A Comparative Study on Methods of Income Approach to Technology Valuation

Hyun-woo Park*
Korea Institute of Science and Technology Information, Seoul, Korea
Seung-Pyo Jun
Korea Institute of Science and Technology Information, Seoul, Korea
Sang-Gook Kim
Korea Institute of Science and Technology Information, Seoul, Korea

This paper compares the different features of various methods of the income approach to the valuation of technology in practical application. For its purpose, this paper begins with the re view of the relevant literature and the development and application of practical models, then i nvestigates the properties of various methods or techniques of the income approach, and exa mines how the valuation results differ depending on valuation methods and their characteristi cs under an illustrative case. Finally, it presents implications and further study issues based on the previous discussion.

*Corresponding Author. Email address: hpark@kisti.re.kr

I. INTRODUCTION

One can use different methods in valuing technologies, depending on the types of subject technologies or the purposes of valuation. The approaches used to measure the value of an technology asset are classified broadly as income, cost, and market, based on the perspective on the values of technologies. Each approach has different features in the procedure of its application and the determination of valuation variables.

First, the income approach is, in the perspective of 'look forward', to value a subject technology by calculating the present value of future cash flows created from the use of the technology asset. In other words, this approach considers as a basis of a technology's value the present value or discounted cash flow generated when the subject technology is applied to a product in the process of commercialization.

Second, the cost approach is, in the perspective of 'look backward', to value a technology on the basis of on its reproduction cost or replacement cost. In this approach, a technology's value is calculated on the basis of the cost required in its development due to the difficulty of estimation of future income.

Third, the market approach is, in the perspective of 'look around', to use prices and other relevant information generated by market transactions involving identical or comparable assets. In this approach, a technology is valued on the basis of the prices of comparable assets at the arm's length transactions.

Among these three approaches, the market approach is considered as the first choice for technology valuation. However, the income approach has been used the most commonly among practitioners while the market approach has limitations in practical application due to the lack of comparable market data. In fact, valuation practitioners, the most frequently, use the income approach on the ground that the potential economic value created from the use of a technology

asset can properly be evaluated by the approach. Although the income approach has the positive aspect as such, it has the possibility to lack objectivity in valuation results because of arbitrary judgments in estimating major variables needed to apply the income approach.

In this paper, we first will review the relevant literature in the valuation of technology and the development and application of practical models, then look into the properties of various methods of the income approach, and examine how the valuation results differ depending on various valuation methods, and their characteristics under an illustrative case and assumptions on business environment. Finally, we will present the implications on practical application in the future and further study issues based on the above discussion.

II. RELEVANT LITERATURE AND MODELS REVIEW

2.1. Review of Relevant Literature

The issues of technology valuation have been recently studied in various aspects. The prior studies on the valuation of technology are discussed in three groups as follows.

The first group of the research employed a theoretical approach to analysis and evaluation of economic value of technology, which includes the theoretical examination of origin and perception of technology value. This field includes Greenhalgh and Rogers (2006), Chiesa et al. (2007), Lee (2009), and Raymond (2010). This field also includes Menell (2000), which historically considered the opinions of the value of the intellectual property such as technology and comprehensively examined the viewpoints of various researchers, Guellec and Potterie (2000), which researched how information on patents such as patent-developing nations, technology fields of patents, patent-right possessors, and patent-possessing regions influences the values of patents, Ramanathan, et al. (2001), which examined the viewpoint and method of valuation of new knowledge-based intangible assets, Reitzig (2003), which conducted analysis on the influential factors of the values of patented technologies in the semiconductor industry, and Li and Chen (2006), which developed the new system of technology valuation. Also, Van Triest and Vis (2007) deals with valuing patents of cost-reducing technology, and Bergstein and Estelami (2002), Amram (2005), Dissel et al. (2005), and Kochupillai and Smith (2007) investigated the valuation methods considering the characteristics of value creation of early stage technologies.

The second group of prior studies attempted to develop new models or methods of analyzing and assessing the value of technology, or systematizing the determinants of the value of technology for application of the models. The studies on the models and methods include Reilly and Garland (2001), which presented the direction of assessment model in the software field, UNECE (2003), which comprehensively examined the existing methods and models of technology valuation and presented the various viewpoints on the valuation of patented technology, Hunt et al. (2003, 2004), Chang (2005), and Wu and Tseng (2006), which examined various real options models for the valuation of technology investments, Park and Park (2004), which examined the new method of technology valuation, based on the structural relationship between technology factors and market factors, Chang (2005) and Wu and Tseng (2006), which presented the real option approach for the valuation of the intellectual property such as a patent, and Chiu and Chen (2007), which attempted the application of the AHP method in patent valuation.

