Investment Decision with Floating Rate Loan Choice Based on NPV Approach

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ABSTRACT
The pattern of the uncertainty of cash flows and the cost of capital associated with a project plays a central role in determining whether and when this project would be undertaken. For example, the difference between hurdle rate and break-even rate may directly defer the investment decision to a later date, thus reducing a company's current cash flows. However, once financial instruments such as floating loans or bonds as well as interest rate swaps are taken into account, investment decision-making may be expedited. As a result, the efficiency of the firm can be improved.

Keywords: *Net Present Value, Floating Rate Loans, Investment Uncertainty*

1. INTRODUCTION

Since its formalization and formalization by [1], seminal papers such as [2-5] on the theory of capital and accounting have attached great importance to net present value(npv) as an essential criterion when a management team is contemplating its investment decisions. the past three decades have seen the development of a huge volume of literature on the application of the npv approach in economics, finance, and accounting, among other fields. in recent years, how the investment decision-making of a project is impacted by its uncertainty of cash flows and cost of capital has attracted more attention which is manifest in the papers such as [6-8]. However, few literatures so far has considered if the scenario where the project can be financed through financial innovations such as floating loans or bonds and how this financing choice is going to impact the undertaking and timing of the project concerned.

In other words, the interaction between financing methods and investment decisions has been rarely investigated in the past literature. this paper aims to fill the gap among the literature in this regard.

2. LITERATURE REVIEW

There have been two strands of literature regarding the uncertainty surrounding the NPV of a project: one is to focus on how to measure the expected value of a project with stochastic cash flows over its life. For example, [9] surveyed three different techniques that may be employed to evaluate innovation projects. The first technique is called risk-adjusted NPV, which represents the risk associated with innovation project as the probability of successful development, and the expected NPV of innovation project can be written as:

$$rNPV = NPV\,PR_0 - \sum_{i=0}^{n} NPVC_i R_0/R_i \qquad (1)$$

Where rNPV = NPV of the risk-adjusted payoff minus the sum of the NPV of the risk-adjusted costs; NPV PR0 = NPV of the risk-adjusted payoff; R0 = current risk; NPV CiR0/Ri = sum of the risk-adjusted costs.

The second technique is called stochastic NPV, where the expected value of the NPV is obtained as:

$$E(NPV) = \sum_{t=0}^{n} \frac{E(NCF_t)}{(1+r_f)^t} \qquad (2)$$

Where E(NPV) = expected NPV; E(NCFt) = the expected value of the net cash flow in each year t; rf = the risk-free rate. Here, the expectation is taken with respect to risk-neutral probability.

The third is called certainty equivalent NPV, which adjusts future cash flows generated by the project taking into account their risk through introducing a coefficient α ranging from 0 to 1 as in Equation 3:

$$NPV_{CEQ} = \sum_{t=0}^{n} \frac{\alpha t E(NCF_t)}{(1+r_f)^t} \qquad (3)$$

Where $NPV_C EQ$ = certain equipment NPV; E(NCFt) = expected value of cash flows in the year t; rf = risk free rate. It is evident that the higher the risk associated with a given cash flow (either because it is expected in the long term or it is related to a high ? volatile? input), the lower the value of the coefficient α.

The other strand studies the way the uncertain interest rates affect the NPV of a project and thus the associated investment decisions. [10] and [11] are typical of this stream of literature. These two articles aim to show that investment decisions on nearly all investment projects should be governed by a modified NPV rule induced by the option rights values in anticipation of lower interest rates (cost of capital) in later dates. The analysis provides a simple rationale for setting corporate hurdle rates above the cost of capital, i.e., an investment should not be undertaken until its projected rate of return is substantially in excess of its break-even rate. The interest rate dynamics are given by the Ito equation for the short rate, r,

$$dr = \lambda \times r \times dt + \sigma \times \sqrt{r} dz \quad (4)$$

where z is a Brownian process.

