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Pricing executive stock options under employment shocks

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ABSTRACT

We obtain explicit expressions for the subjective, objective and market value of perpetual executive stock options (ESOs) under exogenous employment shocks driven by an independent Poisson process. Previously, we obtain the executive's optimal exercise policy from the subjective valuation that is necessary for the objective one, or fair value. The perpetual ESO is compared with the true finite maturity ESO finding that the approximation is reasonably good. To illustrate the usefulness of the objective valuation for accounting purposes, we analyze the statistical distribution of the fair value when there is uncertainty about the employment shock intensity. Finally, the role of ESOs in the design of executives' incentives is also discussed.

1. Introduction

The increasing relevance of executive stock options (ESOs) as a component of corporate compensation has led the International Accounting Standard Board (IASB) to issue the International Financial Reporting Standard 2 (IFRS 2) in February 2004. In March 2004, the Financial Accounting Standard Board (FASB) has also revised the Financial Accounting Standard 123 (FAS 123R) with a similar purpose, namely, to provide a fair value method for shared based compensation arrangement.[4]

ESOs are mainly American-style call options that, in contrast with conventional ones, exhibit some features that aim to create the required incentives for aligning executive's goals with shareholders' interests.[5] In concrete, ESOs cannot be sold or transferred, though partial hedge is possible by trading correlated assets. They can only be exercised after ending the vesting period. The executive is also subject to a departure risk or employment shock. If he leaves the firm, either voluntarily or not, he must exercise the ESOs. If the departure occurs during the vesting period, the executive loses his ESO

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[4] We will only concentrate on the FAS 123R since both standards establish rather the same purpose concerning the fair value.
[5] For a detailed discussion about the differences between standard options and ESO grants, see Rubinstein (1995).

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package. The executive typically exercises the option earlier of what it would be optimal for a tradable American option. The related empirical evidence on this fact can be found, among others, in Huddart and Lang (1996), Carpenter (1998) and Bettis et al. (2005). As a result, the standard methods used to price American options are not directly applicable and a growing literature has been searching for the proper valuation of ESOs. In this regard, accounting standards have established that a fair value based method should incorporate, at least, the stylized facts of a vesting period, employment shocks and suboptimal exercise. In this work, we propose a valuation framework that considers all these features for ESO valuation. We also assume that the possible dilution effect is anticipated by the market and it is already reflected in the stock price immediately after the ESO grant.[6]

We obtain the three different ESO valuations that can be found in the literature. In the first place there is the risk-neutral valuation, or market price, corresponding to an unconstrained agent. Next, there is the subjective valuation made by a constrained executive, who has not a fully diversified portfolio since he cannot trade his holdings of ESOs and firm's stocks. This implies a suboptimal exercise rule and hence a lower subjective value. Finally, there is the objective valuation or fair value, which is the cost to the firm of issuing the ESOs. This is the value attached by an agent with a fully diversified portfolio who is restricted to follow the executive's exercise policy. In this work, we will concentrate on the fair value though it is necessary to obtain previously the exercise rule from the subjective valuation. It is satisfied that the fair value lies between the market value and subjective one, see Ingersoll (2006).

It must be remarked that the aforementioned valuations depend crucially on how the exercise policy is obtained. In this sense, we can distinguish between two different approaches. The first one is based on structural models in which the exercise policy is obtained from the maximization of the executive's expected utility subject to a given set of constraints. Lambert et al. (1991) is an early example. They obtain the subjective ESO value by using the certainty equivalent (CE) principle. Huddart (1994) and Kulatilaka and Marcus (1994) use this framework to provide an estimate of this subjective value determining the exercise rule on a binomial tree. However, they restrict the executive to hold his wealth only in the risk-free asset. Hall and Murphy (2002) allow a more general setting in which the executive's wealth holds the restricted stocks. Cai and Vijh (2005) show a more extended version where the executive's wealth is split into the market portfolio and the risk-free asset. All these studies are characterized to be static since the executive maximizes the expected utility of his terminal wealth. Meanwhile, Kahl et al. (2003) and Ingersoll (2006) use a dynamic approach to solve the constrained executive's consumption-portfolio investment problem.

A second approach is based on reduced form models in which the exercise policy is described either by some exogenous random event or by some exogenous parameter (or both) that forces the early option exercise. An early example can be found in Jennergren and Näslund (1993), who introduce an exogenous and independent Poisson process with constant intensity, or exit rate, whose first arrival forces the early exercise of ESOs. Carpenter (1998) shows that this type of models performs as well as the structural ones. Carr and Linetsky (2000) develop an analytical specification under a stochastic intensity framework. Under the binomial approach, Hull and White (2004) and Ammann and Seiz (2004) calculate the fair value where the early exercise behavior is modeled, respectively, as a barrier and an adjusted strike price. The continuous version with barrier can be found in Ingersoll (2006). Sircar and Xiong (2007) provide an analytical valuation for a perpetual American ESO considering the resetting and reloading provisions that are features in many option programs. Finally, Cvitanic et al. (2008) obtain a closed-form valuation in continuous time such that the exit rate is modeled under the same approach as pricing default bonds and the early exercise is also captured through a barrier.

This paper develops an analytical ESO valuation based on Ingersoll's structural model and it also includes a job termination risk along the lines of Jennergren and Näslund (1993). Ingersoll's framework assumes a general factor model for the evolution of asset returns. In our work, the risk factors are reduced to just the market risk and the executive can only allocate his wealth across the market portfolio, the firm's stock and the risk-free asset. Since the executive is assumed to be undiversified, he is constrained to hold more of the firm's stock than its corresponding share in the market portfolio. As a result, there are two sources of risk, one from the non-diversifiable systematic risk factor and the other from the idiosyncratic component that is not correlated with market risk. Notice that under a well-diversified portfolio, the single source of risk would come exclusively from the market portfolio and any other idiosyncratic component would have vanished.

Our analytical expressions are obtained by assuming perpetual options. Moreover, by incorporating an additional source of risk, the job termination risk, we get a valuation model similar to that of Sircar and Xiong (2007) without the reloading and resetting provisions. Note, however, that they just solve the case of a well-diversified or risk-neutral agent, so the ESO market value is only obtained. Our model provides closed-form expressions for both the subjective and objective values.

Though this context is unreal, the perpetual ESO prices approach the finite maturity ones reasonably well. As expected, perpetual ESO values become a better approximation the longer the maturity. Interestingly the fair value of an American-style ESO with a maturity of 10 years, which is the benchmark case in the literature, turns out to be well captured through our perpetual valuation.

In short, the main contribution of this paper is that we obtain closed-form valuation expressions for perpetual ESOs under employment shocks at the grant date for the three alternative cases mentioned above. We show that these analytical

[6] See Hull and White (2004), Leung and Sircar (2009) and FASB statement 123R.