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Research on Different Dividends Tax and Maturity Structure of Liabilities by Numerical Simulation

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Abstract: Based on the mathematical analysis and external financing framework, this paper analyzes the influence of different tax rate on dividends over the company's debt maturity structure. The numerical calculation indicates that different tax rate on dividends will affect the company's maturity structure of liabilities; the company's long-term debt increases with the increase of the different tax rate, while short-term debt decreases. Furthermore, the different tax rate on dividends is beneficial to the entrepreneur engaged in long-term investment.

Key words: Numerical simulation, tax rate on dividends, maturity structure of liabilities

INTRODUCTION

"The dividend tax system" refers to the taxation provisions of dividend received by the shareholder or enterprise. In most countries, the tax system for investors is a double taxation system. That means the tax department could levy tax on dividends obtained by investors in addition to corporate income tax on profits. Some scholars believe that the system is "unfair and inefficient" (Arlen and Weiss, 1995; Arlen and MacLeod, 2003). McLure and Charles (1975) holds that double taxation means unified tax on company profits without considering the income discrepancy of shareholders.

In the last decades, there are three main viewpoints on the economic role of tax on dividends: Tax penalties concept, taxes unrelated concept and core capital concept. Harberger (1966) believed that, dividend tax is actually a double taxation of equity investment income. Such double taxation reduces the after-tax dividend income of equity investors, then increases the cost of capital and makes social idle capital flowing to non-company enterprise. Some scholars hold that double taxation of equity investment income is "neutral" and it could not affect the capital cost of endogenous financing and dividend policy (King, 1974; King and Mervyn, 2010). Sinn (1991, 2008) analyzes the different development stages of the company and then builds the "Nucleus Theory of the Firm". The theory states that companies in the early days may operate with a small number of "nucleus capitals" instead of issuing numerous new shares.

On the basis of fixed-investment model and external financing analysis framework under asymmetric information (Holmstrom and Tirole, 2000; 2002, Holmstrom, 2011), this study investigates the effect of different tax rate on dividends over the firm's maturity structure of liabilities by numerical simulation.

ASSUMPTION

This study introduces different dividends tax rate on the basis of the liquidity risk management model. The basic assumptions are given in the following:

- **Participants:** An entrepreneur and investors
- **Three periods:** Date 0 represents ex enter period; date 1 represents intermediate period; date 2 represents ex post period
- At date 0, the entrepreneur has a project requiring fixed investment I. The entrepreneur initially has "assets" A and need to borrow I-A from investors
- At date 1, the investment yields deterministic and verifiable income $r \geq 0$
- At date 1, the firm is hit by a random liquidity shock. Continuation, though, requires reinvesting an amount p, where p is ex ante unknown and has cumulative distribution function F (p) with density f (p) on $p \in (0,\infty)$. The realization of p is learned at date 1
- If the firm does not reinvest p, then the firm is liquidated. The liquidation value is 0. If the firm

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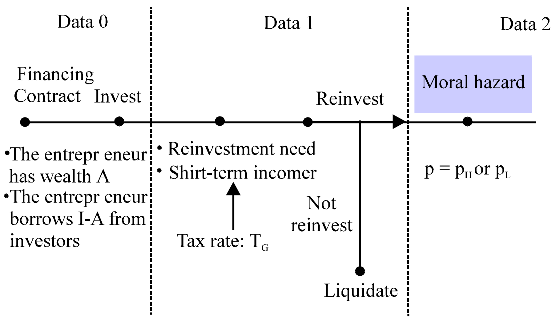

Fig. 1: Figure of the timing

reinvests 0, then the firm yields, at date 2, R with probability p and 0 with probability 1-p

- The probability of success p is affected by the effort degree of the entrepreneur but it is unobservable. Behaving yields probability $p = p_H$ of success and no private benefit to the entrepreneur and misbehaving results in probability $p = p<p_H$ of success and private benefit B>0. Let $\Delta p = p_H - p_L > 0$
- The investment has positive NPV (net present value) if the entrepreneur behaves but negative NPV otherwise
- There exists in the economy a store of value. That is, 1 unit invested at date 0 delivers a return of 1 unit at date 1
- Both the entrepreneur and investors are risk neutral
- The entrepreneur is protected by limited liability
- Both the entrepreneur and investors have no time preference and the riskless rate is taken to be 0
- Investors behave competitively in the sense that the loan, if any, makes zero profit
- The government takes different tax policies to the stock dividends based on the holding period. T_G is the statutory tax rate for short-term income, T_G-τ is the statutory tax rate for long-term income. Where τ>0 is the parameter of different tax rate

