They find that these two dates are the same for more than 95% of the time, and these two dates differ within 2 days for more than half of the remaining 5%. An incomplete list of studies that also use the filing date as the announcement day are: Jegadeesh, Weinstein and Welch (1993), Denis (1994), and Datta, Iskandar-Datta, and Raman (2005).
13Additional details of sample construction are provided in Appendix C.
One potential draw back of using the announcement return as a proxy for information asymmetry is that cross-sectional studies point out alternative underpricing determinants (e.g., Corwin 2003, Lowry 2003). To mitigate these other concerns, I conduct the following test: For each firm in the sample, I first mark its SEO announcements in the chronological order (i.e., a SEO announcement is the $n^{th}$ time in history), then I pool all firms according to this order. This pooling is likely to alleviate the impact of temporary market factors, e.g., a temporary liquidity shock (Corwin 2003), and thus can reflect the more persistent determinant: information asymmetry. Figure 9 plots the median value of the SEO announcement cumulative abnormal returns (CARs). The black line represents the full sample, whereas the blue dashed line represents a balanced sample (i.e., firms that have at least 5 SEO announcements). The descriptive statistics are listed in Table 1 Panel A. From Figure 9 we can see that the magnitude of SEO underpricing becomes smaller and smaller as firms conducting more and more SEOs, supporting the model premise in Section II that equity issuances reduce information asymmetry between firms and potential investors.

To test the model predictions, I focus on the joint implications of proposition 1 and proposition 2. Specifically, these two propositions indicate that (1) firms that can benefit more from revealing information will likely to issue equity, and (2) if we observe more equity issuances, then the marginal firm is less likely to be a high quality firm, i.e., signaling is more effective when there are less signals. To test these predictions, I first separate firms based on whether they have conducted IPOs during hot or cold market as in Alti (2006). The horizontal line in Figure 7 represents the median IPO volume, and the hot (cold) market is defined as the time period that the total IPO volume is above (below) the median. Figure 10 and Figure 11 plot median CARs for the hot and cold Market IPO firms with respect to the chronological order of SEO announcements. From these figures we can see that cold market IPO firms experience a much sharper reduction of the SEO underpricing effect, suggesting that investors seem to reward a firm conducting IPO in the cold market (higher adverse selection cost period) by reducing its premium in the long run. These results are consistent
with the model predictions.

Table 1 lists the descriptive statistics for both the median cumulative abnormal returns (CARs) and the median market cap.\textsuperscript{14} The economic magnitude of the reduced underpricing effect is quite significant. For instance, a firm in the full sample issuing its first seasoned equity carries a cost of 2.35\%, while issuing equity the 5th time carries a cost of 1.44\%. This translates into a nearly 40\% reduction in the underpricing magnitude. To examine the robustness of the event day specification, Table 2 presents additional CARs over the event days [-1,1], [-3,3], and [-5,5]. These results are consistent with using event days [-2,2].

Overall these results indicate that a sufficiently large premium is imposed to firms at an early development stage, whereas these premiums become smaller to large and more mature firms. This explains why small growth firms, which are likely to have higher demand for equity financing, may not be the main contributor to the observed equity issuances (DeAngelo, DeAngelo and Stulz 2010).

\textbf{B. Evidence on Leverage and Investment Efficiency}

At the firm level, Gustafson and Iliev (2017) examine the effect of removing barriers to equity issuance. They find that a US deregulation, which allows small firms to accelerate their public equity issuance (translates to a shock on $\delta_e$), increases a firm’s probability of issuing equity and the amount of investment. Their evidence is in line with the model prediction in Section II.

The model can also explain the aggregate trend of leverage according to the fluctuation of the cost of equity and cost of debt ($\delta_d$ and $\delta_e$). For instance, the recent financial crisis in 2007 has suddenly made debt a much more expensive financing method. As can be seen on Figure 7, SEOs after the crisis are much more frequent relative to earlier time periods. In general, the model predictions are consistent with the macro level evidence, e.g., Erel, Julio, Kim and Weisbach (2011).