The third group of prior studies conducted case studies and empirical analyses of technology valuation. The case studies included Kellog and Charnes (2000), Ramanathan, et al. (2001), Stewart (2002),

and Hartman and Hassan (2006), which analyzed the biotechnology cases through applying real options valuation, and Sarathy (2001), Reilly and Garland (2001), and Reitzig (2003), which examined the main technology valuation problems in a software technology field, and Bass and Kurgan (2010), which reviewed nanotechnology valuation. Also, the empirical analysis of technology valuation include UNIDO (1983), which analyzed the degree of contribution of technology to the total value created from the use of a technology by examining the cases of international technology transfer, Hirschey and Richardson (2001), which analyzed the effects of patents' quality on technology valuation through the comparison for Japanese and the U.S. firms, Kossovsky (2002), which conducted an option-based valuation of nearly 8,000 intellectual property assets, and Van Triest and Vis (2007), which presented the case study of the patent valuation of cost-reducing technology. Finally, other case studies include Kossovsky (2002), Park et al. (2010), and Park and Shin (2010), which analyzed a variety of features of valuation variables based on a large quantity of practical data.

These various studies and empirical analyses have enhanced the understanding of technology valuation and contributed to the development of the current governmental policies and systems to support technology-driven corporations.

2.2. Development and Application of Models

Models or techniques for technology valuation are diverse just as usages of the valuation are, and it is a reality that even the same model shows different features according to valuators in applying variables that significantly impact on values of technology.

In particular, in applying the DCF (discounted cash flow) based income approach, the economic life span of a technology must be estimated for calculation of the future income flow produced by commercializing the subject technology, and a proper discount rate must be determined in order to convert future cash flows into present values. In addition, the technology's contribution factor must be judged in order to separate the part that the technology has contributed from the flow of total income. Besides, establishing various assumptions and determining variables are required in valuation methods of the income approach.

First of all, various methods can be applied for determining the economic life span of technology. In case that the subject of technology valuation is a patented technology, the legal life span of a patent can simply be adopted or the analyses of applicants or citations using the information of patent applications of relevant fields in the past can be utilized. In addition, the life cycle of products using relevant technologies can be referenced. For the purpose of estimating life span of these technologies, classifying technologies or patents is needed and for this end, a classification system of technologies or patents can be utilized or it is necessary to classify them into proper groups of technologies. As methodologies for the analyses of life span of technologies, information analyses such as bibliometrics can be utilized or methodologies such as the analyses of rankings and trends using database, citation analysis, co-word, and co-citation can be also utilized (KISTI, 2003).

Risks in commercializing technologies are classified largely into the systematic and non-systematic. Systematic risks are caused by common factors of the entire capital market and are difficult to remove or to avoid, such as changes in macroeconomic cycles, changes in interest rates, changes in purchasing powers, or political, economic, and social changes with great impacts on the entire capital market. The non-systematic risks are caused by the unique factors of a corporation and are possible to remove, such as changes in sales revenues of companies regardless of the economic cycles of the entire economy, the possibility of success/

failure of technology development, operation status, management ability, labor-management problems, patent use, advertisement campaign, reactions of consumers, lawsuits, relationship with the government, corporate image, etc. As the methods of determining discount rate for converting the future cash flow into present value by reflecting these risks, a WACC (weighted average cost of capital), or a risk premium or built-up method can be utilized, and a required rate of return used by venture capitalists when estimating new venture investments can also be applied. Related research include Ballster and Wiese (2010), and Hanlin and Claywell (2010).

In determining the contributory factor of technologies, various methods are utilized. The most common method to determine the contributory factor of technologies is technology factor method; technology factor means the degree to which a technology itself takes a estimated portion of cash flows generated by the use of a subject technology within a specific corporation. This technology factor method is said to have been suggested by Arthur D. Little (Rafeiner, 2002). According to this, the degree of changes in technology factor is determined by the number evaluated in quantity of the contribution to corporations made by superior competitiveness of technology. Before this, Dow Chemical had measured technology factor using utility attributes and competitiveness attributes after evaluating present values of additional cash flow. The US National Technology Transfer Center (NTTC) has carried out evaluation regarding the possibility of commercial survival of technologies by expanding indices for evaluating utility attributes and competitiveness attributes with technology factor method of Dow Chemical as a basic model. Inavisis, a San Diego-based IP management company, calculated technology factors in consideration of industrial factors and individual technology ratings. On the other hand, the UNIDO explained about technology pricing in technology transfer through the concept of LSLP (licensor's share of licensee's profit) (Arni, 1984; UNDO, 1983), which can be said to share the same meaning with the concept of the technology factor. Besides, rules of thumb, in which a certain part (25% or 33%) of income flows produced by commercializing a technology is considered attributable to the technology, are also used (Razgaitis, 2003). In the meantime, technology valuation organizations in Korea developed and have used the methods of determining the contributory factors of technology in consideration of the purposes and usages of technology valuation.

Because a valuator needs to establish various assumptions and estimates various variables, besides the above important variables, which change final amounts of valuation, it can be said that feasibility and credibility of valuations are determined by on how much reliable and objective grounds the estimations or calculations of these variables are carried out.

III. FEATURES AND COMPARISON OF METHODS OF INCOME APPROACH

3.1. Types and Features of Methods

3.1.1. Incremental Cash Flow Method

The incremental cash flow method starts with an analysis of the influence of the subject (patented technology) on the future free cash flow of the business. The incremental cash flow method is also named ‘incremental income method’ or ‘premium profits method’. The value of the subject, taking taxes into account, is the present value of the increases in such future free cash flows. As it deals with the free cash flows, which can be directly attributed to the subject, the method is referred to as a direct technique. It is often applied to technologies which result in identifiable cost savings. The procedure to value the subject technology is as follows:

ⅰ) Derive pre-tax incremental cash flows of subject technology
ⅱ) Subtract tax expenses
ⅲ) Consider incremental contributory asset charges
ⅳ) Calculate the present value of incremental cash flows

Because of the need to isolate the incremental income attributable to the subject, this technique has limited application. Even for products which, thanks to special features, can be sold for higher prices than those of competitors, the benefit may be influenced by contributory assets, such as a trademark or assembled workforce. In most cases, it is simply not possible to determine the effect of a particular technology on selling prices or volumes; therefore, patented technologies are valued usually by indirect techniques.

This method provides a direct measure of the economic benefit provided by the asset. The application of contributory asset charges is dependent upon the nature of the increment. For example, premium pricing would not require a contributory asset charge for PP&E (property, plant and equipment) or fixed assets, but a working capital charge would be appropriate. Cost savings and pre-mium pricing are more readily measurable, but incremental market share becomes more subjective. Baseline assumptions may only be available within the subject entity and may be difficult to identify for market participants.

3.1.2. Residual Value Method

The residual value method estimates a figure for the subject by deducting from the entity value of the business those of all the other assets. It therefore necessitates determining not only the value of the business but also the values of the other assets; thus, this method involves all the problems of the other methods.

The usual procedure is to deduct from the income of the business the contributions from the other assets; the remaining "excess earnings" are considered attributable to the subject. For that reason, it is sometimes referred to as the multiperiod excess earnings method. Although it must own as well as use the technology, the business does not need to own the other assets; they may, for example, be leased. The valuation of a technology by this method conforms to the following procedure:

ⅰ) Derive future cash flows for subject technology
ⅱ) Subtract tax expenses
ⅲ) Apply contributory asset charges
ⅳ) Calculate the present value of future cash flows

This method has the two principal requirements. First, it must be possible to set out reasons why the excess earnings are attributable solely to the subject; this is usually assumed away when the subject is the principal asset of the business. Second, all the other assets have to be identifiable and susceptible to valuation. In particular, the valuator must reasonably establish their contribution to the total income.

A detailed discussion of the first requirement is beyond the scope of this paper. The authors would merely point out that this method tends to overvalue the subject, as any possible synergies from the interactions of the various assets are attributed totally to the subject, which, in effect, is assigned a major element of goodwill.

Specifically, the excess earnings method is dependent upon the ability to prepare reasonable expected cash flows. This is mitigated somewhat by assessing the projections in the context of the total business unit. However, it suffers from inability to recognize all relevant going concern components in the contributory assets charges. All of the "excess" income is attributed to an amortizable intangible asset

and/or goodwill. Goodwill is created, in part, by the mortality of the current customers. Period of charge for contributory assets needs to be carefully assessed. Future assets are also considered in estimating the excess income. Other intangible assets are considered in the contributory asset charges.

3.1.3. Relief from Royalty Method

Another indirect technique is the relief from royalty method. This is based on the concept that the owner of an asset – in this case, technology – does not need to license it from a third party, which require paying royalties; therefore, the owner is "relieved" from them. The payments saved are attributed as income to the subject, consequently, whose value is the payments' present value, taking taxes into account, over the remaining useful life (Anson and Suchy, 2005). This method calculates the technology value as follows:

ⅰ) Determine royalty rate for comparable asset
ⅱ) Multiply with matching valuation base
ⅲ) Subtract tax expenses
ⅳ) Calculate the present value of royalty savings

Such relieved payments are calculated with reference to the projected financial information of the business, based on established royalty rates, which are usually obtained from license agreements for comparable assets. The two principal conditions need to be met for using this method. First, comparable assets, the subject of license agreements, can be identified. Second, the valuator is able to know the detailed terms of the related agreements to assess the comparability of possible transactions and calculate the applicable royalty rates.

If the first condition is met, the scope of the method is relatively broad. To identify comparable transactions and to determine the contents of the agreements not only requires knowledge of case law and relevant publications but, to an increasing extent, access to databases, such as RoyaltySource (www.royaltysource.com). Conceptually, the relief from royalty method is part of the income approach; however, because of references to market transaction, it is also sometimes described as a hybrid method.

Meanwhile, practical rules of thumb are applied in a number of industries to divide the income of a business between the licensee and owner (profit split). The 25% rule, dating back to Edison's film patents, dictates that a quarter of the income should go to the owner of the intellectual property (the licensor) and 75% to the producer (the licensee); the justification is that the producer should receive the lion's share because of risks assumed (Goldscheider, et al., 2002).

In certain industries, mainly engineering, royalty rates, especially licenses based on turnover, tend to be guided by this rule. Smith and Parr (2000) speaks of "self-fulfilling prophecies" in this context. Accordingly, the profit split method is suitable to calculate payments for the relief from royalty method. An important use is establishing the plausibility of valuation parameters, such as royalty rates.

3.1.4. Tech. Factor Method

The technology factor method is to translate the future economic income into the present value on the basis of the potential ability to create economic benefit when a patented technology is applied to a product. This method requires the estimation of anticipated period of income stream or future cash flow, required capital expenditures, cost structure, a discount rate, etc.

In order to value the subject technology by this method, we first need to estimate all the business value created from the application of the technology, and then multiply the business value by technology's contri-

bution factor. The calculation of the technology value by this method is as follows:

ⅰ) Derive pre-tax future cash flow created of the subject technology
ⅱ) Subtract tax expenses
ⅲ) Determine the technology's contribution factor to the business value
ⅳ) Calculate the present value of future cash flows

Technology factor method can cause the different valuation results depending on the estimation of various valuation variables. In fact, such variables are estimated under certain assumptions. Therefore, if the estimation is not made based on sufficient reliable data or the variables are determined subjectively by a valuator, the valuation results inevitably lack objectivity or rationality.

3.2. Comparison of Methods

By definition, we can represent four methods to value a technology asset based on the estimation of free cash flows as follows:

- Incremental Cash Flow Method : $\sum PV\,(FCF_n - FCF_0)$
- Residual Value Method

(1) Direct Calculation :

$$\sum PV\,(FCF_n) - PV\,(OA)$$

(2) MPEE : $\sum PV\,(FCF_n - CAC)$

- Tech. Factor Method : $\sum PV\,(FCF_n) * TF$

where, PV : present value with a discount rate
FCF_n : free cash flow after the introduction of new technology
FCF_o : free cash flow with the past technology
OA : other assets than a subject technology
CAC : contributory asset charges
TF: technology factor (contributory factor of a subject technology)

We can assume that, conceptually, all the methods should give the same result. Under the assumption, we can compare the methods with each other.

Comparing the incremental cash flow method with the residual value method (1) - direct calculation - produces the result that the total present value of free cash flows that would be generated under an old technology without adopting a new technology should be equal to the present value of other assets in the subject company as follows:

- Incremental Cash Flow Method vs. Residual Value Method (1)

$$\sum PV\,(FCF_n - FCF_0) = \sum PV\,(FCF_n) - PV\,(OA)$$

$$\sum PV\,(FCF_n) - \sum PV\,(FCF_0) = \sum PV\,(FCF_n) - PV\,(OA)$$

$$\sum PV\,(FCF_0) = PV\,(OA)$$

Comparing the incremental cash flow method with the residual value method (2) - excess earnings - produces the result that the total present value of free cash flows with the old technology should be equal to the total present value of other contributory asset charges over the useful life of the subject technology as follows:

- Incremental Cash Flow Method vs. Residual Value Method (2)

$$\sum PV\,(FCF_n - FCF_0) = \sum PV\,(FCF_n) - \sum PV\,(CAC)$$

$$\sum PV(FCF_n) - \sum PV(FCF_0) = \sum PV(FCF_n) - \sum PV(CAC)$$

$$\sum PV(FCF_0) = \sum PV(CAC)$$

Comparing the residual value method (1) - direct calculation - with the residual value method (2) - excess earnings - produces the result that the present value of other assets should be equal to the total present value of other contributory asset charges as follows:

- Residual Value Method (1) vs. Residual Value Method (2)

$$\sum PV(FCF_n) - PV(OA) = \sum PV(FCF_n) - \sum PV(CAC)$$

$$PV(OA) = \sum PV(CAC)$$

Comparing the incremental cash flow method with the tech. factor method produces the result that the total present value of free cash flows generated from other assets should be equal to the total present value of free cash flow with the old technology as follows:

- Incremental Cash Flow Method vs. Tech. Factor Method

$$\sum PV(FCF_n - FCF_0) = \sum PV(FCF_n) * TF$$

$$\sum PV(FCF_n)(1 - TF) = \sum PV(FCF_0)$$

Comparing the residual value method (1) - direct calculation - with the tech. factor method produces the result that the total present value of free cash flows from other assets after applying the new technology should be equal to the present value of other assets as follows:

- Residual Value Method (1) vs. Tech. Factor Method

$$\sum PV(FCF_n) - PV(OA) = \sum PV(FCF_n) * TF$$

$$\sum PV(FCF_n)(1 - TF) = PV(OA)$$

Comparing the residual value method (2) - excess earnings - with the tech. factor method produces the result that the total present value of free cash flows from other assets after applying the new technology should be equal to the total present value of other contributory asset charges as follows:

- Residual Value Method (2) vs. Tech. Factor Method

$$\sum PV(FCF_n) - \sum PV(CAC) = \sum PV(FCF_n) * TF$$

$$\sum PV(FCF_n)(1 - TF) = \sum PV(CAC)$$

IV. APPLICATION AND RELATIONSHIP OF METHODS

4.1. Application of Methods

4.1.1. An Illustrative Case

The next numerical examples illustrate the process involved in applying several different methods under the income approach to the valuation of a patented technology.