We summarize the timing in Fig. 1:

OPTIMAL MODEL

Suppose that the financing contract between the entrepreneur and investors takes the following state-contingent form:

$$\{\rho^c;(R_b,0);(1-T_G)r;((1-T_G+\tau)R-R_b,0)\}$$

- The contract specifies that p^c is a cutoff of reinvestment: if $p \le p^c$, the firm continues; if $p \ge p^c$, the firm liquidates
- At date 1, the entrepreneur gets nothing and the short-term income $(1-T_G)$ r will totally owned by investors
- If the project success, the entrepreneur and investors get R_b and $(1-T_G+\tau)$ R-R_b respectively in the case of continuation; if the project fail, both of them get 0

According to the contract, the probability of reinvestment is:

$$\Pr ob\{\rho \le \rho^c\} = F(\rho^c)$$

So, the entrepreneur's optimization problem becomes:

$$\begin{cases} \max\limits_{R_b,\rho^c} \; F(\rho^c)p_H R_b - A \\ \text{s.t.} \;\; F(\rho^c)p_H R_b \ge F(\rho^c)(p_L R_b + B) \\ \qquad (1-T_G)r + F(\rho^c)p_H[(1-T_G+\tau)R - R_b] \\ \qquad \ge I + \int_0^{\rho^c} \rho f(\rho)d\rho - A \end{cases} \tag{1}$$

Where the objective function is the entrepreneur's net utility; the first constraint is the entrepreneur's incentive-compatibility constraint; the second constraint is the investors' individual rationality constraint. The investors' individual rationality constraint holds with equality, so the optimal model (1) can be simplified as:

$$\begin{cases} \max\limits_{R_b,\rho^c} \; (1-T_G)r + F(\rho^c)p_H(1-T_G+\tau)R \\ \qquad -[I + \int_0^{\rho^c} \rho f(\rho)d\rho] \\ \text{s.t.} \;\; (\Delta p)R_b \ge B \\ \qquad (1-T_G)r + F(\rho^c)p_H[(1-T_G+\tau)R - R_b] \\ \qquad \ge I + \int_0^{\rho^c} \rho f(\rho)d\rho - A \end{cases} \tag{2}$$

We need to examine the characteristics of the objective function $U_b(p^c)$ and the function p (p^c) for solving the optimization problem (2):

$$U_b(\rho^c) = (1-T_G)r + F(\rho^c)p_H(1-T_G+\tau)R - [I + \int_0^{\rho^c} \rho f(\rho)d\rho]$$

$$P(\rho^c) = (1-T_G)r + F(\rho^c)p_H[(1-T_G+\tau)R - B/\Delta p] - \int_0^{\rho^c} \rho f(\rho)d\rho$$

Proposition 1: The objective function U_b (p^c) has following characteristics:

- If $p^c<P_1$,$U_b(p^c)$ is increasing with p^c

- If $p^c > P_1, U_b(p^c)$ is decreasing with p^c
- If $p^c = P_1, U_b(p^c)$ reaches its maximum

where, $\hat{\rho}_1 = p_H(1 - T_G + \tau)R$

Proof: Since:

$$\frac{\partial U_b(\rho^c)}{\partial \rho^c} = f(\rho^c)[p_H(1 - T_G + \tau)R - \rho^c]$$

and f $(p^c)>0$, proposition 1 is true.

Proposition 2: The function P (ρ^c) has following characteristics in the optimization problem 2:

- If $\rho^c < \hat{\rho}_0$, P (ρ^c) is increasing with p^c
- If $\rho^c > \hat{\rho}_0$, P (ρ^c) is decreasing with p^c
- If $\rho^c = \hat{\rho}_0$, P (ρ^c) reaches its maximum

where $\hat{\rho}_0 = p_H[(1 - T_G + \tau)R - B/\Delta p]$

Proof: Since:

$$\frac{\partial P(\rho^c)}{\partial \rho^c} = f(\rho^c)[p_H((1 - T_G + \tau)R - B/\Delta p) - \rho^c]$$

And f $(\rho^c)>0$, proposition 2 is true.

