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# Investment timing and capital structure with loan guarantees ☆

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ABSTRACT

The equity-for-guarantee swap (EGS) is a new popular financial derivative. We derive closed-form solutions for the interaction of the optimal investment and financing with the swap in a real-options framework. We find that there is an U-shaped relationship between investment timing and the coupon payment. In contrast to the classical model, EGS induces different investment and financing strategies. In particular, it delays investment. Whether the swap leads to debt overhang distortion depends on guarantee cost and the profitability of the project but it induces the borrower's risk-shifting incentive. The larger the guarantee cost, the stronger the incentive.



## 1. Introduction

To solve financing constraints faced by small and medium-sized enterprises (SMEs), a new financial contract, called equity-for-guarantee swap (EGS), is introduced by entrepreneurs in China. This is an agreement among a bank/lender, an insurer and an SME/borrower, where a bank lends at a given interest rate to an SME and once the SME defaults on the loan, the insurer must pay all the outstanding interest and principal to the bank instead of the SME. In return for the guarantee, the SME must allocate a fraction of equity to the insurer, which is called the guarantee cost. Through the intervention of

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insurers, the credit standing of borrowers is promoted, so that they can get financial services easier and cheaper from commercial banks. In particular, Chinese private online financial organizations have recently shaken the traditional financial markets monopolized by state-owned banks. For example, Alibaba's Yu'e Bao has raised US$ 65.38 billion in eight months. To decrease financial risk originated from the Internet finance, it is believed that a credit guarantee system including the EGS would play an important role.

Recently, much attention has actually been paid to EGS. For example, Yang and Zhang (2013) derive its equilibrium price while Yang and Zhang (forthcoming) discuss its utility-based price. Wang et al. (2015) consider a borrower who enters into EGS and invests in a take-it-or-leave-it project with a cash-out option. However, there is no literature considering the interaction of investment and financing with EGS and whether it leads to inefficiencies from debt overhang and asset substitution.

Our paper is related to the literature on real options, which employs the real options approach to investigate the interplay between financing and investment, such as Sarkar (2011), Hackbarth and Mauer (2012) and Sundaresan et al. (forthcoming). However, they do not take financing constraints into account.

We develop a real-options framework with the EGS to overcome financial constraints. The inefficiencies under the swap from debt overhang and asset substitution are discussed.

The remainder of the paper is organized as follows. Section 2 describes the model setup and provides a benchmark model without the swap. Section 3 derives closed-form solutions for the investment, financing, default threshold, guarantee cost and the firm's value. Section 4 provides numerical analysis. Section 5 concludes.

## 2. Model setup and an all-equity benchmark

*Model setup*. We assume the only asset owned by an SME is an option to invest in a single project by paying a fixed investment $I$ (sunk cost). The project generates cash flow $QX(t)$ after the investment is exercised, where $Q > 0$ is constant, representing the product quantity of the project and $X(t)$ is its product price. We suppose that the price follows a geometric Browmian motion given by

$$\frac{dX(t)}{X(t)} = \mu dt + \sigma dB(t),\ t \geqslant 0, \quad X(0) = x_0 > 0 \text{ given}, \tag{1}$$

where $B(t)$ denotes the standard Brownian motion defined on the risk-neutral probability space $(\Omega, \mathcal{F}, \mathbb{Q})$ and $\mu$ and $\sigma > 0$ are constant. The cash flow $QX(t)$ can be regarded as the firm's earnings before interest and taxes at time $t$ if the firm is in operation.

Following Goldstein et al. (2001), we assume a simple tax structure that includes personal and corporate taxes, where interest payments are taxed at a personal rate $\tau_i$, effective dividends are taxed at $\tau_d$, and corporate profits are taxed at $\tau_c$, with full loss offset provisions.

Let $\Pi(x)$ denote the after-tax value of the asset in place if the current price level is $x$, then we immediately get

$$\Pi(x) = \frac{1-\tau}{r-\mu} Qx, \tag{2}$$

where $r$ is the constant risk-free interest rate, $\tau$ is the effective tax rate defined by $1-\tau = (1-\tau_c)(1-\tau_d)$ and $\mu < r$ for a well-known reason.

*The benchmark model*. We consider here the benchmark model where the SME finances the real investment with equity only. We denote the value of the unlevered firm by $E_u(x)$ if the current product price is $x$ then the firm's optimal investment problem can be formalized as follows:

$$E_u(x) = \sup_{T_U^i} \mathbb{E}\left[ \int_{T_U^i}^{+\infty} e^{-rt}(1-\tau)QX(t)dt - e^{-rT_U^i} I | X(0) = x \right], \tag{3}$$

where $T_U^i > 0$ is the stopping time when the investment is exercised. Since this is an optimal stopping problem of Markovian dynamics, it suffices to consider the stopping times with the following form: