A study on input variables of valuation model for investment decision-making: Assessing the beta parameters of regulated water industry

By

LEE, Soo Youn

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC MANAGEMENT

2024

A study on input variables of valuation model for investment decision-making: Assessing the beta parameters of regulated water industry

By

LEE, Soo Youn

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC MANAGEMENT

2024

Professor Lee, Jinsoo

A study on input variables of valuation model for investment decision-making: Assessing the beta parameters of regulated water industry

By

LEE, Soo Youn

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC MANAGEMENT

Committee in charge:

Professor Lee, Jinsoo, Supervisor

Professor Lee, Junesoo

Professor Lee, Jongyearn

Approval as of May, 2024

Abstract

Financial assumptions in analyzing the profitability of investment projects carried out by public enterprises are easy to be subjective despite the national and social influence that public projects have. In addition, due to the characteristics of public enterprises that are not generally listed on the exchange market, it is difficult to secure market data such as beta, which indicates systematic risk, when determining the cost of capital. To resolve the problem that the profitability of a project may vary depending on this estimation method and suggest a more reliable beta range that can be applied to the water industry, we studied cases of global water companies regulated by water rates and government agencies. In this study, companies in the regulated water production and supply industry listed on the UK and US markets were selected as potential peer groups. The final peer groups were selected by reviewing the liquidity of stocks and the proportion of sales in the regulated water sector. By applying the beta of the selected peer group and the capital structure of K-water, a public water company in Korea, finally, the appropriate range of beta that can be applied to the water industry was derived.

TABLE OF CONTENTS

List of tables

I. Introduction

A. Background

Investment decisions by public enterprises have a significant impact on national finances and the quality of public services. Due to the nature of the large-scale and long-term investment process, the impact continues in the long term and is difficult to reverse. In public investment decision-making, not only public aspects but also profitability analysis must be reviewed in advance based on reasonable standards, and investment decisions must be made through risk simulation for changes in various conditions.

In particular, the government and organizations responsible for the supply of public goods (water, electricity, roads, etc.) must build facilities and supply chains through appropriate reinvestment to secure and utilize stable resources. In this regard, government and public enterprises are responsible for maintaining and supplying public services by charging users fees for investment and operation costs. From this perspective, it is very important in the public sector to make rational investment decisions and determine fee levels.

Nevertheless, there are many limitations in the analysis of investment profitability performed by public enterprises. First, the business areas carried out by public companies are significantly different, and it is difficult to apply consistent standards to all companies due to differences in the characteristics of each industry and the financial structure of each company. For example, the power generation business, which is sensitive to the influence of the global power market, such as oil price fluctuations, and the water supply business, which has relatively constant

demand and is less sensitive to external factors, have very different business structures and risks. In the absence of reliable standards, an unprofitable business may become a promising business depending on assumptions such as the payback period or the discount rate in the profitability analysis method performed by public enterprises.

Moreover, Market data for valuation such as the cost of capital, which must reflect the characteristics and risks of the business, is often difficult to derive for unlisted companies. Generally, for unlisted companies, data from the same industry group is applied, but for public companies, there are often no companies in the same industry group that can be compared. This is because in the domestic market, especially in the SOC field, public companies often have exclusive rights to conduct business by relevant laws and have a profit structure that is different from that of private companies due to government regulation of rates.

Although the discount rate is a decisive factor in evaluating the profitability of an investment plan, Due to the limitations of the calculation method and the inability to reflect the individual characteristics, the profitability and business plan of the project are greatly affected by what assumptions are applied. In these situations, decision-makers are always left wondering whether this is a reasonable assumption.

B. Research questions

In this study, we will examine the reasonable range of stock beta for the cost of capital that should be applied to analyze the profitability of the investment project of K-water, a public enterprise specializing in water production and distribution in South Korea. We are going to study the appropriate range of beta, which may be controversial in determining the cost of

capital for unlisted companies, using data from global water companies traded in the stock market.