According to proposition 1 and 2, Fig. 2 illustrates the shape of the objective function $U_b(\rho^c)$ and function P (ρ^c). We are then led to consider three cases for the solution of the optimization problem 2:

- If $P(\hat{\rho}_1) \geq I - A$, the entrepreneur can get funding and the first-best solution is:

$$\rho^{c*} = \hat{\rho}_1$$

$$R_b^* = \frac{\hat{\rho}_1}{p_H} + \frac{(1 - T_G)r + A - [I + \int_0^{\hat{\rho}_1} \rho f(\rho)d\rho]}{F(\hat{\rho}_1)p_H}$$

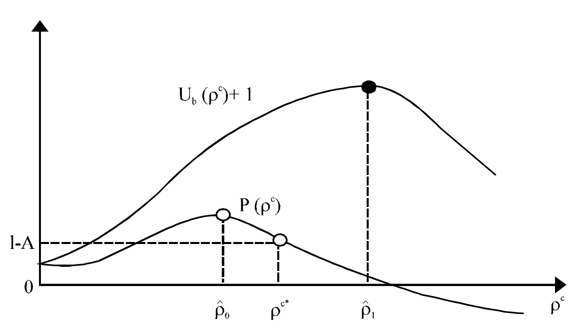

Fig. 2: Optimal continuation policy

- If $P(\hat{\rho}_1) < I - A \leq P(\hat{\rho}_0)$, the entrepreneur can get funding and the first-best solution is $R_b^* = B/\Delta p$, where the cutoff is $\rho^{c*} \in [\hat{\rho}_0, \hat{\rho}_1)$ then given by:

$$(1 - T_G)r + F(\rho^{c*})\hat{\rho}_0 - \int_0^{\rho^{c*}} \rho f(\rho)d\rho = I - A$$

- If $P(\hat{\rho}_0) < I - A$, funding is not feasible.

COMPARATIVE ANALYSIS

Let us define a cash-rich firm as one that is meant to disgorge money at the intermediate stage: $(1-T_G)r\ p^{c*}$, in particular, $(1 - T_G)r \geq \hat{\rho}_1$ suffices to ensure that the firm is cash rich. For a cash-rich firm, the optimal contract can be implemented through a combination of short-term debt d and long-term debt D, where:

$$d = (1-T_G)r-p^{c*}$$

$$D = (1 - T_G + \tau)R - \frac{B}{\Delta p}$$

The project could continue if $(1-T_G)r-p^{c*}$.

Proposition 3: If $P(\hat{\rho}_1) < I - A \leq P(\hat{\rho}_0)$, the "first-best cutoff" of reinvestment is increasing with the increase of different tax rate τ and decreasing with tax rate T_G.
Proof: For the following Eq.:

$$(1 - T_G)r + F(\rho^{c*})\hat{\rho}_0 - \int_0^{\rho^{c*}} \rho f(\rho)d\rho = I - A \quad (3)$$

Taking partial derivative on both sides:

$$f(\rho^{c*})\hat{\rho}_0 \frac{\partial \rho^{c*}}{\partial \tau} + F(\rho^{c*})\frac{\partial \hat{\rho}_0}{\partial \tau} - \rho^{c*} f(\rho^{c*})\frac{\partial \rho^{c*}}{\partial \tau} = 0$$

Also, because $\partial\hat{\rho}_0/\partial\tau = p_H R$, then:

$$\frac{\partial \rho^{c*}}{\partial \tau} = -\frac{p_H R F(\rho^{c*})}{f(\rho^{c*})(\hat{\rho}_0 - \rho^{c*})} > 0$$

For the Eq. 3, taking partial derivative on both sides, we can get that:

$$-r + [\hat{\rho}_0 - \rho^{c*}]f(\rho^{c*})\frac{\partial \rho^{c*}}{\partial T_G} + F(\rho^{c*})\frac{\partial \hat{\rho}_0}{\partial T_G} = 0$$

Also, because $\partial\hat{\rho}_0/\partial T_G = -p_H R$:

$$\frac{\partial \rho^{c*}}{\partial T_G} = \frac{r + p_H R F(\rho^{c*})}{f(\rho^{c*})(\hat{\rho}_0 - \rho^{c*})} < 0$$

Proposition 4: If $P(\hat{\rho}_1) < I - A \leq P(\hat{\rho}_0)$, the firm's long-term debt is increasing with the increase of different tax rate τ, the short-term debt is decreasing with the tax rate T_G.

