Economic Modelling 29 (2012) 1780–1785

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Attracting private investment: Tax reduction, investment subsidy, or both?[☆]

Sudipto Sarkar [*]

302 DSB, McMaster University, 1280 Main Street West, Hamilton, ON L8S 4M4, Canada

ARTICLE INFO

Article history:
Accepted 25 May 2012

JEL classification:
H2

Keywords:
Investment incentive
Tax reduction
Investment subsidy
Real option

ABSTRACT

This paper uses a real-option model to examine the net benefit to a government from using tax cut and/or investment subsidy as incentives to induce immediate investment. Although earlier papers generally concluded that investment subsidy dominates tax cut, it is observed that many governments use a combination of subsidy and tax cut. We show that, when the government uses a different discount rate from private firms, and when it has to borrow money to provide an investment subsidy, it is possible to get an internal optimum; that is, it might be optimal for the government to provide an investment subsidy as well as charge a positive tax rate on the profits from the project. Thus, we provide an explanation for the puzzling fact that many governments provide an investment subsidy to a firm while simultaneously taxing its profits.

1. Introduction

It is widely accepted that private investment has a significant and positive effect on economic growth (Kim, 1998). Private corporate investment helps reduce unemployment, increases government revenues by way of tax collections, reduces imports and/or increases exports, helps with technology transfer, develops local entrepreneurship, etc. Not surprisingly, governments around the world have stepped up efforts to attract private investment.[1] The two methods most commonly used by governments to encourage private investment are tax rate reduction and investment grant/subsidy (Bond and Samuelson, 1986; Nam and Radulescu, 2004; Pennings, 2000; Yu et al., 2007).

This paper compares the efficacy of these two methods, in terms of their ability to attract investment as well as how they impact the net benefit to the government from the investment project. It also examines the optimal combination (from the government's perspective), if any, of these two investment incentives. Of course, tax reduction and investment subsidy should not be viewed as substitutes for strong economic fundamentals and basic "desirable" conditions for investment, such as solid infrastructure, reliable and transparent legal system, adequate property rights, macroeconomic and political stability, and an educated workforce.

There has been some research on the relative effectiveness of tax cut versus investment subsidy as investment incentives (Pennings, 2000, 2005, Yu et al., 2007; Zee et al., 2002). Such analyses are useful for governments trying to decide whether to offer tax rate reduction or investment subsidy (or what combination of the two to offer) to spur corporate investment. Zee et al. (2002) stress the importance of cost-effectiveness: a tax reduction is costly because of the forgone tax revenues, but an investment subsidy requires an upfront expenditure by the government and exposes it to the risk of the project turning out to be "unviable;" they conclude (without any quantitative analysis) that the investment subsidy is generally the least meritorious incentive. Pennings (2000) uses a real-option model to study combinations of tax reduction and investment subsidy that a government can use to manipulate the entry trigger for an irreversible investment under uncertainty. He shows that, with a zero-cost combination (that is, the value of the government's tax collections is exactly offset by the subsidy it provides), the entry trigger is a decreasing function of the tax rate (his Eq. (7)). Thus, a higher tax rate (but with a correspondingly higher subsidy, so that the total cost to the government remains zero) will result in a lower investment trigger and will thus accelerate investment. An obvious implication of this result is that the government is better off increasing the tax rate as well as the subsidy; in other words, an investment subsidy is more efficient than a tax cut. This was shown explicitly by Yu et al. (2007), in their Proposition 1: for a given investment threshold, the expected present value of investment subsidy is smaller than that of tax rate reduction. Thus, these models seem to be in agreement that the government will be better off with a full investment subsidy and a high tax rate.

However, it is observed that many governments provide investment subsidy *and* tax reduction at the same time (Hansson and Stuart, 1989; Morisset and Pirnia, 2000). Hansson and Stuart (1989) argue that this behavior can be explained if the tax policy is set

---

[☆] I acknowledge financial support from a SSHRC (Canada) grant.

[*] Tel.: +1 905 525 9140x23959; fax: +1 905 521 8995.
E-mail address: sarkars@mcmaster.ca.

[1] Even affluent Western countries use various incentives to increase investment in certain sectors, industries or geographical regions (Fuest and Huber, 1998; Holland and Vann, 1998; Morisset and Pirnia, 2000; Zee et al., 2002). It has become common for countries to compete for private investment using various incentives, particularly in recent years because of high capital mobility.

0264-9993/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.econmod.2012.05.030

sequentially by successive governments; however, their explanation does not work for stable tax policies. Pennings (2005) uses a real-option model of FDI (where the firm has the choice of exporting or investing) to explain a government's decision to provide an investment subsidy in combination with a positive tax rate. However, even he finds that the host government will maximize net domestic benefits by nearly fully subsidizing the investment cost in combination with taxing away all benefits that exceed the gains from exporting. Thus, his result is very close to the earlier result of Pennings (2000) and Yu et al. (2007). Pennings (2005) argues that the optimal choice (i.e., maximizing the subsidy and the tax rate) is not observed in practice because of exogenous limits on state aid, i.e., "... state aid is often limited to a certain percentage of the investment cost" (page 885), hence a combination of investment subsidy and tax cut is used.

