The Discount Rate for The Valuations of Intangible Assets — Evidence from Taiwan's Semiconductor Industry

Ming-Che Lu and Ting-Yu Chen

***Abstract*—This study attempts to link the discount rate of the intangible assets with patent rights, computer softwares, customer relations, trademarks, other intangible assets, and goodwill. By requiring the weighted average capital cost equal to the weighted average return on assets, the discount rate of the intangible assets can be estimated with the return on intangible assets. Since the characteristics of industry dominate the performance of intangible assets and Taiwan's semiconductor industry ranks as a global leadership, our study will focus on the semiconductor industry of Taiwan. The empirical results reveal that patent rights, computer softwares, other intangile assets, and goodwill are significantly relevant to the discount rate of the intangible assets in Taiwan's semiconductor industry. Our findings provide deeply insights into the valuations of intangible assets.**

***Index Terms*—Discount rate, valuation of intangible assets, weighted average cost of capital, weighted average return on assets.**

I. Introduction

The source of corporate value has gradually changed from tangible assets to intangible assets. The rate of investment in intangible assets is much faster than that in tangible assets. Countries with more knowledge will have more wealth, and intangible assets will also become an important key to business growth. Therefore, the father of modern management, Peter Drucker, proposed in this economic age where knowledge is power, knowledge will replace capital, natural resources, and labor. It has been discovered that the role of wisdom is increasingly important in today's enterprises. Taiwan's semiconductor industry has developed vigorously in recent years. In the overall environment and economic development, the semiconductor industry has always been the core industry for my country's economic development, and it has a key and important position in enhancing international competitiveness. However, with the migration of traditional industries, the semiconductor industry does not need to invest in large amounts of tangible assets, and gradually cannot focus on the use of machinery, plant and other equipment to create tangible asset value as in the past. The semiconductor industry is a highly capital-intensive and technology-oriented knowledge-intensive industry [1]. It emphasizes professional knowledge, and focuses on R&D and talent cultivation. At the same time, it also emphasizes innovative industries. Therefore, the ability and efficiency of knowledge creation, diffusion and application are very important.

In the case of enterprises determining company value and maintaining competitive advantage, intangible assets have very low marginal costs, can be used by multiple people at the same time, are not restricted by space and time, and can be used in conjunction with other tangible or intangible assets, thereby improving the efficiency and effectiveness of overall asset utilization. Since the service life is an important factor affecting the appraised value of intangible assets. However, the discount rate of intangible assets in the market still lacks an objective measurement standard, which may be because the characteristics of various assets are different, and the required rate of return for intangible assets of market participants is also different. In terms of risk, if there is no way to use a reliable or objective evaluation standard, the discount rate of intangible assets may be too high (low) for discount estimation, and the estimated price of intangible assets will be too low (high).

Once a company has intangible assets belonging to the industry, it knows how to evaluate the economic benefits brought by the intangible assets. The company will be able to understand how to overcome the use and expansion of efficiency compared to its opponents, and play the value of the company's own intangible assets. Therefore, the purposes of this research include (1) adopting the weighted average cost of capital equal to the weighted average return on assets to calculate the expected return on investment in intangible assets for each Taiwan's semiconductor firm and (2) exploring whether patent rights, computer softwares, customer relations, trademarks, other intangible assets, and goodwill are relevant to the discount rate of intangible assets in Taiwan's semiconductor industry.

II. Future Cash Flow of Intangible Assets

A. Intangible Assets Evaluation Method and Discount Rate

Ref. [2] found that although intangible assets are not entities and cannot be actually observed, their contribution to corporate value has gradually increased. In addition, after business mergers, assets and liabilities are recognized and disclosed at fair value in accordance with the acquisition method. Therefore, the theory and technology related to the evaluation of intangible assets are derived and developed.

According to [3], taking smart capital as the starting point, the evaluation methods are divided into three categories: cost method, market method, and income method. The basis of the cost method is that the investor will not pay more than the

Manuscript received January 29, 2021; revised June 1, 2021.

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doi: 10.18178/ijtef.2022.13.1.715

original cost of constructing the intangible asset to rebuild another new intangible asset. The market method uses the quoted prices of assets that are similar or comparable to the evaluated subject matter in the public market as a reference for fair market prices to further calculate the fair value of intangible assets. The income law focuses on the discount of future cash flows that can be generated by the durability of intangible assets. Under the framework of the income method, there are multiple evaluation methods for intangible assets, such as the DCF method, etc. The DCF method analyzes the future incremental free cash flow generated by intangible assets, discounting these free cash flows to their present value, we can obtain an estimate of the value of intangible assets.

Therefore, in order to determine the discount rate method, the most common model used to determine the required return of an asset is the capital asset pricing model (CAPM). Assume that there is a positive correlation between the CAPM system risk (beta) and the required rate of return, and estimate the publicly traded asset beta by regressing the return of the asset and the return of the relevant market index. However, intangible assets are not publicly traded, and there is no return data to use, and beta cannot be directly estimated. Therefore, this article uses the assumption of [4], the weighted average cost of capital (WACC) is equal to the weighted average return on assets (WARA), the method of evaluating the value of the company's equity and determining the discount rate to estimate the required return of intangible assets rate. [5] found that the tax shield is proportional to the company's future annual free cash flow. The risk of the tax shield's present value is equal to the risk of the company's free cash flow, while the risk of the company's free cash flow is less than the risk of intangible assets. Therefore, the study believes that if the present value of the tax shield is not separately listed as an asset of the enterprise. As a result, the discount rate of intangible assets including tax shields is lower than the real discount rate of intangible assets.

B. Weighted Average Cost of Capital

According to the capital structure theory derived by [6], the cost of capital is used as a reference value, and then the present value of the overall capital structure of the enterprise is reviewed, so that the weighted average cost of capital (WACC) lays the foundation for future use. [7] believe that the weighted average cost of capital is an agent that a company can use as an intangible asset to require a rate of return, but it is not always correct. If the risk of intangible assets is higher than the risk of the entire enterprise, WACC will underestimate the required rate of return. The concept of WACC as the starting point as the starting point of the company's discount rate has been widely accepted [8]. The [9] study added market trading perspectives and used market trading data, because market participants have different identifications of intangible assets, which will produce a discount rate different from the discount rate obtained by ordinary enterprises when evaluating intangible assets, WACC is used as a benchmark for the discount rate. Since further used the ordinary least squares method to test whether WACC has a significant relationship with the weight of intangible assets. The results show that there is no significant relationship between the two, which means that different WACC is used as the discount rate for intangible assets with different risks and will not significantly affect WARA [9].

However, [10] found that Beta cannot explain the rate of return in the capital market, and the ratio of company size to net market value can explain the rate of return better than Beta. Therefore, this study uses the weighted average cost of capital as the relevant variable, and the company size and market value to net price ratio as the control variables.

C. Weighted Average Return on Assets

The so-called return on assets is a measure of whether the assets owned by the company are fully utilized, and it shows the company's ability to use assets to create value. Chauvin and [11] believe that when calculating enterprise value, the value brought by intangible assets should not be ignored. [12] pointed out that the output indicator of R&D innovation is patent rights, and innovation can create market value while achieving excellent performance. Therefore, patent rights are also a significant factor affecting corporate value.

According to 13], using the balance sheet as a sample, the amount on both sides of the accounting identity must be balanced. Therefore, on both sides of the balance sheet are assets and liabilities equity, and explain how to use the DCF method and the weighted average return on assets (WARA) to evaluate the value of individual intangible assets. Research shows that the weighted average return on assets is like the return on a company owning an asset portfolio, with risk and return moving in the same direction. The unlevered cost of equity funds is a reasonable approximation that can represent the rate of return of intangible assets, which can replace WACC as a discount rate. [4] made adjustments to Smith and Parr's WARA law. This adjustment particularly increased the value of tax shields as sole proprietorship assets, the research results show that the leveraged cost of equity is the overall corporate value, which is more suitable as the discount rate of intangible assets than the unlevered cost of equity, because in practice most of the intangible assets come from debt financing. In order to prevent the return on assets from being underestimated, [4] adjusted the WARA method as shown in Fig. 1.