\textsuperscript{14}Market cap is the market value of equity on event day 0.
A. The Role of Financial Slack

The recent trend of accumulating cash inside corporations has attracted much of the attention from researchers. For instance, Bates, Kahle and Stulz (2009) document a substantial increase in cash holdings in U.S. firms from 10.5% in 1980 to 23.2% in 2006. Both agency problems and precautionary motives have been tested to explain this phenomenon. Among the various studies, Harris and Raviv (2017) also build a model based on the information asymmetry problem. They link the cash holdings with firms’ growth opportunities.

In this section I examine the role of financial slack by extending the benchmark model. The model here varies from prior approaches in that it relies on the intertemporal realization of a firm’s quality to outside investors rather than the realization of the uncertainty of investment returns, i.e., the decision maker inside a firm knows the profitability of all investment projects. Nevertheless, cash could be reserved depending on the amount of required investment and the cost of external financing. Specifically, cash is more likely to be retained if there exists high profitable future project and issuing equity today could significantly reduce future financing cost.\footnote{The approach in this paper does not generate an optimal level of cash. Rather, initial wealth level is given exogenously and the interest is to study how this wealth level affect capital structure decisions. Studies with optimal cash policy can be found in Anderson and Carverhill (2011).}

To make the model trackable I only relax assumption A3 (i.e., assumption A1, A2 and A4 hold). Denote $W_0$ as the financial slack available to this firm. Without loss of generality let us focus on the scenario in which the firm can only choose one method at one time, i.e., this firm is not allowed to use both cash and outside resources to finance a project. Figure 5 enumerates the total payoffs under different choice paths. The conditions for getting access to each branch are listed in the parentheses. For instance, choosing cash financing at both stages requires $W_0 > I_1 + I_2$ and will generate $R_1 \rho_i + R_2 \rho_i$ at the end of the model; choosing cash plus debt financing requires $W_0 > I_1$ and will generate $R_1 \rho_i + R_2 \delta d \rho_2$. The final payoffs
for each financing combination is denoted as P1 to P9. Similar as the benchmark model, P3, P6 and P9 are strictly dominated by P2, P5, and P8 due to the adverse selection cost. Thus, the equilibrium condition is determined by comparing P1, P2, P4, P5, P7, and P8.

Figure 5. The Role of Financial Slack: Payoff structure of an augmented benchmark model. $W_0$ denotes the initial wealth level. A firm can choose at each stage whether to finance the project with cash, debt or equity. Conditions for getting access to each branch are listed in the parentheses.

To show the impact of financial slack on the optimal financing order, I consider a special case that $\rho_i = \rho_H$. Let us divide the financial slack $W_0$ into four regions as shown in Figure 6. I first discuss the case of $I_1 < I_2$. In Panel A of Figure 6, the four regions of $W_0$ are the following: (I) $0 < W_0 < I_1$, (II) $I_1 < W_0 < I_2$, (III) $I_2 < W_0 < I_1 + I_2$, and (IV) $W_0 > I_1 + I_2$.\footnote{I omit the discussion of intermediate boundary values as those can be easily combined into either side of the region. For instance, $W_0 = I_1$ can be included in either region (I) or (II).}

As shown in Figure 5 and 6 Panel A, in region (I), the problem reduces to the benchmark
Figure 6. The effect of financial slack on financing decisions. This figure shows the optimal financing order for a highest profitability type ($\rho_i = \rho_H$) firm facing two investment projects that arrive sequentially. Two cases are discussed separately as shown in Panel A ($I_1 < I_2$) and Panel B ($I_1 > I_2$). Each panel is divided into four regions and the reduced optimal choices are listed at the top. Shaded areas indicate no-equity regions.
scenario as the amount of financial slack is too small to finance any project. Thus the
maximum payoff is $\max(P5, P8)$. In region (I) the financing pattern is either (Debt+Debt)
or (Equity+Debt). In region (II), the firm is able to finance the first project internally but
will have to finance the second project with debt or equity. Thus, the available payoff is
$P2, P5$ and $P8$. However, since $P2$ is strictly better than $P5$ for the highest profitability
type firm ($\rho_i = \rho_H$), the maximum payoff is $\max(P2, P8)$ and the financing pattern is either
(Cash+Debt) or (Equity+Debt). In region (III), the firm is only able to finance one of
the two projects internally. Thus, $P2, P4, P5, P7$, and $P8$ are available. Similarly, $P4$
is strictly better than $P5$, $P7$ is strictly better than $P8$, and $P4$ is strictly better than $P7$,
the payoff in region (III) is $\max(P2, P4)$ and the financing pattern is either (Cash+Debt)
or (Debt+Cash). In region (IV) the firm is able to finance all projects with cash and the
optimal solution is $P1$.