Under this assumption, the term structure of interest rates can be solved and the price of a zero-coupon bond is given by:

$$p(r,T) = e^{-b(T)r} \quad (5)$$

Where

$$b(T) = \frac{2(e^{\gamma T}-1)}{(\gamma-\lambda)(e^{\gamma T}-1)+2\gamma}$$

And

$$\gamma = \sqrt{\lambda^2 + 2\sigma^2}$$

b(T) has an interpretation of the modified duration of a T-maturity zero-coupon bond.The Ingersoll and Ross formula for the optimal short-term interest rate at which to exercise the option to undertake the project is given by:

$$r^* = r^0 + \left(\frac{1}{(b(T)}\right)\ln\left(\frac{(v-b(T))}{v}\right) \quad (6)$$

where r0 is the instantaneous rate at which the project has a zero NPV at which investment should be undertaken.

$$r^0 = \frac{1}{b(T)}\ln I \quad (7)$$

And

$$v = \frac{\lambda+\gamma}{\sigma^2} \quad (8)$$

where I denote the ratio of the point investment to the point output at time T.

Note that r0 is not the project's internal rate of return. The break-even rate, r0, is an instantaneous rate, but the project lasts for T periods, so its internal rate of return(IRR) is the T -period rate at which it has a zero NPV. This is IRR = −(1/T) log I = [b(T)/T]r0

Similarly, the acceptance rate r∗ for a project is the acceptance level of the short-term interest rate and not the T -period rate. The acceptance T -period rate(hurdle rate) for a given project is rT∗ = [b(T)/T]r∗ or if we substitute this relationship into Equation 6

$$r_T^* = \frac{b(T)}{T} r^* = IRR + \frac{1}{T}\ln\left(\frac{v-b(T)}{v}\right) \quad (9)$$

These two T -period rates differ from their instantaneous counterparts because of positive or negative term premia or even in the absence of term premia and drift, the yield curve has a tendency to slope downward due to Jensen's inequality. Further, if we assume that there is no term premia, i.e., we set λ = 0. Approximating the hurdle rate for small choices of σ through a Taylor expansion produces

$$r_T^* \approx IRR - \left(\frac{\sigma}{\sqrt{2}}\right) \quad (10)$$

In general, this approximation is valid for well-behaved projects, i.e., projects with a single IRR. All these literature have all shared one thing in common: they implicitlyly assume that the interest rates are fixed once the commitment of investment is made (which is exactly why there exists an optimal market interest rate for the project tbe beundertaken). However, the recent development in financial derivatives such as floating loans and interest rate swaps might be able to change this situation. In the next chapter, we are going to examine how the availability of this floating rate loan choice is going to impact investment decisions.

3. ALTERNATIVE FINANCING METHODS AND IMPLICATIONS

As can be seen in the last chapter, [12] derived an optimal instantaneous interest rate r∗ lower than the break-even rate r0 for a management team to undertake the project. However, this implicitly assumes that the cost of capital would be the same as this optimal short-term interest rate over the economic life of the project therein once the investment is made, whereas it is often not the case a firm will always use financing instruments with a fixed rate. For example, the evidence has been documented in [13] that between 1992 and 2007, a considerable number of firms issued floating rate bonds as an effective mechanism to mitigate a firm's interest rate risk when the rates are high and expected to fall. When a firm is allowed to use floating rate instruments (either loan or bonds) to finance its projects, it is intuitive that it does not have to wait until the short-term interest rate hits the aforementioned optimal short rate r^*. For example, if the current short rate is $\tilde{r} > r^*$ but the term structure of forwarding rate (e.g. LIBOR or SOFR) is downward sloping, the Swap Fixed Rate(r^{SFR})–as a weighted average of forwarding rate with greater weighting placed on the near term rates–is smaller than $\tilde{r}$. If it is small enough and less than r^*, it would be advisable for the decision-maker on running the project to enter into a contract with a bank that borrows the needed funds to initiate the project under consideration at a floating rate (a short term reference rate such as LIBOR plus a fixed quoted margin) and at the same time a concomitant interest swap contract with a counterparty that locks in the fixed interest rate which is lower than the optimal interest rate of undertaking the project. Obviously, doing so would benefit the firm so that it does not have to wait for the actual short rate to fall to r^*. In other words, the option of using floating rate instrument and interest swap enables the firm to generate higher efficiency in the timing of investment decisions by allowing the firm to leverage anticipated fall in the short term rate. Even when the current short term interest rate is not small enough to reach r^*, it may still be possible for the firm to benefit from financing the project with the option of entering into a floating-rate. The rationale behind it is that the actual future spot interest rate may be lower than the forward interest rate since the forward rates tend to fail to track the future spot rates and poorly reflects their variations([14]) which would actually yield the optimal cost of capital for the project.

