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Optimal Financing Strategy Based on Tax Shield Effects: A Case Study of Tesla

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Abstract: Traditional capital structure theories mostly focus on the idealized model of the tax shield effect, ignoring the financial distress costs and agency costs that may be caused by high debt ratios, resulting in significant differences between theory and practice. Therefore, combining actual enterprise data to explore how to balance the tax shield effect and implicit costs in the dynamic adjustment of capital structure has become an important topic in both theory and practice. This paper takes Tesla as a case to study the debt financing strategy based on the tax shield effect and its optimization effect on the weighted average cost of capital (WACC), aiming to combine market environment factors to obtain a more accurate WACC minimum value prediction model to maximize the tax shield effect. Regarding how to maximize the tax shield effect and minimize WACC through debt financing in the dynamic adjustment of capital structure, this paper first constructs a theoretical model and concludes that the higher the debt ratio, the lower the WACC. However, in the actual data analysis, the calculation results of the theoretical model differ significantly from the actual model. Therefore, the formula incorporates the constraints of financial distress costs and agency costs, which are relatively small in the early stage of enterprise development and have a greater impact when the enterprise is relatively mature, thereby changing the optimal WACC range.

Keywords: Tax shield effect, Tesla, Weighted average cost of capital

1. Introduction

Financing is the process by which enterprises obtain funds through internal or external channels, which is mainly divided into internal financing and external financing. Among them, internal financing is the use of enterprises' own funds (such as retained earnings, depreciation) into investment, with low cost but limited scale. External financing refers to borrowing funds from external sources when internal funds are insufficient. If there is no bank intermediary, the enterprise directly raises funds from the market (such as issuing stocks and bonds), which is called direct financing. If funds are obtained indirectly through financial institutions (such as bank loans), it is referred to as indirect financing [1]. Debt financing is another external financing method besides equity financing. Debt financing refers to a financing method integrated by enterprises from outside as their own debt rather than equity in order to meet their own capital needs. The lender of funds thus becomes the creditor and can obtain the corresponding interest income according to the agreement. Debt financing is an important way for enterprises to raise funds through borrowing, and one of its core advantages is the tax shield effect.

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The so-called tax shield means that enterprises can realize the effect of postponing or exempting tax burden by adopting certain methods. The tax shield effect is that interest is deductible before tax, while dividends are paid only after tax. Therefore, enterprises tend to choose the way of debt financing rather than equity financing to achieve the purpose of less tax. The debt tax offset in question is called the debt tax shield; the introduction of provisions on depreciation of fixed assets and amortization of intangible assets in the enterprise income tax allows qualified enterprises to realize pre-tax deductions of costs and tax credits, and this type of non-liability factor is called non-debt tax shield. This paper studies the effect of debt tax shield on debt tax offset. Firstly, it analyzes Tesla's debt financing, builds a financing model affected by bond interest rate, risk rate, natural growth rate and corporate tax rate, and then uses MATLAB software to calculate the minimum WACC under limited conditions through the control variable method. Finally, the data of Tesla in 2014 are introduced, and the actual and theoretical WACC are obtained.

2. Introduction to Tesla

Tesla is an American automotive and energy company founded in 2003 and headquartered in Palo Alto, California, United States. The company's main activities include the design, manufacture and sale of products such as electric vehicles, solar panels, energy storage devices [2], and related software and services. Tesla's electric vehicles are known for their advanced technology and excellent performance, including models such as Model S, Model X, Model 3 and Model Y. The company's solar panels and energy storage devices have also received widespread attention and are designed to help people achieve a more environmentally friendly and sustainable lifestyle. In addition, Tesla has developed autonomous driving technology and provides a range of intelligent features and services for its cars. Tesla has many fans and loyal users around the world, and has made contributions in the field of environmental protection and sustainability.

3. Establishment of weighted average cost of capital model

3.1. Definition of variables

In order to build the model, the following key variables and their definitions need to be defined in Table 1.

Table 1: Definition and description of variable symbols

r_d	Coupon rate
β	Risk rate (the systemic risk of a business, usually expressed as a Beta coefficient)
r_f	Risk-free interest rate
r_m	Market yield
g	Natural growth rate (sustainable growth rate of the firm)
T	Corporate tax rate
E	Equity market value
D	Market value of debt
V	Total enterprise value $V=(E+D)$
r_e	Cost of equity
γ	Risk premium coefficient

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3.2. Model establishment

3.2.1. Calculation of cost of equity (r_e)

The cost of equity can be calculated through the Capital Asset Pricing model (CAPM) [3]:

$$r_e = r_f + \beta^* \left(r_m - r_f\right) \tag{1}$$

Where: $r_m - r_f$is the market risk premium, reflecting the additional return required by investors for taking on systemic risk

3.2.2. Calculating the after-tax cost of debt(r_d^*)

Since debt interest is deductible before tax, the after-tax debt cost needs to be adjusted to the after-tax cost actually borne by the enterprise [4]:

$$r_d^* = r_d * \left(1 - T\right) \tag{2}$$

The formula reflects the direct impact of the tax shield effect on the financing cost of enterprises.