(a) Basic Assumptions

Company A is the proprietor of a patented technology. As part of an extensive restructuring project, it is necessary to value the technology as of January 1, 2012. The company manufactures several models of a single product; the patented technology reduces the production costs of the entire range. The technology is covered by six U.S. patents, one European patent, and six patents in other

countries, with remaining terms of 10 to 12 years. The remaining useful life of technology is estimated to be eight years from past experience and patent citation analysis.

Based on legal counsel's assessments, the protection of the technology is considered high; therefore the company's entire product range is effectively protected against any kind of imitation by competitors. The assessments took particular account of the patents' validity, extent of the protection, and territories covered.

(b) Business Projections

Company A sees no need to lower its prices or otherwise pass on the cost benefits because of the positioning of its products compared to competitors. Management assumes that this advantageous situation will not change for the remainder of the technology's life and that it will continue to have no bearing on the products' volume and price structure. The major difference from its competitors is the margins; this means that the contribution of the technology to future income – the incremental profits – can be identified.

Table 1 contains the profit projections for Company A for 5 years until 2016, which was estimated based on past business experience and market forecasting. Cost of sales was estimated to be 66-67% of sales, resulting in 33.1-33.5% of gross margin, and selling, general, and administrative expenses (SG&A) was estimated to be 16-17% of sales, resulting in EBIT of a little higher than 16% of Sales.

At the valuation date, the fixed assets and working capital were appraised $2,000 thousands and $2,400 thousands respectively; the tax rate is 22.0% and the WACC (weighted average cost of capital) is 10.0% with the capital structure of Company A.

4.1.2. Application of Methods and their Results

(a) Incremental Cash Flow Method

Analyses of the technology's impact on material usage revealed that they depend on the specific version, as materials of different qualities are used in the various models; therefore, the annual savings are determined not only by the number of units manufactured but also by the product mix.

Calculating the annual savings requires projecting sales until the end of the asset's useful life. Because of the technology life cycle and the state of development of the relevant markets, the company assumes that, after the end of the projected period (2012-2016), revenues will grow with the market at 2% annually. After the projected period, the product mix of the last year of the plan is assumed to continue. At the end of the technology's useful life, 2019, it will be replaced by a successor process before year-end. The projected sales and corresponding cost savings are shown in Table 2.

TABLE 1. PROJECTED INCOME OF THE TECHNOLOGY PRODUCT

	2012	2013	2014	2015	2016
Sales	7,200	7,780	8,080	8,240	8,420
Cost of Sales	(4,820)	(5,180)	(5,400)	(5,500)	(5,600)
Gross Profit	2,380	2,600	2,680	2,740	2,800
Gross Margin	33.1%	33.4%	33.2%	33.3%	33.5%
SG&A	(1,220)	(1,340)	(1,360)	(1,380)	(1,420)
EBIT	1,160	1,260	1,320	1,360	1,420
Tax	(255)	(277)	(290)	(299)	(312)
NOPAT	905	983	1,030	1,061	1,108

TABLE 2. PROJECTED SALES AND MARGIN IMPROVEMENT

	2012	2013	2014	2015	2016	2017	2018	2019
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440
Growth	20%	8%	4%	2%	2%	2%	2%	-15%
Extra Gross Profit	328	382	378	392	420	428	438	372
Margin Improvement	4.6%	4.9%	4.7%	4.8%	5.0%	5.0%	5.0%	5.0%

The value of the patented technology is obtained by discounting annual cost savings resulting from it; since the improvements in margins are subject to Company A's corporate taxes, the additional burdens must be deducted. Table 3 shows the calculations.

TABLE 3. VALUATION BY INCREMENTAL CASH FLOW METHOD

	2012	2013	2014	2015	2016	2017	2018	2019
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440
Extra Gross Margin	328	382	378	392	420	428	438	372
Tax (22%)	(72.2)	(84.0)	(83.2)	(86.2)	(92.4)	(94.2)	(93.4)	(81.8)
Net Incremental Income	255.8	298.0	294.8	305.8	327.6	333.8	341.8	290.2
PV Factor (15.0%)	0.8696	0.7561	0.6575	0.5718	0.4972	0.4328	0.3759	0.3269
Present Value	222.5	225.3	193.9	174.8	162.9	144.5	128.4	94.9

Tech. Value	1,347.2

(b) Residual Value Method

There are two ways to calculate the residual value: either as the difference between that of the entity and those of all the other assets, or as the present value of the excess earnings; they are likely to lead to different results; it is therefore necessary to analyze and interpret the reasons.

In view of the simplified assumptions of Company A, whose only assets are working capital, fixed assets, and technology, there is no difficulty calculating the residual value.