Proof: It is easy to get that:

$$\frac{\partial D}{\partial \tau} = R > 0 \text{,} \quad \frac{\partial d}{\partial \tau} = -\frac{\partial \rho^{c*}}{\partial \tau} < 0$$

Proposition 5: If $P(\hat{\rho}_1) < I - A \leq P(\hat{\rho}_0)$, the firm's long-term debt is increasing with the increase of tax rate T_G.

Proposition 6: If $P(\hat{\rho}_1) < I - A \leq P(\hat{\rho}_0)$, increase in the tax rate T_G has positive and negative effects on the firm's short-term debt:

- If $\partial \rho^{c*} / \partial T_G < -r$, the total effect is positive
- If $\partial \rho^{c*} / \partial T_G > -r$, the total effect is negative
- If $\partial \rho^{c*} / \partial T_G = -r$, the total effect is 0

NUMERICAL SIMULATION

Now, we make some numerical calculations on the theoretical results.

Table 1 reveals that the firm's short-term debt is decreasing with the decrease of the different tax rate and the long-term debt is increasing with it. Where, basic parameters are:

$$A = 3,\ R = 25,\ B = 9,\ \rho\sim U\,[0{,}21],\ T_G = 0.2,$$
$$r = 24,\ P_L = 0.3,\ p_H = 0.9$$

Table 1: Debt maturity structure with different τ

	$P(\hat{\rho}_1)$	$P(\hat{\rho}_0)$	ρ^{c*}	d	D
0.00	15.3	19.7	9.9	9.4	5.0
0.02	15.4	19.8	10.7	8.5	5.5
0.04	15.6	19.9	11.5	7.7	6.0
0.06	15.7	20.0	12.4	6.8	6.5
0.08	15.8	20.2	13.2	6.0	7.0
0.10	16.0	20.3	14.1	5.1	7.5

Table 2: Debt maturity structure with T_G (1)

	$P(\hat{\rho}_1)$	$P(\hat{\rho}_0)$	ρ^{c*}	d	D
0.05	20.4	24.7	19.7	3.1	10.0
0.06	20.1	24.4	18.8	3.8	9.8
0.07	19.7	24.1	17.9	4.5	9.5
0.08	19.4	23.7	16.9	5.2	9.3
0.09	19.1	23.4	15.8	6.1	9.0
0.10	18.7	23.1	14.6	7.0	8.8

Table 3: Debt maturity structure with T_G (2)

	$P(\hat{\rho}_1)$	$P(\hat{\rho}_0)$	ρ^{c*}	d	D
0.05	11.70	26.88	20.4	2.37	10.0
0.06	11.72	26.91	20.2	2.34	9.8
0.07	11.76	26.95	20.0	2.31	9.5
0.08	11.80	26.99	19.8	2.27	9.3
0.09	11.85	27.04	19.6	2.23	9.0
0.10	11.91	27.10	19.4	2.18	8.8

Table 2 indicates that the firm's short-term debt is increasing with the increase of tax rate T_G and the long-term debt is decreasing with it. Where, basic parameters are:

$$A = 1,\ r = 24,\ p\sim U[0.21],\ p_H = 0.9,\ r = 24,\ \tau = 0.05$$

Table 3 indicates that the firm's short-term debt is decreasing with the increase of tax rate T_G and the long-term debt is decreasing with it. Where, basic parameters are:

$$R = 25,\ B = 9,\ P_L = 0.3,\ p_H = 0.9,\ r = 24,\ p\sim U[16.22],\ \tau = 0.1$$

CONCLUSION

This study discusses the influence of different tax rate on dividends over the company's maturity structure of liabilities. We get some conclusions through theoretical derivation and numerical calculations. Firstly, different tax rate on dividends will affect the company's maturity structure of liabilities. The firm's long-term debt increases with the increase of different tax rate on dividends but short-term debt decreases. It is helpful for the entrepreneur engaged in long-term investment. Secondly, the firm's risk management is influenced by different tax rate on dividends. Finally, different tax rate on dividends improves the entrepreneur's welfare.

The conclusion that different tax rate on dividends is good for long-term investment in the market has rich policy implications. At present, the reform and innovation of Chinese capital market is being fully implemented. In fact, the policy that the government takes different tax for personal dividends achieved by investing in stocks according to the holding period has been officially launched in January 2013. Our study provides a solid microeconomic theoretical basis for the implementation of the policy.

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