II. Methods

A. Data collection

In this study, we start with the fact that the most key and controversial variable is stock beta to derive a discount rate that takes industry-specific risks into account for investment decision-making. To overcome the limitations presented above in that there are no consistent standards tailored to the characteristics of each industry in the case of regulated public projects and that it is difficult to secure market data in the case of unlisted companies, the case of water companies listed on the global market was reviewed. Data was collected for companies in the UK and the US where there are three or more listed water companies and there is a government agency that regulates the water companies. A list of potential companies was determined, and their suitability as a peer group was reviewed in various ways. Data such as stock prices and sales were based on data published on exchanges and annual reports.

B. Data Analysis

In this study, we first analyze the process of deriving beta and capital cost in the water rate determination process for unlisted water companies in the UK and the Netherlands as a case study. we aim to present the appropriate beta range for Korean water companies through case

analysis based on the data collected from the final peer group. To calculate the proxy beta, the Hamada equation is applied to derive the unlevered beta through the peer group's beta, and the appropriate beta range is calculated by applying K-water's target capital structure.

III. Literature Review

In investment decision-making, profitability analysis refers to evaluating whether a project is profitable by estimating cash inflows and outflows from the implementation of the project and evaluating its financial feasibility from the perspective of the entity carrying out the project. The preliminary feasibility study operation guidelines for public enterprises (Ministry of Strategy and Finance, 2019) require that large-scale new investments by public institutions not only meet policy objectives but also meet profitability to prevent financial risks to public institutions. Kang (2021) stated that the preliminary feasibility study for public institutions first conducts a preliminary review of whether the business plan is in legal and policy compliance, and then evaluates it based on two criteria: ‘public nature’ and ‘profitability’. The preliminary feasibility study of the business plan established by each public institution is conducted to ensure that decisions are made on the feasibility of the project that the public institution wishes to promote, appropriate business timing, business scale, etc. (Kang, 2021).

The profitability analysis often uses the discounted cash flow method (DCF), which evaluates the present value by estimating future cash flows and then discounting them by the opportunity cost of capital, represented by the weighted average cost of capital (WACC). To calculate the present value of an estimated cash flow for profitability analysis, future cash flows must be

discounted by an appropriate discount rate. In general, the financial discount rate refers to the opportunity cost of capital determined in the market. Since future cash flows in a typical project belong to the company's shareholders and creditors, the weighted average cost of capital (WACC), which simultaneously considers the risks of equity capital and debt capital, is applied as the financial discount rate. (Kang, 2021)

$$WACC=(E/(E+D)\times Re) + (D/(E+D)\times Rd\times(1-T))$$

Where: E = Market value of the firm's equity, D = Market value of the firm's debt

Re = Cost of equity, Rd = Cost of debt, T = Corporate tax rate

The cost of equity capital is derived from CAPM (Capital Asset Pricing Model). The risk-free interest rate can be applied to the government bond interest rate, and the risk premium can be applied to the market risk premium.

(CAPM) $ERi = Rf + \beta i\ (ERm-Rf)$

where: ERi = expected return of investment, Rf= risk-free rate

βi = beta of the investment, $(ERm-Rf)$ = market risk premium

$$Beta(\beta) = Covariance\ (Re,\ Rm) / Variance\ (Rm)$$

where: Re = the return on an individual stock, Rm = the return on the overall market

Covariance = how changes in a stock's returns are related to changes in the market's returns

Variance = how far the market's data points spread from their average value

Here, beta, which means systematic risk, indicates how volatile the stock is compared to the market index, and can be expressed as the slope of a regression analysis of the returns of individual stocks against the returns of the market index. Stocks with a beta value greater than 1 are interpreted as being more volatile than the overall market index.