CORPORATE BALANCE SHEET (MARKET VALUE)

V_U	Monetary Assets Tangible Fixed Assets Intangible Assets Tax Shield	Debt Equity
	V_L	V_L

Fig. 1. Schematic diagram of [4] adjusting the WARA method.

A Business enterprise can be regarded as a portfolio of assets. Therefore, the weighted average return of a portfolio of assets (tangible and intangible) should conceptually approximate the weighted cost of all forms of used capital (debt and equity), i.e., the WACC. In other words, the operation of the acquired business is fundamentally equivalent to the combined assets of the acquired business [14].

III. Hypotheses, Research Methods and Data Sources

A. Hypotheses

In the accompanying intangible asset returns and

intangible asset risks, the uncertainty of the future returns of intangible assets is the return risk of intangible assets, and this uncertainty will cause unpredictable results for enterprises. In order to determine the future returns of intangible assets, this study uses the weighted average return on assets (WARA) method to obtain the discount rate of intangible assets to estimate whether the type of intangible assets will affect the discount rate of intangible assets. Therefore, the following hypotheses are proposed.

Hypothesis 1 Patent rights are positively associated with the discount rate of intangible assets.

Hypothesis 2 Computer softwares are positively associated with the discount rate of intangible assets.

Hypothesis 3 Customer relations are positively associated with the discount rate of intangible assets.

Hypothesis 4 Trademarks are positively associated with the discount rate of intangible assets.

Hypothesis 5 Other intangible assets are positively associated with the discount rate of intangible assets.

Hypothesis 6 Goodwill is positively associated with the discount rate of intangible assets.

B. Methods

This study follows the assumption used by [4], that the weighted average cost of capital (WACC) is equal to the weighted average return on assets (WARA), to estimate the return on assets of each company's intangible assets. We assume an effective capital market, in which the market value of equity in the overall market enterprise value reflects the added value brought by intangible assets, and the corporate value is divided into operating assets, fixed assets, intangible assets, and the present value of tax shields as separate items of assets. In order to avoid the underestimation of the market value of intangible assets, the company's assets are priced efficiently and the market value of the assets is shown on the balance sheet. The company's liabilities are financed at the same amount and borrowing interest rate every year, which means that the market value of intangible assets is the difference between the overall market value of the company and the market value of other assets, which can be expressed as:

$$VL = E + D$$

$$= MA + TFA + IA + PVTS \quad (1)$$

$$IA = VL - MA - TFA - PVTS \quad (2)$$

Among them, *VL* represents the overall market enterprise value, *E* represents the market value of equity, *D* represents the market value of debt, *MA* represents the market value of operating assets, *TFA* represents the market value of fixed assets, *PVTS* represents the present value of tax shield, and *IA* represents the market value of intangible assets. Calculate the market value of intangible assets by shifting the term of equation (1), which is equation (2).

However, in order to determine the discount rate of intangible assets, we continue the weighted average cost of capital (WACC) equal to the weighted average return on assets (WARA) method to obtain the required rate of return for each asset. In practice, enterprises with a certain scale usually operate in debt, and the interest expense of interest-bearing debt can save the enterprise income tax expenses. This credit can be regarded as an asset of the enterprise, which can be expressed as follows:

$$WACC=R_e \frac{E}{E+D}+R_d \frac{D}{E+D} \quad (3)$$

$$WARA=R_{MA} \frac{MA}{V_L}+R_{TFA} \frac{TFA}{V_L}+R_{IA} \frac{IA}{V_L}+R_{PVTS} \frac{PVTS}{V_L} \quad (4)$$

Among them, *WACC* represents the weighted average cost of capital, *WARA* represents the weighted average return on assets, R_e represents the levered cost of equity, R_d represents the cost of debt funds, R_{MA} represents the expected return on investment in operating assets, R_{TFA} represents the expected return on investment in fixed assets, R_{IA} represents the expected return on investment in intangible assets, and R_{PVTS} represents the expected return on tax shield. After shifting the term of equation (4), the expected return on investment in intangible assets can be expressed as follows:

$$R_{IA}=\frac{WACC-R_{MA}\frac{MA}{V_L}-R_{TFA}\frac{TFA}{V_L}-R_{PVTS}\frac{PVTS}{V_L}}{\frac{IA}{V_L}} \quad (5)$$