As can be seen in Figure 6 Panel A, when $I_1 < I_2$, the optimal financing order depends
on the amount of financial slack relative to the size of the required investment. Panel B
shows the similar analysis with $I_1 > I_2$. Figure 6 indicates that the larger the financial slack,
the larger the possible payoff. The shaded areas indicate regions that equity financing is
never the optimal choice, i.e., no-equity region. Thus, we can also see that the smaller the
amount of cash available to this firm, the higher the chance of observing an equity issuance.
However, unless this firm has more than enough cash to finance all projects (region IV),
there does not exist a strict pecking order for either debt or cash financing.

The patterns in Figure 6 provide another explanation for firms to retain cash in addition
to the existing explanations summarized by Bates, Kahle and Stulz (2009), i.e., transaction
motive, precautionary motive, tax motive and agency motive. Specifically, the decision to
retain cash is related to the amount of required investment and the trade-off between today’s
and future’s cost of capital. For instance, when the future project requires a large amount
of investment and issuing equity today can significantly reduce the future financing cost
(Figure 6 Panel A, Region II), cash could be retained as the optimal choice of a profit
maximization problem.

Comparing Panel A with Panel B in Figure 6, we can see that the no-equity zone is smaller for a growing firm, which is featured by $I_1 < I_2$. Thus, the financing preferences shown in Figure 6 are also consistent with the traditional view that growth opportunities are supported more by equity than debt (Myers 1977).

V. Conclusion

In this paper I develop a two-stage model to describe corporate financing and investment decisions. In each stage the firm faces an investment project that requires outside financing. Equity issuances are accompanied by the adverse selection costs due to the information asymmetry between the firm and the security markets. Thus, if one stage is viewed separately, the classical pecking order theory holds. However, equity issuances are not independent events in the firm’s history that has no impact on the firm’s future cost of capital. To model this impact, I assume that an equity issuance can reveal managers’ information to potential investors. As a result, the equilibrium condition of the two-stage model no longer yields a strict preference for debt financing. The firm has incentive to issue underpriced equity if the benefit from future project could outweigh the current adverse selection cost. The possibility of larger gains from the future period generates an option-like payoff for today and can improve the investment efficiency. I find empirical evidence in support of model predictions.
Appendix A. An Example of the model

A simplified example can illustrate the proposed model mechanism. Suppose the economy has one good firm, one bad firm, and a sufficiently large number of average firms. The capital market initially does not know firm type and therefore prices all firms based on the average quality. Figure A1 below illustrates the timing of events. A firm that has no financial slack faces two investment projects. Projects arrive sequentially at $t = 1$ and $t = 2$ (a two-stage game) and provide a return at the end of the model ($t = 3$). Firms can choose either debt or equity to finance projects. Debt is always cheaper than equity contemporaneously. The repeated interaction between the firm and the capital market is modeled as follows: If a firm decides to issue equity at $t = 1$, the capital market learns the firm’s true quality at $t = 2$. If the firm issues debt at $t = 1$, the capital market learns nothing and continues to price the firm based on the average quality of all firms.