When using CAPM, the rate of return of individual assets is determined by β. When deriving the cost of equity capital of an unlisted company, a component with a high risk of subjective judgment is the beta value, which indicates the degree of risk in the process of calculating the cost of equity capital. The beta of an unlisted company without price data for the market index is estimated using the beta value of a listed company belonging to the same industry. Using the beta of the same industry group with similar operating risk, the beta of an unlisted company is estimated by correcting for financial risks according to capital structure, such as debt ratios that differ for each company. As a company's debt increases, financial risk also increases, so the Hamada Equation is a Tool of analyzing the impact of financial leverage using debt on the cost of capital (Hamada, 1972).

(Hamada Equation) $\beta L = \beta U[1+(1-T)\ (D/E)]$, $\beta U = \beta L\ /\ [1+(1-T)\ (D/E)]$,

where: βL=Levered beta, βU=Unlevered beta

T=Tax rate, D/E=Debt to equity ratio

IV. Case Study (1)

A. Ofwat in the United Kingdom

Ofwat, the UK's water services regulator, is a non-departmental government agency[1] established in 1989 following the privatization of the water and wastewater sector in England and Wales. Ofwat's role is to protect consumer rights and ensure the long-term sustainability of water supply and wastewater systems by promoting effective competition under the Water Industry Act 1991 (Ofwat, 2023). Additionally, one of its main missions is to ensure that water and wastewater companies properly perform their legal functions and that they can raise the necessary funds (Ofwat, 2023). Ofwat's role is to set limits on the fees charged for services related to water, considering proposed capital investment plans, including the construction of new water and wastewater facilities, and expected improvements in operational efficiency.

Ofwat applies WACC to determine water rates, and returns on equity are calculated by applying CAPM. Ofwat selected three companies listed on the market in the UK as a peer group to derive beta for the regulated water sector when determining the cost of equity capital. In PR 2019 announced by Ofwat (2020), among the three listed companies, Pennon was excluded from the peer group. Because a significant portion of their operating revenue comes from activities other than regulated water. The beta value was derived for Severn Trent and

[1] A non-departmental government department (NMGD) is a department of the UK government that deals with matters where direct political oversight is deemed unnecessary or inappropriate.

United Utilities, well-established 'pure-play' water companies. Ofwat periodically (every five years) reviews the adequacy of the list. In PR 2024(2022), Pennon, which sold its waste business division in 2020, was reexamined as a peer group, and it was determined that there were limitations in obtaining reliable beta data due to the temporary increase in cash flow and debt impact due to the sale of the business division. Therefore, it is proposed to maintain the original view of excluding Pennon from the list (Ofwat, 2022). Ofwat discloses detailed data and criteria for return on investment and cost of capital when determining rate limits. The upper and lower limits are derived based on detailed assumptions such as market rate of return and beta data period.

Table 1: A case study of Ofwat (2022)

Parameter	Lower-bound	Upper-bound
Notional gearing	55%	55%
Risk-free rate	0.47%	0.47%
Total market return	6.00%	6.92%
Unlevered beta	0.26	0.29
Debt beta	0.15123	0.05
Asset beta	0.34	0.32
Notional gearing	55%	55%
Re-levered beta	0.58	0.64
Allowed return on equity	3.67%	4.60%

Sources: Appendix 11 Allowed return on capital (Ofwat, 2022)

B. The Authority for Consumers and Markets (ACM)

The Dutch Authority for Consumers and Markets ("ACM") is an independent regulator that protects the interests of consumers and companies. ACM is responsible for overseeing market competition, regulating business sectors, and enforcing consumer protection laws. In particular, ACM is an organization responsible for regulating the utility sector, including energy transmission and distribution systems, transportation, communications, postal, medical services, and water in the Netherlands (ACM, 2023). One of ACM's important roles in regulating the market is to set methods for determining tariffs. ACM is responsible for determining regulatory methods for the rates charged to consumers, taking into account an appropriate return on invested capital.