In this study, the expected return rate of investment in intangible assets in the semiconductor industry and the value of intangible assets are subjected to linear regression analysis. Analyze the impact of the expected return rate of investment in intangible assets through various intangible assets, so the model is set as follows:

$$R_{IA}=\alpha_0+\alpha_1 PAT+\alpha_2 SOFT+\alpha_3 CLIR+\alpha_4 OIA+\alpha_5 GW+\alpha_6 SIZE+\alpha_7 MB+\varepsilon \quad (6)$$

where R_{IA} is the expected return on investment in intangible assets; α_0 is the intercept term; *PAT*, *SOFT*, *CLIR*, *OIA*, *GW* are patent rights, computer softwares, customer relations and trademarks, other intangible assets, and goodwill, respectively. In addition, *SIZE* is the logarithm of total assets, *MB* is the ratio of market value to book value, and ε is the error term.

C. Data Sources

The sample source of this study is based on the listed semiconductor companies provided by the Taiwan Economic Journal (TEJ), with a total of 150 companies. The research period is the combined cross-sectional data from 2015 to 2019, for a total of five years. The main data sources of this study include acquiring the financial data of the research object from the database of Taiwan Economic Journal, and retrieving the consolidated financial report and related data of the enterprise through the public information observatory.

IV. Results

Table I lists the narrative statistics of the market value of operating assets, market value of fixed assets, market value of intangible assets, present value of tax shield, market value of equity and market value of debt to the overall market enterprise value.

TABLE I: DESCRIPTIVE STATISTICS OF PAOPORTIONS OF VARIOUS ASSETS AND CAPITALS

Variable	Mean	Standard deviation	25th Percentile	Median	75th Percentile
MA	31.73	40.23	14.21	23.87	37.94
TFA	18.73	19.67	4.23	12.23	28.74
IA	49.50	47.31	40.00	58.14	71.95
PVTS	0.02	0.04	0	0	0.01
E	76.07	20.29	66.16	82.22	90.61
D	23.92	20.29	9.39	17.77	33.83

Notes: *MA* represents the market value of operating assets, *TFA* represents the market value of fixed assets, *IA* represents the market value of intangible assets, and *PVTS* represents the present value of tax shield; each divided by the market value of total assets.

Table II lists the narrative statistics of the company sample variables from 2015 to 2019 with a sample size of 750 and 11 incomplete data.

TABLE II: DESCRIPTIVE STATISTICS OF VARIABLES IN THE EMPIRICAL MODEL

Variable	Mean	Standard deviation	25th Percentile	Median	75th Percentile
R_{IA}	0.3902	0.1848	-0.0091	0.0453	0.1259
PAT	0.2389	0.3427	0.0000	0.0003	0.4847
SOFT	0.4187	0.4349	0.0039	0.2187	1.0000
CLIR	0.0081	0.0484	0.0000	0.0000	0.0000
OIA	0.0443	0.1723	0.0000	0.0000	0.0000
GW	0.1691	0.3093	0.0000	0.0000	0.1696
SIZE	15.128	1.6151	14.026	14.951	16.079
MB	1.3220	1.4792	0.5352	0.8990	1.4651

Notes: R_{IA} represents the required return on intangible assets, *PAT* represents the patent rights, *SOFT* represents the computer softwares, *CLIR* represents the customer relations and trademarks, *OIA* represents other intangible assets, *GW* represents the goodwill, *SIZE* is the logarithm of total assets, and *MB* is the ratio of market value to book value.

TABLE III: CORRELATION MATRIX OF VARIABLES IN THE EMPIRICAL MODEL

	R_{IA}	*PAT*	*SOFT*	*CLIR*	*OIA*	*GW*	*SIZE*	*MB*
R_{IA}	1	0.08**	0.07**	0.06	-0.03	0.01	0.10**	0.53***
PAT	0.04	1	-0.29***	0.16***	0.07**	0.10*	0.003	0.10*
SOFT	0.03	-0.41***	1	-0.18***	-0.23***	-0.29**	-0.04	0.05
CLIR	0.05	-0.03	-0.15***	1	0.07*	0.36***	0.11***	0.07**
OIA	0.03	-0.12***	-0.19***	-0.03	1	0.22***	0.17***	-0.01
GW	0.05	-0.18	-0.41***	0.18***	-0.04	1	0.28***	0.001
SIZE	0.04	-0.05	-0.10*	0.03	0.04	0.25	1	-0.06*
MB	0.33***	0.10**	-0.01	0.08**	-0.007	-0.01	-0.10**	1