<table>
<thead>
<tr>
<th>$t = 1$</th>
<th>$t = 2$</th>
<th>$t = 3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm choose debt or equity financing for the first investment project</td>
<td>Firm choose debt or equity financing for the second investment project</td>
<td>Profits realized</td>
</tr>
</tbody>
</table>

Table A1 below lists a numerical example to show the incentives from the good firm’s perspective. Suppose the good firm’s two investment projects each generate $200$ of profits, whereas the average firm’s two projects each generate $100$. Investors at $t = 1$ cannot differentiate a firm’s true productivity and will consider all firms’ projects worth $100$. Thus, a potential equity investor is only willing to sign the following contract: the firm gets $100 \times 90\%$, the investor gets the remaining profit. A potential debt investor is willing to sign the following contract: the firm gets $100 \times 99\%$, the investor gets the remaining profit. The payoffs to the firm (i.e., old stakeholders) are listed in Table A1. If the model does not contain the second financing round at $t = 2$, the good firm would be better off by issuing debt at $t = 1$. This is the mechanism and prediction in the traditional literature. However, when we
consider the repeated setting, due to the information revealing mechanism associated with equity financing, the proposed model argues that the good firm would choose to issue equity at \( t = 1 \) and issue debt at \( t = 2 \) to get a maximum payoff of $288.

This example shows how a repeated game changes a firm’s financing patterns comparing to a single-stage game.

<table>
<thead>
<tr>
<th>Table A1</th>
<th>Payoffs for the Good Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t = 1 )</td>
<td>( t = 2 )</td>
</tr>
<tr>
<td>If issue Equity</td>
<td>Investors know the true quality of the firm</td>
</tr>
<tr>
<td>90</td>
<td>If issue Debt: 198</td>
</tr>
<tr>
<td>If issue Debt</td>
<td>Investors consider the firm to be the average quality</td>
</tr>
<tr>
<td>99</td>
<td>If issue Debt: 99</td>
</tr>
</tbody>
</table>

### Appendix B. Proof of Proposition

**Proof of Proposition 2.** As described in Section II.C, the impact of the investment efficiency can be summarized into the comparison between the two scenarios: X and Y. Scenario X represents the NPVs of the possible investment choices under assumptions A1 and A3 (which result in no equity financing), whereas Scenario Y contains the NPVs for investment choices under assumptions A1, A2 and A3 (i.e., with the potential of financing with equity). Thus, the difference between Scenario Y and X will indicate the benefits accompanied by equity issuances (assumption A2).

Let us first list the general solutions for the above two scenarios. For Scenario X it is straightforward to see that a project \( I_t \) will receive financing if and only if \( R_t \delta_d \hat{\rho}_t > I_t \). For Scenario Y, whether to forgo a project or not depends on the comparison between Y1 to Y4 and zero. The following summarizes the general solutions:

**Scenario X:** *Invest in project \( I_t \) iff \( R_t \delta_d \hat{\rho}_t > I_t \).*

**Scenario Y:**
(i). Not forgoing any project: \[ \max(Y_1, Y_2) > \max(Y_3, Y_4, 0). \]

(ii). Only invest in I_1: \[ Y_3 > \max(Y_1, Y_2, Y_4, 0). \]

(iii). Only invest in I_2: \[ Y_4 > \max(Y_1, Y_2, Y_3, 0). \]

(iv). No investment: \[ 0 > \max(Y_1, Y_2, Y_3, Y_4). \]

Since neither of Y(ii), (iii) and (iv) provides additional efficiency gain comparing to Scenario X, we can focus our discussion on Scenario Y(i), as any failing condition in (i) would lead to one of (ii), (iii) and (iv). Recall in Section II we define \( \rho_i \in [\rho_L, \rho_H] \), which is a firm’s profitability type. Thus we can consider Y1 to Y4 as a function of \( \rho_i \):

\begin{align*}
Y_1 & : R_1\delta_d\tilde{\rho}_1 + R_2\delta_d\tilde{\rho}_2 - I_1 - I_2, \text{ a constant function of } \rho_i. \\
Y_2 & : R_1\delta_e\tilde{\rho}_1 + R_2\delta_d\rho_i - I_1 - I_2, \text{ is a linear increasing function of } \rho_i. \\
Y_3 & : R_1\delta_d\tilde{\rho}_1 - I_1, \text{ a constant function of } \rho_i. \\
Y_4 & : R_2\delta_d\tilde{\rho}_2 - I_2, \text{ a constant function of } \rho_i.
\end{align*}