The first method to calculate the residual value is direct calculation. In this method, we need to determine the value of the company on its own, then identify and value all contributing assets. Finally, the values of the fixed assets and working capital are deducted from the value of the entity. The calculations are shown in Table 4. We obtain the technology value of 1,146.1 million won.

The second method to calculate the residual value is the multiperiod excess earnings. Calculating the residual value by means of the excess earnings method begins by determining the returns on the contributory assets, which are deducted to establishing the excess earnings. Discounting them by their asset-specific rates of return gives the value of the technology. Applying this method involves a number of areas which are the subject of disagreement between practitioners. The procedure is therefore merely sketched briefly.

Contributory asset charges consist of two components: a return on the related invested capital plus the return of it over time. The values of contributory asset start with its fair value at the valuation date. In subsequent periods, it is reduced by depreciation and increased return on capital is calculated from its level at the beginning of each period and the asset-specific rate of return.

TABLE 4. VALUATION BY RESIDUAL VALUE METHOD - DIRECT CALCULATION

	2012	2013	2014	2015	2016	2017	2018	2019	
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440	
EBIT	1,160	1,260	1,320	1,360	1,420	1,452	1,482	1,258	
Tax (22.0%)	(255.2)	(277.2)	(290.4)	(299.2)	(312.4)	(319.4)	(326.0)	(276.8)	
NOPAT	904.8	982.8	1,029.6	1,060.8	1,107.6	1,132.6	1,156.0	981.2	
Changes in WC	(864)	(70)	(36)	(20)	(22)	(20)	(22)	2,552	liquidation
Net CAPEX	(220)	(20)	(260)	(20)	(300)	(30)	(360)	1,240	liquidation
FCF	(179.2)	892.8	733.6	1,020.8	785.6	1,082.6	774.0	4,773.2	
PV (10.0%)	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	
Present Value	(162.9)	737.8	551.2	697.2	487.8	611.1	397.2	2,226.7	

Total Present Values	5,546.1
Working Capital	2,400
Fixed Assets	2,000
Tech. Value	1,146.1

It has already been explained that Company A's income should be understood to be its free cash flow. This means that to calculate the excess earnings, it is necessary to deduct the contributory assets charges. In the example, this calculation is simplified because the free cash flow is arrived at by deducting (a) the changes in working capital and (b) the net capital expenditure (CAPEX less depreciation) from the net operating profit less taxes (NOPLAT). Therefore, the excess earnings are obtained by deducting the returns on the funds invested in working capital and fixed assets from NOPLAT, as shown in Table 5, which gives the tech. value of 1,565.5 million won.

(c) Relief from Royalty Method

Another value of the patented technology is the present value of the notional royalty payments which the entity saves because of its ownership. To do this, it is first necessary to determine the future royalties either from comparable transactions or from a profit split.

TABLE 5. VALUATION BY RESIDUAL VALUE METHOD - EXCESS EARNINGS

	2012	2013	2014	2015	2016	2017	2018	2019
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440
EBIT	1,160	1,260	1,320	1,360	1,420	1,452	1,482	1,258
Tax (22%)	(255.2)	(277.2)	(290.4)	(299.2)	(312.4)	(319.4)	(326.0)	(276.8)
NOPAT	904.8	982.8	1,029.6	1,060.8	1,107.6	1,132.6	1,156.0	981.2
Return on Investment								
Working Capital (3.0%)	(72)	(74.2)	(76.4)	(78.7)	(81.0)	(83.5)	(86.0)	(88.6)
Fixed Assets (7.0%)	(140)	(138)	(122)	(122)	(106)	(110)	(94)	(86)
Other Intangibles	(432)	(466.8)	(484.8)	(494.4)	(514.8)	(514.8)	(525.6)	(446.4)
Excess Earnings	260.8	303.8	346.4	365.7	405.8	424.3	450.4	360.2
PV Factor (15.0%)	0.8696	0.7561	0.6575	0.5718	0.4972	0.4328	0.3759	0.3269
Present Value	226.8	229.7	227.8	209.1	201.8	183.6	169.3	117.4

Tech. Value	1,565.5

First, we can calculate the value of the technology by the royalty payments saved. Usually, royalties are determined by applying a fixed rate to an agreed base, normally revenues. Often further payments are made, either up front for training and services or at milestones with annual minimums. The first step is to identify licensing transactions for comparable technologies. Then the consensus terms of such licenses are applied to the subject for its remaining useful life. A search of databases revealed that the royalties for licenses of patented technologies comparable to the subject are typically applied to sales. Based on six agreements, the median royalty is approximately 4%; no importance was given to any other relevant terms. The notional royalty payments saved are obtained by applying a rate of 4% to the projected sales up to the end of the useful life of the technology; the details are shown in Table 6. This method presents the tech. value of 1,130.3 million.