There are two things that are worth mentioning here: first, the uncertainty of interest rates plays the central role in the management team's decision as to whether or not to undertake the project, and the signal for the firm to set out the project is not an optional optimal short rate any more but a profile of the term structure of forwarding rates. The corresponding profiles of forwarding rates as the signal for the management team to mount the project, in contrast to the single point optimal interest rate derived in [8], are multiple solutions and depend upon the duration and internal rate of return(IRR) of the project. A more detailed relationship between the qualified term structure of forwarding rate and the duration or IRR of the project is subject to a static analysis similar to the one seen in [8]. Moreover, suppose a firm decides to enter into a floating rate contract without the coverage of interest rate swap contract. In that case, it will bear the interest rate risk induced by the contingency of future spot rates on the economic situation or even the monetary policy by the central bank. In this situation, an analysis of Monte Carlo simulation using the parameters calibrated using the CIR model on the term structure of interest rate or estimated from the actual data on the short-term interest rate would be of enormous use for the management team. The quantiles of simulated distribution of NPVs should be compared with a benchmark NPV, say, the one imputed from the optimal interest rate r^* and the return v.s. The management team should weigh risk trade-off to decide the project's financial viability. The employed method of Simulation can be borrowed from [4] or [14], and the details are beyond the scope of this paper.

Second, the examination of the term structure of interest rates plays a central role in investment decisions. Therefore, how to model interest rates become a key issue here. CIR model on term structures assume exogenously given process for the short interest rates while typical macroeconomists view short term interest rates as set by Central Bank’s monetary policy rule ([14]). In order to reconcile their differences and understand the mechanism through which the macroeconomy influences the term structure, we need to take a closer look at the joint behavior of the yield curve and macroeconomic variables. This can be viewed as another channel through which the macroeconomic situation impacts the investment decisions in addition to its effects on the cash flows generated by the project.

4. CONCLUSION

This paper reviewed the main literature that studied the issues of uncertainty involved in calculating NPV, whether it be interest rate uncertainty or cash flow uncertainty. Next, we focus on the potential issues arising from the uncertainty of interest rates given the choice of using floating-rate financing instruments. This is a channel through which the financial innovation in derivatives and financing instruments influence the investment decisions made by the management teams in a firm. The intuition behind this connection is simple and clear: the option of using more flexible financial instruments allows the firm to take advantage of its speculation over the central bank's monetary policy and expectation over the movement of the term structure of interest rates, thus providing more lubrication to the friction between hurdle rate and break-even rate created by the "waiting to invest" options in a specified period of time.

The caveat of this paper is that the real decision-making process as to whether or not to undertake a project is far more complicated than the common NPV rule, i.e., positive (negative) NPV implies yes(no). In reality, given the uncertainty of the cost of capital and cash flows, the financing and investing decisions are apt to be intertwined and interdependent, particularly when there are more financing instruments for risk control or speculation are available for use.

The most important implication from the aforementioned theoretic hypothesis is that the availability of financial instruments such as floating rate bonds facilitates the investment decisions by the firms and thus is conducive to the efficiency and growth of the general economy. The extent to which these financial instruments positively impact the economy can be examined using data of financing and investing behaviors at the firm level before and after the introduction of such kinds of financial instruments in empirical research. In addition, a concrete example with simulated interest rates using the CIR model could also be useful in illustrating our idea in Section 3. The connection between financial derivatives and investment decisions is a broad topic and subject to research from a wider perspective using more innovative methodologies and different ways of thinking.

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