Figure 3 graphically illustrates the above relationships between Y1 to Y4 and \( \rho_i \). From this figure we can see that the NPV structure between Y1 and Y2 resembles the payoff structure of a call option. When \( \rho_i \) is small, the firm is better off without issuing equity. When \( \rho_i \) is large, issuing equity brings more benefit from the future period. In Figure 3, Y3 and Y4 are drawn arbitrarily. However, it can be seen that solving Scenario Y(i) depends on the comparison between the three lines: Y3, Y4, 0, and the option-like payoff line: \( \max(Y_1, Y_2) \).

According to Figure 3, we can divide the solution into the following four cases:

**Case 1**: If \( Y_3 > 0 \) and \( Y_4 > 0 \) (i.e., \( R_1\delta_d\tilde{\rho}_1 > I_1 \) and \( R_2\delta_d\tilde{\rho}_2 > I_2 \)).

As shown in Figure 3, Case 1 means that all project are sufficiently profitable as in proposition 1. Thus, the firm issue equity if \( \rho_i > \rho^* = \tilde{\rho}_2 + \frac{R_1(\delta_d-\delta_e)}{R_2\delta_d}\tilde{\rho}_1 \).

**Case 2**: If \( Y_3 > 0 \), and \( Y_4 < 0 \) (i.e., \( R_1\delta_d\tilde{\rho}_1 > I_1 \) and \( R_2\delta_d\tilde{\rho}_2 < I_2 \)).

With \( Y_3 > 0 \) and \( Y_4 < 0 \), we have \( \max(Y_3, Y_4, 0) = Y_3 \). Since \( Y_4 < 0 \) makes \( Y_1 = Y_3 + Y_4 < Y_3 \), if \( \rho_i < \rho^* \), the firm will be better off without investment in the second project and thus revert back to Scenario X. On the other hand, if \( \rho_i > \rho^* \), Y2 might be preferable.
if the following condition hold:

\[
Y2 > Y3 \quad \Rightarrow \quad R_1\delta_e\bar{\rho}_1 + R_2\delta_d\rho_i - I_1 - I_2 > R_1\delta_d\bar{\rho}_1 - I_1 \\
\Rightarrow \quad \rho_i > \frac{I_2}{R_2\delta_d} + \frac{R_1(\delta_d - \delta_e)}{R_2\delta_d} \bar{\rho}_1
\]  \hspace{1cm} (B1)

Condition (B1) implies that even if the second project by itself is a negative NPV project to old stakeholders (due to the adverse selection cost), because equity issuance in the first stage can reduce the second stage’s financing cost, this project will also receive financing. Figure A2 illustrates this relationship graphically. Under Scenario X, the triangle of \(\Delta FGK\) represents the deadweight loss of outside financing for the second project. Under Scenario Y, the deadweight loss reduces to triangle \(\Delta FMN\), as indicated by condition (B1), which is equivalent to \(R_2\delta_d\rho_i - R_1(\delta_d - \delta_e)\bar{\rho}_1 > I_2\). To draw this condition, imagine first tilting the angle of \(R_2\delta_d\bar{\rho}_2\) towards \(R_2\delta_d\rho_i\), then shifting this line downwards by \(R_1(\delta_d - \delta_e)\bar{\rho}_1\), as shown in Figure A2. Thus, the shaded area of \(\Diamond MNKG\) is the efficiency gain from the second project.\(^{17}\)

\[\text{Figure A2. The efficiency diagram. This figure shows the change of investment efficiency under Case 2: If } Y3 > 0, \text{ and } Y4 < 0 \text{ (i.e., } R_1\delta_d\bar{\rho}_1 > I_1 \text{ and } R_2\delta_d\bar{\rho}_2 < I_2\).} \]