TABLE 6. VALUATION BY RELIEF FROM ROYALTY METHOD - ROYALTY PAYMENTS SAVED

	2012	2013	2014	2015	2016	2017	2018	2019
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440
Royalty Payments on Sales (4%)	288	311.2	323.2	329.6	336.8	343.2	350.4	297.6
Training	20	-	-	-	-	-	-	-
Royalty Savings	308	311.2	323.2	329.6	336.8	343.2	350.4	297.6
Tax (22%)	67.8	68.5	71.1	72.5	74.1	75.5	77.1	65.5
Net Royalty Savings	240.2	242.7	252.1	257.1	262.7	267.7	273.3	232.1
PV Factor (15.0%)	0.8696	0.7561	0.6575	0.5718	0.4972	0.4328	0.3759	0.3269
Present Value	208.9	183.5	165.8	147.0	130.6	115.9	102.7	75.9

Tech. Value	1,130.3

Second, sometimes royalty payments are determined by applying rules of thumb specific to an industry to split the profit to which the patented technology contributes between the parties. Before adopting this method, it is necessary to establish if such a rule of thumb is applicable. Analyses of licensing agreements reveal that it is indeed customary in the industry to apply the 25% rule to earnings before interest and taxes (EBIT).

To forecast the relevant EBIT, the first step is to analyze in detail the income statements and balance sheets for the last three fiscal years as well as management's previous projections. Upon doing this, it was discovered that, based on its past record, management's EBIT projections for the period could be used without modification. The figures beyond the projected period to the end of the technologies' life were determined by applying the EBIT margins at the end of the projected period (16.9% in 2016) to the anticipated sales for the remaining years. The future saved royalty payments are 25% of such EBIT, as shown in Table 7. We obtain the tech. value of 1,152.3 million by the profit split method.

(d) Tech. Factor Method

To value a technology valuation by tech. factor method, we need to determine the useful life of the technology, free cash flow (FCF), discount rate, and technology factor (or contribution factor). FCF is calculated by adding depreciation to and deducting increases in working capital and capital expenditure from after-tax operating profit or NOPAT. It is assumed that after

TABLE 7. VALUATION BY RELIEF FROM ROYALTY METHOD - VALUE BY A PROFIT SPLIT

	2012	2013	2014	2015	2016	2017	2018	2019
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440
EBIT	1,160	1,260	1,320	1,360	1,420	1,452	1,482	1,258
Owner Split (25.0%)	290	315	330	340	355	363	370.5	314.5
Tax (22%)	63.8	69.3	72.6	74.8	78.1	79.9	81.5	69.2
Net Royalty Savings	226.2	245.7	257.4	265.2	276.9	283.1	289.0	245.3
PV Factor (15.0%)	0.8696	0.7561	0.6575	0.5718	0.4972	0.4328	0.3759	0.3269
Present Value	196.7	185.8	169.2	151.6	137.7	122.5	108.6	80.2

Tech. Value	1,152.3

the useful life of the technology, the business is liquidated. Summing up the discounting each year's FCF and adding the collected working capital and the residual value of capital expenditure gives the technology value in this method.

In this case of technology business, the useful life of subject technology is estimated to be 8 years, and the contribution factor of the technology to business value is determined to be 30%. The calculated value of the technology is 1,288.7 million, as shown in Table 8.

4.2. Comparison of Valuation Results by Method

4.2.1. Comparison of Valuation Results

Table 9 summarizes the values of the patented technology by the six different valuation method. Since each involves specific application requirements, they differ from 1,130.3 million won (royalty payments saved) to 1,565.5 (excess earnings) and are comparable to only a limited extent; obviously, the choice of method may have a significant influence on the result. Accordingly, the valuator must ensure that the basic assumptions of the method selected are fully supported by the underlying facts.

4.2.2. Relationship of Methods

The relationship between six methods of the income approach based on the estimation of free cash flows can be summarized as shown in Table 10. According to the final results of comparison of the methods, we can get the relationship between the methods that the total present value of free cash flows with the old technology,

TABLE 8. VALUATION BY TECH. FACTOR METHOD

	2012	2013	2014	2015	2016	2017	2018	2019	
Sales	7,200	7,780	8,080	8,240	8,420	8,580	8,760	7,440	
EBIT	1,160	1,260	1,320	1,360	1,420	1,452	1,482	1,258	
Tax (22%)	(255.2)	(277.2)	(290.4)	(299.2)	(312.4)	(319.4)	(326.0)	(276.8)	
NOPAT	904.8	982.8	1,029.6	1,060.8	1,107.6	1,132.6	1,156.0	981.2	
Changes in WC	(864)	(70)	(36)	(20)	(22)	(20)	(22)	2,552	liquidation
Net CAPEX	(220)	(20)	(260)	(20)	(300)	(30)	(360)	1,240	liquidation
FCF	(179.2)	892.8	733.6	1,020.8	785.6	1,082.6	774.0	4,773.2	
PV Factor (15.0%)	0.8696	0.7561	0.6575	0.5718	0.4972	0.4328	0.3759	0.3269	
Present Value	(155.8)	675.0	482.3	583.7	390.6	468.5	290.9	1,560.4	