3.2.3. Calculation of weighted average cost of capital(WACC)

WACC is the weighted average of the cost of equity and the cost of after-tax debt, and the formula is as follows [5]:

$$WACC = \left(\frac{E}{V} * r_e\right) + \left(\frac{D}{V} * r_d^*\right) \tag{3}$$

Where $\frac{E}{V}$ and $\frac{D}{V}$ represent the weight of equity and debt in the capital structure, respectively.

3.2.4. Introduction of natural growth rate (g)

The natural rate of growth can be used to assess a firm's ability to grow sustainably and affect the cost of equity and the cost of debt. If the natural growth rate of the business is high, equity investors may demand a higher rate of return (rise). High growth rate may also reduce the risk rate of enterprises (β), thus reducing the cost of equity [6].

3.2.5. Model optimization objectives

The goal of the enterprise is to minimize and thus maximize the value of the enterprise. The optimization problem can be expressed as:

$$minWACC = \left(\frac{E}{V} * r_e\right) + \left(\frac{D}{V} * r_d^*\right) \tag{4}$$

There are some constraints in this formula. $V = (E + D)$ means that the capital structure is conserved. $r_e = r_f + \beta * (r_m - r_f)$ represents the constraints of the CAPM model. $r_d^* = r_d * (1 - T)$ represents the after-tax debt cost constraint. Among them, g influence r_e and β dynamic risk adjustment g influence r_e and r_e.

4. Deficiencies and optimization of the model

4.1. Tesla data analysis

Tesla has been listed on the Nasdaq exchange since 2010 under the ticker TSLA. Tesla's total liabilities and total assets increased from $179 million and $386 million in 2010 to $48.39 billion and $122.07 billion in 2024, respectively, and the debt ratio peaked in 2012 (0.89) [7]. Subsequently, it gradually declined, indicating that the corporate structure was gradually stable. The risk-free interest rate fluctuates between 0.5 and 4.5% [8], reflecting changes in the macroeconomic environment. The equity risk premium, as recently updated by Professor Damodaran, is 4.33% [9], assuming the same. The systematic risk of stocks in the monthly data of 5 years queried in Yahoo Finance website is 2.51[10]. With the tax reform in the United States, tax incentives, different tax rates and sales volume in different countries, the corporate income tax rate has also changed in different quarters, but the general trend has dropped from 35% to about 10% [7]. Table 2 shows detailed data statistics of Tesla from 2010 to 2024.

Table 2: WACC of Tesla from 2010 to 2024

A given year	Total liabilities (Millions of dollars)	Total assets (millions Usd)	Debt ratio (%)	Risk-free rate (%)	Market risk premium (%)	Beta	Cost of debt (%)	Corporate income tax rate (%)	WACC (%)
2010	179	386	0.46	3.2	4.33	1.2	5	35	6.01
2011	489	713	0.69	2.8	4.33	1.3	4.8	35	4.79
2012	989	1114	0.89	1.8	4.33	1.4	4.5	35	3.48
2013	1749	2416	0.72	2.5	4.33	1.5	4.2	35	4.46
2014	4879	5849	0.83	2.3	4.33	1.6	3.9	35	3.64
2015	6961	8092	0.86	2.1	4.33	1.7	3.6	35	3.34
2016	16750	22664	0.74	1.8	4.33	1.8	3.3	35	4.09
2017	23022	28655	0.80	2.3	4.33	1.9	3	30	3.76
2018	23427	29740	0.79	2.9	4.33	2	2.8	25	4.11
2019	26199	34309	0.76	1.9	4.33	2.1	2.6	20	4.19
2020	28418	52148	0.54	0.9	4.33	2	2.5	15	5.51
2021	30548	62131	0.49	1.4	4.33	2.5	2.4	15	7.24
2022	36440	82338	0.44	2.8	4.33	2.51	2.6	15	8.60
2023	43009	106618	0.40	4	4.33	2.51	2.6	15	9.76
2024	48390	122070	0.40	4.2	4.33	2.51	2.5	15	9.94

4.2. Model deficiencies

From the values of WACC in the above table, it is found that the calculated model in formula (4) is quite different from the actual model. Domestic scholar Zhang Jinming conducted an interval data test on the total sample of 1359 samples obtained from 455 listed companies that issued A-shares from 2001 to 2003, and concluded that the relationship between debt financing ratio and corporate performance is approximately "inverted U", and the optimal value of the debt financing ratio of listed companies is 30% [11]. The higher the debt ratio of this model, the smaller the WACC, indicating that the model has some limitations. The model in this paper is the minimum value of WACC under ideal conditions, which mainly considers the minimum WACC in the direction of the tax shield effect.