ACM is determining the maximum rates that electricity and drinking water companies in the Dutch Caribbean can charge customers. The rates charged to consumers are calculated by applying WACC, and the cost of equity capital is determined using the CAPM method. Beta values are calculated by using the case of regulated water companies listed in the Eurozone, the US, and Latin America. As a peer group, ACM selected not only the three European listed companies used by Ofwat but also 11 water companies listed on the stock markets of each country, including the United States and Brazil. They calculate stock betas primarily using three years of daily data. Equity beta is calculated by converting Asset beta using the Hamada method. The leverage for beta estimation is chosen as the median of the three-year average of the quarterly gearing ratios. Table 2 below summarizes the ACM's cost of capital for the most recent decision for the regulatory period 2022-2026.

Table 2: A case study of the Authority for Consumers and Markets

Parameter	Electricity Production	Electricity Distribution	Water Production and Distribution
Gearing(D/A)	27.29%	40.59%	28.57%
Risk-free rate	1.87%	1.87%	1.87%
Equity risk premium	6.11%	6.11%	6.11%
Asset Beta	0.64	0.46	0.62
Equity Beta	0.88	0.77	0.87
Cost of equity	7.23%	6.60%	7.16%

Sources: WACC for energy and drinking water companies in the Caribbean Netherlands for the year 2023-2025 (ACM, 2022)

Table 3: ACM's peer group for water production and distribution

Company	Country
Athens Water Supply & Sewage	Greece
Severn Trent Plc	United Kingdom
United utilities group	United Kingdom
Pennon Group	United Kingdom
Cia Saneamento Do Parana-Prf	Brazil
Cia Saneamento Minaas Gerais	Brazil
American Water Works	United States
Essential Utilities	United States
California Water Service	United States
Middlesex Water Co	United States
Sjw Group	United States

Sources: WACC for energy and drinking water companies in the Caribbean Netherlands for the year 2023-2025 (ACM, 2022)

As seen in the above case, not only in Korea but also in major countries, data from listed water companies are being used to determine the cost of capital and regulate public utility charges in water supply systems. However, it can be seen that the standards for which companies are selected as comparative groups and which data are applied are different depending on each country, industrial conditions, and the company's business environment.

V. Case study (2)

A. Reference group

As mentioned earlier, CAPM is generally applied when estimating the cost of equity capital. Beta in CAPM refers to the sensitivity of individual assets to market risk. When an individual stock's beta relative to the market index like S&P 500 is greater than 1, it means that the individual stock is more volatile than the market and involves more risk for investors. Therefore, stocks with a large beta require a higher rate of return. Since stock sensitivity cannot be statistically calculated for companies unlisted on the exchange market, data from comparative companies in similar business groups must be used. Selecting an appropriate peer group is an essential step for estimating a reliable beta that effectively reflects systematic risk.

First of all, we should *distinguish our potential peer group*. The potential peer groups were set as companies classified in the regulated water industry among companies in the utility sector listed on the US (NYSE and Nasdaq) and UK Stock Exchange (LSE). The Regulated water industry includes Companies that distribute water for sale and water treatment companies.

Among the companies disclosed in the stock markets of the two countries, The top 7 companies in market capitalization were selected as potential groups. The size of the peer group for estimating beta was set at around 7 companies. Statistical errors decrease as the number of companies increases, but on the contrary, representativeness may decrease depending on the similarity or size of the business. K-water's paid-in capital is around KRW 10.6 trillion in 2023, and the average market capitalization of the selected companies in the potential peer group is around KRW 1.2 trillion. The potential peer groups are as follows.

Table 4: The list of potential peer groups

Potential peers	Country	Market Capital (Billion KRW)
European Water Companies(UK)		
Severn Trent Plc	United Kingdom	12,039
United utilities group	United Kingdom	10,387
Pennon Group	United Kingdom	4,045
US Water Companies		
American Water Works	United States	35,690
Essential Utilities	United States	14,536
California Water Service	United States	4,001
American states water company	United States	3,842

Sources: Yahoo Finance (2023)

To select the final peer group for securing reliable data, we reviewed the liquidity of each stock and the size of revenue from the regulated water business sector for each company.