Business Value	4,295.6
Tech. Value	1,288.7 (= 4,295.6 × 0.3)

TABLE 9. COMPARISON OF THE VALUATION RESULTS BY METHOD OF INCOME APPROACH

	Tech. Values	Deviation
Incremental Cash Flow	1,347.2	0.49
Residual Value 1 (Direct Calculation)	1,146.1	-0.81
Residual Value 2 (Excess Earnings)	1,565.5	1.91
Relief from Royalty 1 (Royalty Payments Saved)	1,130.3	-0.92
Relief from Royalty 2 (Profit Split)	1,152.3	-0.78
Tech. Factor	1,288.7	0.11
Average	1,271.7	0.00

the present value of other assets, and the total present value of other contributory asset charges should be the same. Conceptually, the total present value of future free cash flows with old technology (or, future free cash flows before adopting a new technology), the present value of other assets, and the total present value of other contributory asset charges should be equal. However, the results of valuation by methods generally differ when they are applied for the practical use.

If the cash flow increases by a large margin as a new technology is adopted, the incremental cash flow method would produce the relatively high values. If the present value of existing other assets is small, then valuation results by direct calculation tend to become higher. If the degree of other assets' contribution to cash flow, valuation results by excess earnings method would produce higher valuation results. When it comes to the tech. factor method, the results of valuation depend on the size of technology factor, which could cause discrepancies from the results by other methods.

TABLE 10. RELATIONSHIP BETWEEN SIX METHODS OF INCOME APPROACH

	(2)	(3)	(4)
(1)	$\sum PV(FCF_0) = PV(OA)$	$\sum PV(FCF_0) = \sum PV(CAC)$	$\sum PV(FCF_n)(1 - TF) = \sum PV(FCF_0)$
(2)		$PV(OA) = \sum PV(CAC)$	$\sum PV(FCF_n)(1 - TF) = PV(OA)$
(3)			$\sum PV(FCF_n)(1 - TF) = \sum PV(CAC)$
	$\sum PV(FCF_0) = PV(OA) = \sum PV(CAC)$		

(1) Incremental Cash Flow Method
(2) Residual Value Method - Direct Calculation
(3) Residual Value Method - Excess Earnings
(4) Tech. Factor Method

V. CONCLUSION AND IMPLICATIONS

This paper considers patented technologies as assets to be valued; the key factor is the competitive advantage associated with them, specifically the legal protection provided to the underlying technologies and related products. In this context, the value of a patent is composed of the value of the unprotected technology plus that of the legal protection; it must be borne in mind that, normally, a technology is protected not just by a single patent but a portfolio.

The basic valuation methods under the income approach were briefly outlined. All of those rely on the contribution of a patented technology to the total income generated by all the assets involved with the business. On this basis, six methods were illustrated:

The incremental cash flow method h as a limited scope since, in many cases, the basic requirement of isolating the relevant a mounts cannot be met. In particular, the effe ct of the application of new technology on i ncremental market share or changes in sales volume is not easy to identify. Also, other as sets, with the introduction of new technolog y, can contribute to the incremental income cash flow but it is not possible to isolate the changes in cash flow attributable to changes in the contribution of other assets.

The residual value method includes the direct calculation method and the multiperiod excess earnings method. The residual value method presupposes that the subject is the leading asset for the entity's income generation, plus all contributory assets have to be identified and valued; the problematic aspect is that all the synergies resulting from the interaction of the assets involved are allocated to the subject. In particular, excess earnings method faces the problem of inability to recognize all relevant going concern components in the contributory assets charges. With residual value methods in the form of the excess earnings techniques, particular importance should be attached to determining the contributory asset charges and to calculating the asset-specific rates of return.

The relief from royalty method includes the royalty payment saved method and the profit split method. The royalty payment saved method has a considerably broader range; it is applicable if comparable assets are the subject of license agreements and the data needed to calculate royalties are available; alternatively, profit split method or the 25% rule may be applied. In valuing a technology asset using a comparable royalty rate, however, it is hard to acquire the information on licensing agreements of comparable assets and determine their similarity to the subject technology.

The technology factor method has been the most commonly used one in Korea, especially in the valuation of technology assets. This method has a basic problem that valuators' subjective opinion can be reflected in determining the technology factor. Therefore, we need to develop the scientific formula to measure the factor, which should be able to obtain the valuation experts' consensus.

The illustrative examples demonstrated the practical application of the different methods of the income approach. Each method produced different results, depending upon the perspective of valuation under the business environment of the subject entity; therefore, it is necessary to be careful of interpreting and using the valuation results. In particular, securing objectivity in estimating various valuation variables when applying a certain method practically.

As the need of technology valuation are increasing not only in traditional fields such as technology licensing and transactions, technology investment, the evaluation of R&D output, M&A (Mergers and acquisitions), etc. but also in a new field such as financial reporting with the widespread introduction of IFRS (International Financial Reporting Standards), it is necessary to develop practical models that can be accepted by valuation experts on a international level.

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