This paper shows it can be optimal to use both investment subsidy and tax cut in combination, to encourage immediate investment; however, this result is derived as an endogenous outcome of the model, and not by appealing to an exogenous limit on investment subsidy. Consistent with the large literature on government discount rates, we allow the government's discount rate to be different from the private firm's discount rate. This is where our model differs from earlier studies (Pennings, 2000; Yu et al., 2007, etc.), in which the two discount rates were the same. This small modeling change can explain simultaneous taxation and subsidization.

We show that when the two discount rates are equal, the investment subsidy does dominate, as in Pennings (2000) and Yu et al. (2007). However, when they are different and the government's discount rate is large enough, the result is reversed and tax reduction dominates. Finally, if the government's discount rate is an increasing function of its borrowing (which is quite plausible), then it is possible that the optimal incentive scheme is a combination of investment subsidy and tax reduction. These outcomes are illustrated with numerical examples.

The rest of the paper follows the outline below. Section 2 introduces the model, identifies the firm's optimal investment policy and computes the government's net benefit from immediate investment in the project; it also briefly discusses the appropriate discount rate for the government. Section 3 identifies, for various situations, the optimal incentive package (tax cut and investment subsidy) that the government can offer to induce immediate investment in the project; and briefly discusses the properties of this optimal combination, illustrating the results with numerical examples. Section 4 concludes.

2. The model

We use a standard real-option model, similar to Pennings (2000). As in Pennings (2000), we have kept the model simple, so that we can focus on the main issue: tax reduction versus investment subsidy. A firm has an option to invest in a production facility at any time by paying a fixed investment cost I. Once the investment is made, the infinitely-lived project will generate a perpetual stochastic earnings stream (or cash from operations) of x_t per unit time. We assume that x_t follows the usual lognormal process:

$$dx/x = \mu dt + \sigma dz \tag{1}$$

where μ and σ denote the drift and volatility of the process, respectively, and dz the increment of the standard Weiner Process. The firm's earnings are taxed at a constant rate of τ.

2.1. Value of the project

First we value the project when it is in operation; this will be needed for the decision to exercise the investment option. The project value will of course be a function of the earnings level x; however, because of the infinite-horizon setting, it will be time-independent. Let the project value be given by V(x). Then, as shown in the Appendix A, the project value is given by

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

where r is the company's discount rate (we assume $\mu<r$, to ensure convergence).

2.2. Value of the firm's option to invest

The firm's investment policy specifies the optimal time to exercise the option to invest. From the real option literature (Dixit and Pindyck, 1994; Pennings, 2000, etc.), we know that the optimal investment rule is of the form: invest as soon as x rises to some critical level, say x^*. We therefore assume that, when x rises to the trigger x^* (to be determined as part of the solution), the firm will exercise the investment option and implement the project. When the firm makes the investment (i.e., exercises the option to invest), its payoff will be the project value at that time, $V(x^*)$, less the investment cost, I.

Since the option to invest is a perpetual one, its value will depend on x but not time. Let the value of the option to invest be F(x). Then, as shown in the Appendix A, the option value, F(x), must satisfy the ordinary differential equation (ODE):

$$0.5\sigma^2 x^2 F''(x) + \mu x F'(x) - rF(x) = 0 \tag{3}$$

The solution to ODE (3) is $F(x) = F_1 x^{\gamma_1} + F_2 x^{\gamma_2}$, where F_1 and F_2 are constants to be determined by the boundary conditions, and γ_1 and γ_2 are solutions of the quadratic equation

$$0.5\sigma^2\gamma(\gamma-1) + \mu\gamma - r = 0 \tag{4}$$

and are given by

$$\gamma_1 = 0.5-\mu/\sigma^2 + \sqrt{2r/\sigma^2 + (0.5-\mu/\sigma^2)^2} \tag{5}$$

$$\gamma_2 = 0.5-\mu/\sigma^2 - \sqrt{2r/\sigma^2 + (0.5-\mu/\sigma^2)^2} \tag{6}$$

Note that $\gamma_1>1$ and $\gamma_2<0$.

If x falls to zero, the option will be worthless (since zero is an absorbing boundary), which implies $F_2=0$. Thus, we can write the option value as follows:

$$F(x) = F_1 x^{\gamma_1} \tag{7}$$

In order to derive the complete solution, we have to determine the constant F_1 as well as the optimal entry trigger x^*.

2.3. The firm's investment policy

The investment policy is given by the investment trigger x^*. To compute the trigger, we use the well known value-matching and smooth-pasting conditions (Dixit and Pindyck, 1994). First, the value-matching condition requires that the value of the option at exercise must equal the net payoff at exercise:

$$F(x^*) = V(x^*) - I \tag{8}$$

The *optimal* investment trigger must also satisfy the smooth-pasting condition, which requires that the derivative of the option value equal the derivative of the payoff at exercise:

$$F'(x^*) = V'(x^*) \tag{9}$$