Notes: 1. R_{IA} represents the required return on intangible assets, *PAT* represents the patent rights, *SOFT* represents the computer softwares, *CLIR* represents the customer relations and trademarks, *OIA* represents other intangible assets, *GW* represents the goodwill, *SIZE* is the logarithm of total assets, and *MB* is the ratio of market value to book value.
2. Values presented in the lower triangle are the Pearson correlation coefficients; while values presented in the upper triangle are the Spearman correlation coefficients.
3. *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively.

Table III is the correlation coefficient table between the expected return rate of investment in intangible assets and the respective variables. The Pearson correlation coefficient and Spearman correlation coefficient are used to detect whether there is a high correlation between the variables. In the table, the lower left half is the Pearson correlation coefficient, and the upper right half is the Spearman correlation coefficient.

TABLE IV: REGRESSIONS OF THE REQUIRED RETURN FROM INTANGIBLE ASSETS ON VARIOUS TYPES OF INTANGIBLE ASSETS

Model: $R_{IA}=\alpha_0+\alpha_1 PAT+\alpha_2 SOFT+\alpha_3 CLIR+\alpha_4 OIA+\alpha_5 GW+\alpha_6 SIZE+\alpha_7 MB+\varepsilon$

Variable	Coefficient estimate	VIF value
R_{IA}	-0.254 (-3.931)***	
PAT	0.070 (2.927)**	1.687
SOFT	0.072 (3.490)***	2.062
CLIR	0.154 (1.170)	1.062
OIA	0.101 (2.561)**	1.201
GW	0.088 (3.358)***	1.709
SIZE	0.010 (2.528)**	1.078
MB	0.026 (9.326)***	1.036
Adjusted R^2	0.135	
F value	17.083***	

Notes:1. R_{IA} represents the required return on intangible assets, *PAT* represents the patent rights, *SOFT* represents the computer softwares, *CLIR* represents the customer relations and trademarks, *OIA* represents other intangible assets, *GW* represents the goodwill, *SIZE* is the logarithm of total assets, and *MB* is the ratio of market value to book value.
2. Numbers in brackets are t values.
3. *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively.

Table IV Empirical analysis results found that among the independent variables, PAT, SOFT, OIA, and GW are significantly positively correlated, and CLIR are positively correlate, but not significant. It said that it has more patent rights, computer software, its intangible assets, and goodwill, which will increase the expected rate of return on intangible assets, thus conducive to investment in intangible assets. Therefore, this research supports Hypothesis 1, Hypothesis 2, Hypothesis 3, Hypothesis 4, and Hypothesis 5.

In addition, it can be seen from the table below that the VIF value is between 1-2 in the respective variables, indicating that there should be no collinearity between the independent variables in this empirical model.

V. CONCLUSIONS

This study uses the discount rate of intangible assets to conduct multiple regression analysis to explore the correlation between various intangible assets. Through empirical analysis, patent rights, computer software, customer relations and trademarks, other intangible assets, and goodwill have increased, and the rate of return on intangible assets has increased relatively. The ratio of company size to market value net price is an important factor that affects the evaluation of intangible assets measured by market price. Therefore, the profitability of the company increases, the higher the value created by the company, which in turn increases the investment in intangible assets.

The above analysis results show that there is substantial

intangible asset value in my country's semiconductor industry. And our research provides that companies in Taiwan's semiconductor industry can have more reliable intangible asset discount rates for reference when evaluating intangible assets, which has significant reference value for intangible asset evaluation practices.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors made substantial contributions to conception and design of the study, literature review, data collection and performing the analyses, and interpretation of the results, the conclusions.

Acknowledgment

The author would like to express his deepest gratitude to Professor Hajime Tozaki for his constructive suggestions on this research, in the ICEBA conference.

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