Stock liquidity

Harris (2003) defined liquidity as the degree to which large quantities of stocks can be bought and sold quickly at fair prices and low transaction costs. Stocks with low liquidity in the stock market do not sufficiently reflect systematic risk. In the case of stocks with low liquidity, information available in the market cannot be immediately reflected in the price by market participants. Therefore, stock prices can easily be overestimated or underestimated, and the sensitivity of stocks to market risk can be distorted. Therefore, stock liquidity is an essential factor that must be considered when selecting comparable stocks.

Eom et. al. (2005) stated that stock liquidity should be measured individually according to the characteristics of liquidity and the structure of the market and that the characteristics include market width, market depth, and market elasticity. The market width which can be measured by the spread, is the transaction cost for a given trading volume; a high spread means high transaction costs. Market depth refers to the volume of transactions that can be completed at a given price, and can be measured by the number of orders waiting at the highest priority price. Market elasticity refers to the extent to which temporary trading imbalances quickly return, and the recovery speed of indicators such as spreads and trading volume can be examined. Eom et. al. (2005) also stated trading volume is a simple and strong indicator that can reflect most of the above characteristics. Lo and Wang (2000) proposed stock turnover ratio as a reasonable liquidity estimation method.

The bid-ask spread, which is the difference between the price a buyer is willing to pay and the lowest price a seller will accept, can be considered for market liquidity indicator. A narrow spread means high liquidity and a wide bid-ask spread means less liquidity. Large-cap stocks with high trading volume tend to have narrower bid-ask spreads. A smaller difference between the buyer and seller's price expectation means that transaction costs can be lower for investors. On the other hand, small-cap stocks often have wider bid-ask spreads. This means that trading costs are incurred to trade illiquid stocks with wide spreads.

One of the simple and effective indicators available in the market is *trading volume*. Sufficient trading volume can make it easier to execute trades quickly. Higher trading volumes allow investors to enter or exit positions more easily. For example, stocks with low trading volume have lower liquidity because it is difficult to find a counterparty for the transaction. For smaller companies, it can be more difficult to buy and sell stocks, and the liquidity of stocks can affect their prices.

In this respect, *market capitalization* can also be an important indicator of liquidity. It means that a company's stock can be easily traded in the market without causing significant price fluctuations. Larger companies have more shares available for trading, which increases their liquidity and often attracts more investors who trade in large volumes. We have already considered the size of market capitalization when selecting potential peer groups.

The liquidity of the peer group was tested based on the number of days the candidate stock was traded compared to the number of days the market index was traded over the past three years. In addition to the number of trading days, we also considered the share turnover ratio, which is the average daily trading volume over 3 years divided by the number of shares outstanding. The share turnover ratio was found to be around 0.25 - 0.5%. A higher stock turnover ratio means higher liquidity. The stock turnover rates of Apple and Microsoft (average volume of 3 months) are 0.37% and 0.33%, respectively.

Table 5: Peer group's trading volume and share turnover

Peers	% of days company traded	Share Turnover		
		Trading Volume(A)	Shares Outstanding (B, millions)	Share Turnover (A/B, %)
European Water Companies(UK)				
Severn Trent Plc	100%[1)]	737,621	299	0.25
united utilities group	100%	1,998,201	682	0.29
pennon Group	100%	1,004,403	286	0.35
US Water Companies				
American Water Works	100%	924,597	195	0.47
Essential Utilities	100%	1,107,525	273	0.41
California Water Service	100%	249,907	58	0.43
american states water company	100%	184,099	37	0.50

Sources: Yahoo Finance (Historical 3-year Trading Data)

Additionally, we reviewed the revenues generated through the operating activities of the candidate companies based on the opinion that liquidity has a positive impact on corporate performance and operating profitability (Fang, Noe & Tice, 2008). The three-year average

revenue ranged from a maximum of 4.7 trillion won to a minimum of 600 billion won, with the average sales being 2.2 trillion won

Table 6: Total revenue of the peer groups (100 million KRW)