\(^{17}\)Despite the actual shape of \(\Diamond MNKG\). One may concern about whether the area of \(\Diamond MNKG\) is indeed positive. Note that under \(\rho_i > \bar{\rho}_2 + \frac{R_1(\delta_d - \delta_e)}{R_2\delta_d}\bar{\rho}_1\), we have \(R_2\delta_d\bar{\rho}_2 - R_1(\delta_d - \delta_e)\bar{\rho}_1 > [R_2\delta_d\bar{\rho}_2 + R_1(\delta_d - \delta_e)\bar{\rho}_1] - R_1(\delta_d - \delta_e)\bar{\rho}_1 = R_2\delta_d\bar{\rho}_2\). This justifies that the line \(R_2\delta_d\rho_i - R_1(\delta_d - \delta_e)\bar{\rho}_1\) is at least above \(R_2\delta_d\bar{\rho}_2\) inside the solution area.
**Case 3:** If $Y_4 > 0$, and $Y_3 < 0$ (i.e., $R_1\bar{\delta_d}\bar{\rho}_1 < I_1$ and $R_2\delta_d\bar{\rho}_2 > I_2$).

The analysis here is very similar to the previous case. With $Y_4 > 0$ and $Y_3 < 0$, we have $\max(Y_3, Y_4, 0) = Y_4$. Since $Y_3 < 0$ makes $Y_1 = Y_3 + Y_4 < Y_4$, if $\rho_i < \rho^*$, the firm will be better off without investment in the first project and thus revert back to Scenario X. On the other hand, if $\rho_i > \rho^*$, $Y_2$ might be preferable if the following condition hold:

$$Y_2 > Y_4 \quad \Rightarrow \quad R_1\delta_e\bar{\rho}_1 + R_2\delta_d\rho_i - I_1 - I_2 > R_2\delta_d\bar{\rho}_2 - I_2$$

$$\Rightarrow \quad \rho_i > \bar{\rho}_2 + \frac{I_1 - R_1\delta_e\bar{\rho}_1}{R_2\delta_d}$$ (B2)

Condition B2 is equivalent to $R_1\delta_e\bar{\rho}_1 + R_2\delta_d(\rho_i - \bar{\rho}_2) > I_2$, which indicates that there is efficiency gain from the first project. This relationship can be similarly illustrated by Figure A3. Under Scenario X, the triangle of $\Delta FGK$ represents the deadweight loss of outside financing for the first project. Under Scenario Y, the deadweight loss reduces to triangle $\Delta FMN$. To draw condition (B2), imagine first tilting the angle of $R_1\delta_d\bar{\rho}_1$ towards $R_1\delta_e\bar{\rho}_1$, then shifting this line upwards by $R_2\delta_d(\rho_i - \bar{\rho}_2)$, as shown in Figure A3. Thus, the shaded area of $\Delta MNKG$ is the efficiency gain from the first project.  

![Figure A3. The efficiency diagram.](image)

This figure shows the change of investment efficiency under Case 3: If $Y_4 > 0$, and $Y_3 < 0$ (i.e., $R_1\delta_d\bar{\rho}_1 < I_1$ and $R_2\delta_d\bar{\rho}_2 > I_2$)
Case 4: If $Y_3 < 0$, and $Y_4 < 0$ (i.e., $R_1 \delta_d \bar{\rho}_1 < I_1$ and $R_2 \delta_d \bar{\rho}_2 < I_2$).

Finally let us look at the case in which both projects would not get financed if there is no option for issuing equity. $Y_3 < 0$ and $Y_4 < 0$ implies that $\max(Y_3, Y_4, 0) = 0$. Figure 4 shows the possibility of this case. Thus, $Y_2$ would be preferred if the following condition hold:

$$
Y_2 > 0 \Rightarrow R_1 \delta_d \bar{\rho}_1 + R_2 \delta_d \bar{\rho}_2 - I_1 - I_2 > 0 \\
\Rightarrow \bar{\rho}_i > \frac{I_2}{R_2 \delta_d} + \frac{I_1 - R_1 \delta_d \bar{\rho}_1}{R_2 \delta_d} 
$$

(\text{B3})

Condition (\text{B3}) shows that it is possible that both projects can receive financing even if individually they would have been forgone by the managers (i.e., old stakeholders). This further shows the efficiency gain under assumption A2.