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However, in reality, there are many potential factors that affect the risk rate, such as the financial distress cost (such as creditor pressure and bankruptcy risk) and agency cost (such as the conflict of interest between shareholders and creditors) brought by a high debt ratio. This led to an increase in the debt ratio [12]. In addition, the debt cost in the model may be assumed to be fixed or only affected by the tax rate, but in reality, a high debt ratio often causes creditors to demand higher risk premiums (such as rising interest rates), resulting in non-linear growth of debt cost [13].

4.3. Model improvement

4.3.1. Introducing dynamic debt cost function

When financial managers set the target debt ratio, based on the risk aversion tendency of creditors, enterprises with high debt ratio need to pay a higher debt premium, and the growth rate of premium will accelerate with the increase of debt ratio [13].

Thus, the formula is added before formula (2):

$$r_d = r_f + \beta * \left(\frac{D}{E}\right)^{\gamma} \tag{5}$$

In this formula, both β and γ are risk premium coefficients, and the introduction of γ reflects the marginal increasing effect of debt cost when the debt ratio rises.

4.3.2. Introduce financial distress cost and agency cost

In the capital structure trade-off theory, Kraus and Litzenberger combined the tax shield effect with the cost of financial distress, and believed that the optimal debt ratio of enterprises was closely related to the balance of their marginal effect [12]. Therefore, formula (3) is introduced into financial distress cost and agency cost, and the formula is obtained:

$$WACC = \frac{E}{V} * r_e + \frac{D}{V} * r_d^*(1 - T) + \text{Financial distress cost} + \text{agency cost} \tag{6}$$

Financial distress costs are the direct and indirect costs incurred by enterprises when they are facing debt repayment difficulties or near bankruptcy. These costs involve not only explicit financial expenses, but also implicit losses in the efficiency of business operations and market value. Agency costs arise from conflicts of interest between internal and external stakeholders (such as shareholders and creditors, shareholders and management), resulting in inefficient allocation of resources or loss of value.

4.4. Optimized Tesla data analysis

In the growth stage, Tesla is more in line with the original model when the debt ratio is high and the corporate income tax is high, which can significantly reduce the WACC, and the financial distress cost and agency cost are lower at this time. In 2009, Tesla received a $465 million low-interest loan through the U.S. Department of Energy's Advanced Technology Vehicle Manufacturing Loan Program (ATVM). This loan helped Tesla accelerate the development and mass production of the Model S and significantly reduce its debt financing costs [2]. In addition, market confidence and investor tolerance also greatly affect the cost of financial distress and agency costs. Despite the high debt ratio, the market has high expectations for Tesla's innovation ability and long-term growth potential, and creditors may accept lower interest rates in exchange for future earnings. When Tesla is in the mature stage of financing, with the changes in the market and the decrease of investors' tolerance, the impact of risk premium, tax rate change, financial distress cost and agency cost will be relatively greater under low debt ratio, resulting in the increase of WACC.

5. Conclusion

This paper briefly outlines Tesla's debt financing strategies in different life cycle stages. Firstly, it constructs a simple WACC model based on the tax shield effect, which reflects the situation when Tesla is in an upward development period and suffers from low financial distress costs and agency costs. The theoretical data are derived by changing the ratio of variables. The study shows that the increase of the debt ratio can significantly reduce WACC. However, in reality, Tesla has not always maintained a high debt ratio, because a high debt ratio may lead to hidden risk costs, resulting in deviations between the model and the actual situation. In addition, special financing instruments, such as low-interest government loans and convertible bonds play a key role in reducing WACC. The improved model cannot accurately fit the real data and can only reflect the general trend. The specific WACC is also affected by tax policy, market environment, industry characteristics, corporate growth and profitability, exchange rate and internationalization factors. At present, Tesla's debt ratio remains at about 40%, and this paper mainly considers the financial distress cost and agency cost as the main influencing factors. In the follow-up study, more market factors will be reflected in the optimization formula in the form of more direct and intuitive data. The aim is to build a more suitable model for the current situation. In addition, the model takes Tesla as the main analysis object, and the basic models of other industries are consistent with it, but the impact of the market environment after optimizing the model may be different.

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