Peers	Total Revenues		
	2022	2021	2020
European Water Companies(UK)			
Severn Trent Plc	33,811	30,347	28,534
united utilities group	28,491	29,089	28,234
pennon Group	12,884	12,373	10,066
US Water Companies			
American Water Works	45,703	47,366	45,522
Essential Utilities	27,576	22,636	17,629
California Water Service	10,202	9,532	9,573
american states water company	5,924	6,012	5,884

Sources: Yahoo Finance and annual reports (2020-2022)

The portion of regulated water revenue

Peer companies used to estimate beta should have similar systematic risks as K-water. In other words, companies with similar systematic risks will react to changes in market conditions in the same way as their peers. Because revenues for water production, transportation, and supply are regulated by tariffs, they may be less sensitive to changes in market conditions than businesses operating in a free market. In this regard, we have set the standard that peer groups must generate the majority of their revenues from regulated water production and distribution activities, in the same line with the regulated water industry.

Table 7: The portion of regulated water revenue

Peers	Regulated Water Revenues (%)		
	2022	2021	2020
European Water Companies (UK)			
Severn Trent Plc	92%	93%	93%
united utilities group	96%	96%	97%
pennon Group	85%	87%	87%
US Water Companies			
American Water Works	91%	85%	84%
Essential Utilities	47%	51%	63%
California Water Service	91%	97%	88%
American states water company [2]	92%	92%	92%

Sources: Annual reports and notes (2020-2022)

To select the final peer group, we reviewed operating revenue and the proportion of revenue from regulated water production and supply activities (water and wastewater business). As seen in Table 5, most comparative companies showed an average of around 90% of revenue related to water, but in the case of Essential Utilities, revenue in the water business area averaged around 50% for three years. Essential Utilities (2021) announced that the company expanded its utility business into natural gas through the acquisition of Peoples Gas in 2020. The business expansion strategy resulted in a decrease in the proportion of sales in the water sector due to sales in the natural gas sector. Therefore, we excluded Essential Utilities, whose water revenue share was less than 60%, from the final peer group. The final peer group is shown in the table below:

Table 8: The selection of the final peer groups

Peers	% of days company traded	Share Turnover	Total revenue	% of regulated revenue	Selection
European Water Companies (UK)					
Severn Trent Plc	✓	✓	✓	✓	✓
united utilities group	✓	✓	✓	✓	✓
pennon Group	✓	✓	✓	✓	✓
US Water Companies					
American Water Works	✓	✓	✓	✓	✓
Essential Utilities	✓	✓	✓	X	X
California Water Service	✓	✓	✓	✓	✓
American states water company	✓	✓	✓	✓	✓

B. K-water's beta estimates

To calculate the beta of a peer group, generally, two or five years of accumulated market data can be used. If the period is short, the results may be affected by the temporary effects of a specific period. On the other hand, if the analysis period is too long, it has the disadvantage of making it difficult to reflect the latest trends. In this study, we used publicly available data to select the monthly betas of the final peer groups over the past five years. Based on the equity beta, the Hamada model was used to calculate the asset beta according to the capital structure (D/E) of the comparative company. Water companies in the European market have higher debt ratios and lower asset betas than those in the US market. Water companies in the US market have a relatively higher beta than those in the European market.

Table 9: Peer group's levered and unlevered beta

Peers	Levered Beta	D/E	Unlevered Beta
European Water Companies (UK)			
Severn Trent PLC	0.40	138.6%	0.20
united utilities group	0.41	118.1%	0.22
pennon Group	0.30	50.9%	0.22
US Water Companies			
American Water Works	0.65	72.3%	0.42
California Water Service	0.49	38.7%	0.38
American states water company	0.44	56.2%	0.31

1. Annual report (2020~2022)
2. Applied Corporate Tax rate is 25%(UK) and 25.8%(US), Global Tax Summary (OECD, 2023)

To derive the proxy beta, the Hamada equation model was used and K-water's capital structure was applied. The applied debt and capital ratios are the five-year average ratios planned according to the 2023-2027 mid- to long-term financial plan established under the Act on the Management of Public Institutions (Ministry of Strategy and Finance, 2023). By applying the asset betas of six water companies, we calculated the appropriate beta range according to K-water's target capital structure. The appropriate beta level for K-water, using the beta of global water companies, is 0.38 to 0.66.