Finally, the results in case 1 to 4 can be summarized together. Denote $\rho^{**} = \max(\bar{\rho}_2, \frac{I_2}{R_2 \delta_d}) + \max(\frac{R_1(\delta_d - \delta_e) \bar{\rho}_1}{R_2 \delta_d}, \frac{I_1 - R_1 \delta_d \bar{\rho}_1}{R_2 \delta_d})$, it can be easily verified that $\rho^{**}$ is the new cutoff point.

Altogether we can see that when an equity issuance can reveal a firm’s type to investors (assumption A2), it provides an option-like payoff for the firm. The potential benefits generated from the future period lead to efficiency gains from a firm’s investments. Some small NPV projects can receive funding even if they would not be funded under no-equity world.

Appendix C. Sample Construction

To construct the full sample and the balanced sample, I start with all SEOs between 1982 and 2017 reported by the Securities Data Company (SDC). First, I exclude spinoffs, unit offers, financial firms with SIC codes between 6000 and 6999, utility firms with SIC codes between 4900 and 4949. Second, I exclude observations with missing filing dates. Third, if a firm issues several SEOs after one announcement, only the first record is kept. This sample is then merged with CRSP daily return file to obtain the cumulative abnormal
returns (CARs). The final sample (full sample) consists of matched firms during 1983 to 2017 with none missing CARs. The balanced sample consists of firms that have at least 5 SEO announcements.

To separate sample into hot and cold market IPO firms, I start with IPO and SEO volume from 1970 to 2017. Hot (cold) market is defined as the time period that the total IPO volume is above (below) the median. Some observations are lost in this separation as some firms went IPO before 1970.
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Figure 7. Time Series of IPO and SEO volume. This figure plots the time series of the 3-month moving average of IPO and SEO volumes from 1970 to 2017. The horizontal line represents the median IPO volume, and the hot (cold) market is defined as the time period that the total IPO volume is above (below) the median.
Figure 8. Time Series of Median \( \text{CAR}[{-2,2}] \). This figure plots the time trend of SEO announcement returns from 1983 to 2017. Cumulative abnormal returns (CARs) are calculated over the event days \([-2,2]\), where event day 0 is defined as the SEO filing date obtained from the Thompson Financials SDC database. This figure presents CARs for both the full sample and the subsample for NYSE listed firms.

Figure 9. Median \( \text{CAR}[{-2,2}] \). This figure plots the median value of the SEO announcement cumulative abnormal returns (CARs) with respect to the chronological order of SEOs. The balanced sample consists of firms that have at least 5 SEO announcements.
Figure 10. Median CAR[-2,2]. This figure plots the median value of the SEO announcement cumulative abnormal returns (CARs) with respect to the chronological order of SEOs. The full sample is separated into two groups: hot market IPO firms and cold market IPO firms, where hot (cold) market is defined as the time period that the total IPO volume is above (below) the median.

Figure 11. Median CAR[-2,2]. This figure plots the median value of the SEO announcement cumulative abnormal returns (CARs) with respect to the chronological order of SEOs. The balanced sample, which consists of firms that have at least 5 SEO announcements, is separated into two groups: hot market IPO firms and cold market IPO firms, where hot (cold) market is defined as the time period that the total IPO volume is above (below) the median.
### Table 1

#### Median Descriptive Statistics

**Panel A. Full vs. Balanced Sample**

| $n^{th}$ time SEO announcement | Full Sample | | | Balanced Sample | | |
|-------------------------------|-------------|-----------------|-----------------|-----------------|-----------------|
| 1<sup>st</sup>               | 5310  | -2.35%     | 216.51    | 226   | -2.58%     | 179.48    |
| 2<sup>nd</sup>               | 2270  | -2.12%     | 421.79    | 226   | -2.34%     | 348.88    |
| 3<sup>rd</sup>               | 993   | -2.05%     | 637.88    | 226   | -1.95%     | 522.63    |
| 4<sup>th</sup>               | 460   | -1.96%     | 848.75    | 226   | -1.54%     | 689.78    |
| 5<sup>th</sup>               | 226   | -1.44%     | 961.04    | 226   | -1.44%     | 961.04    |