Table 10: The range of beta in regulated water company

Peers	Equity Beta	D/E (Average)	Asset Beta	Estimated Beta
European Water Companies (UK)	0.37	102.5%	0.21	0.38
US Water Companies	0.53	55.7%	0.37	0.66

1. K-water's target Debt to Equity Ratio (107.3%) is applied from the 2023-2027 mid- to long-term financial plan (Ministry of Strategy and Finance, 2023)

2. Applied Corporate Tax rate is 26.5%(KOR), Global Tax Summary (OECD, 2023)

VI. Conclusion

A. Summary

When making investment decisions for public institutions, the application of an appropriate discount rate must be considered. In this study, we presented the appropriate beta range for the regulated water industry through examples of global listed companies. The range of beta presented in this study can be used as an objective reference indicator in various important fields such as investment decision-making as well as water rate determination and asset valuation. The results of this study can be used as a benchmarking example for establishing a peer group that considers risks in the water industry and calculating the cost of equity capital. In addition, it can be a reference in determining not only the capital cost for the feasibility of investment but also utility tariffs that should be charged to users for infrastructure investment and operations. Korea's public utility fee calculation standard (Ministry of Strategy and Finance, 2017) specifies that the appropriate investment compensation for facility investment should be reflected in utility rates. Since there is no specific guideline for the cost of capital, reasonable standards and estimates are continually required in the process. In particular, since many public companies in Korea are unlisted, it may be difficult to provide evidence for market data such as beta. It is expected that the case of this study can be used to suggest reasonable standards when selecting proxy betas in the unlisted public sector.

B. Policy recommendations

Although beta has the limitation of being a subjective estimate for non-public companies, it is very important as it determines whether to implement an investment or determine the

appropriate compensation for investment assets. Therefore, concerning the appropriateness of major decisions such as discount rates, it is necessary to collect opinions from internal and external stakeholders according to established procedures, as in the cases of Ofwat and ACM presented in the previous case study. In various fields, rational decisions need to be made from various perspectives, such as peer group selection methods and decision-making processes, and other aspects to be considered to provide sustainable services. Additionally, socially agreed-upon decisions have the advantage of resolving problems in the implementation process in advance. It is believed that the results derived through the opinions and reviews of various experts and market participants will contribute to resolving irrationalities in advance and leading to transparent decision-making.

C. Limitations and future research

In this study, the range of proxy beta for determining capital costs was derived through the case study of global water rate regulators and regulated water companies. In the case study of the global water rate regulator's capital cost calculation, the unleveled beta is 0.26 to 0.64, which is higher than the 0.21 to 0.37 calculated for K-water in this study. This is due to the limitations of the estimation method, which may vary depending on criteria such as the selection of peer group and scope of data. For example, this study used five years of monthly beta data to propose a stock beta range applicable to regulated water industry companies. However, applying a 3-year beta or a 10-year beta, or using a different basis, such as a daily or quarterly beta, may result in a different proxy beta range. The disadvantage of deriving different values depending on the data collection method is also a limitation of the CAPM and WACC models. In addition, the inability to consider country-specific characteristics is a limitation in

applying the risk coefficient through global cases. Therefore, for rational analysis, it is important to closely analyze the characteristics of each country's water industry and the suitability of benchmark companies and then establish reasonable standards. We also believe that analysis of different estimation scenarios improves the reliability of the study and provides opportunities to reduce the error.