**Panel B. Hot vs. Cold Market IPO firms in the Full Sample**

| $n^{th}$ time SEO announcement | Hot Market IPO Firms | | | Cold Market IPO Firms | | |
|-------------------------------|---------------------|-----------------|-----------------|-----------------|-----------------|
| 1<sup>st</sup>               | 3925  | -2.37%     | 197.11    | 1665  | -2.49%     | 240.67    |
| 2<sup>nd</sup>               | 1677  | -2.23%     | 392.07    | 1032  | -1.91%     | 468.31    |
| 3<sup>rd</sup>               | 734   | -2.07%     | 600.34    | 448   | -1.94%     | 566.69    |
| 4<sup>th</sup>               | 340   | -2.09%     | 815.40    | 190   | -1.68%     | 800.47    |
| 5<sup>th</sup>               | 159   | -1.72%     | 738.95    | 159   | -0.82%     | 1056.77   |

**Panel C. Hot vs. Cold Market IPO firms in the Balanced Sample**

| $n^{th}$ time SEO announcement | Hot Market IPO Firms | | | Cold Market IPO Firms | | |
|-------------------------------|---------------------|-----------------|-----------------|-----------------|-----------------|
| 1<sup>st</sup>               | 159   | -2.65%     | 173.95    | 50    | -2.91%     | 150.84    |
| 2<sup>nd</sup>               | 159   | -2.34%     | 348.01    | 50    | -2.56%     | 277.26    |
| 3<sup>rd</sup>               | 159   | -1.77%     | 431.66    | 50    | -2.72%     | 525.94    |
| 4<sup>th</sup>               | 159   | -1.85%     | 606.84    | 50    | -1.22%     | 752.43    |
| 5<sup>th</sup>               | 159   | -1.72%     | 738.95    | 50    | -0.82%     | 1056.77   |

This table reports the descriptive statistics for both the median cumulative abnormal returns (CARs) and the median market cap. CARs are calculated over the event days [-2,2], where event day 0 is defined as the SEO filing date obtained from the Thompson Financials SDC database. Firms are pooled based on the chronological order of SEO announcements. The balanced sample consists of firms that have at least 5 SEO announcements. In Panel B and C, the full sample and the balanced sample are separated into two groups: hot market IPO firms and cold market IPO firms, where hot (cold) market is defined as the time period that the total IPO volume is above (below) the median. Some observations are lost in Panel B and C due to the hot (cold) market definition, as some firms went IPO before 1970.
<table>
<thead>
<tr>
<th>$n^{th}$ time SEO announcement</th>
<th>CAR[-1,1]</th>
<th>CAR[-2,2]</th>
<th>CAR[-3,3]</th>
<th>CAR[-5,5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>-2.07%</td>
<td>-2.35%</td>
<td>-2.40%</td>
<td>-2.11%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>-2.04%</td>
<td>-2.12%</td>
<td>-1.95%</td>
<td>-1.52%</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>-2.06%</td>
<td>-2.05%</td>
<td>-1.71%</td>
<td>-1.49%</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-1.81%</td>
<td>-1.96%</td>
<td>-2.07%</td>
<td>-1.86%</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-1.78%</td>
<td>-1.44%</td>
<td>-1.59%</td>
<td>-1.36%</td>
</tr>
</tbody>
</table>

This table reports the median statistics for cumulative abnormal returns (CARs). CARs are calculated over the event days [-1,1], [-2,2], [-3,3] and [-5,5], where event day 0 is defined as the SEO filing date obtained from the Thompson Financials SDC database. Firms are pooled based on the chronological order of SEO announcements.