The weighted average cost of capital including the cost of capital can be set conservatively or optimistically depending on the strategy of management. However, in the case of public enterprises, the feasibility of the investment is evaluated by an independent organization in terms of publicness and profitability through a preliminary feasibility study under the Act on the Management of Public Institutions. In addition, utility rates are also regulated, and the details of the rates are determined by the government ministry in charge of the industry. Therefore, there may be limitations in applying only market data to determine criteria. The range of beta, which means the systematic risk, can be comprehensively determined by considering global market trends, domestic industry characteristics, government policy, consumer interests, and service sustainability.

References

Authority for Consumers and Markets (n.d.). Our mission and vision. Retrieved February 29, 2024, from https://www.acm.nl/ en/about-acm/mission-vision-strategy/our-mission

Authority for Consumers and Markets (2022). WACC for energy and drinking water companies in the Caribbean Netherlands for the year 2023-2025. https://www.acm.nl/nl/caribisch-nederland/tarieven-drinkwater-caribisch-nederland

American State Water Company (2023). Annual Report. https://americanstateswatercompany.gcs-web.com/financial-information/annual-reports

American Water Works (2023). Annual Report. https://ir.amwater.com/financials/annual-reports-and-proxy-statements/default.aspx

California Water Service Group (2023). Annual Report. https://www.calwatergroup.com/ investors/ financials-filings-reports /annual-reports-proxies

Eom, K. S., Sun, J. H., Han, S. B., & Kang, D. I. (2005). Research on efficient stock trading mechanisms to increase liquidity. Korea Securities Research Institute.

Essential Utilities (2023). Annual report. https://www.essential.co/financial-information/annual-reports

Fang, V. W., Noe, T. H., & Tice, S. (2008). Stock Market Liquidity and Firm Performance: Wall Street Rule or Wall Street Rules? [Tulane University].

Hamada, R. S. (1972). The Effect of the Firm's Capital Structure on the Systemic Risk of Common Stocks. Journal of Finance, (1972).

Harris, L. (2003). Trading & Exchange; Market Microstructure for Practitioners, Oxford University Press.

Kang, D. S. (2021). A revised study on general guidelines for conducting preliminary feasibility studies for public enterprise and quasi-governmental organizations projects (3rd edition) [KDI Public Investment Management Center].

Lo, A. W., & Wang, J. (2000). Trading volume: Definitions, Data analysis and Implications of portfolio Theory [NBER, National Bureau of Economic Research]. https://www.nber.org/system/files/working_papers/w7625/w7625.pdf

Ministry of Strategy and Finance (2017). Public utility fee calculation standards. National Law Information Center. https://www.law.go.kr

Ministry of Strategy and Finance (2019). Preliminary feasibility study operation guidelines for public enterprises and quasi-governmental organizations. National Law Information Center. https://www.law.go.kr/LSW/admRulLsInfoP.do?admRulSeq=21 00000175303

Ministry of Strategy and Finance (2023). Establishment of mid- to long-term financial management plan for public institutions from 2023 to 2027. https://www.moef.go.kr/nw/nes/detailNesDtaView.do?menuNo=4010100&searchNttId1=MOSF_000000000065595&searchBbsId1=MOSFBBS_000000000028

Ofwat (n.d.). Ofwat's duties. Retrieved February 29, 2024, from https://www.ofwat.gov.uk/about-us/our-duties/

OECD (2023). Statutory Corporate Income Tax Rates. OECD. Stat. Retrieved February 29, 2024, from https://stats.oecd.org/Index.aspx?DataSetCode=CTS_CIT

Ofwat (2022). PR24 Final Methodology – Appendix 11 Allowed return on capital. https://www.ofwat.gov.uk/publication/pr24-final-methodology-appendix-11-allowed-return-on-capital/

Pennon Group (2023). Annual Report. https://annualreport.pennon-group.co.uk/index.html

Severn Trent (2023). Annual report. https://www.severntrent.com/investors/results-reports-and-presentations/

United Utilities (2023). Integrated Annual Report. https://unitedutilities.annualreport2023.com/our-stakeholders/