WATER AS AN INVESTMENT AND THE IMPACT OF REGULATORY RISK

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ABSTRACT

Water is a fundamental commodity. However, China is ranked as one of the top countries in terms of water scarcity. Hence, the country urgently needs large investment in its water sector. In this paper, we investigate the impact of regulatory risk on water investments guided by the 'buffering effect theory' and with the application of the Kalman filter and panel regression within the context of the Capital Asset Pricing Model. The question of utmost importance here is whether regulatory decisions affect systematic risk of water companies traded on the Chinese stock market. In other words, the effect of regulatory intervention measures may be moderated by investors' perception of the overall political environment. We find a significantly negative effect of competition which suggests that when a regulator takes steps to reduce market competition, water companies are likely to gain greater power on the market resulting, in turn, in higher price levels and profit margins. The findings of this study contribute to the understanding of how investors can be attracted to participate in the water industry, not just in China, but also worldwide.

Introduction

China is the second biggest economy in the world. Whatever happens to the Chinese economy in a practical sense now has a global impact. One of the major issues that can potentially have a major effect on the Chinese economy is water (Leadership Group on Water Security in Asia Report, 2009). China is ranked as one of the top countries in terms of water scarcity (Sullivan, *et al.* 2008). Hence, the country is urgently striving to increase water supply. In order to achieve this, further large investments are required since the water industry is one of the most highly capital and infrastructure intensive (Olstein, *et al.* 2009). The government alone cannot provide sufficient financing and thus the participation of private sector investors is necessary (OECD, 2009).

Although the Chinese government takes the initiative to increase private sector investment in its water industry, one of the major concerns of investors is the issue of regulatory risk — that is, changes in regulations. Due to the political cycle and/or change in governments as well as many other considerations, regulations can change. Hence, this can create regulatory risk on the part of investments since investments in the water industry (being an infrastructure-based industry) are long-term (Schouten and Schwartz, 2006; United Nations Environment Programme Finance Initiative, 2006). Hence, political and regulatory risk is one of the major influences on the foreign investment decision (Kobrin 1979). The water industry, due to its nature, is one that is highly regulated (Pescetto, 2008). This industry has the characteristic of being a natural monopoly as it faces a highly inelastic demand. Water is often considered as a public good because the societal dependency on water is high and government has a responsibility to make sure that there is safe access to water for an affordable price (Savenije, 2002). However, from an economic perspective, it may be incorrect to view water as a 'public good' as everyone should have access to safe and affordable water services; thus water should rather be called a 'merit good' (Schouten and Schwartz, 2006).

In the existing literature, very little is known about regulatory risk in the global water industry. The very few existing studies like Gaggero (2012) and Buckland, Williams and Beecher (2015) have focused on the UK or US markets. In this paper, we attempt to document the effect of regulatory risk on investors and investment returns in the water industry. We do this by investigating the impact of regulatory risk on the systematic risk of the water industry at both industry and individual company level. We undertake our investigation in the context of the water industry in China. The Chinese water industry is a very important one. It is the largest market in terms of the number of people served by the private water sector (Pinsent Masons, 2009). China has placed a great emphasis on addressing its huge domestic water needs, with the government announcing a series of regulatory decisions regarding the water industry in the past decade.

The Chinese water industry is also unique. Unlike other countries such as the UK and the US where uniform regulations are lacking, China has a central regulation agency whose policies can affect the whole nation. Yet, at the same time, compared with the UK where there is a central water authority, China's fragmented yet centralized water management system carries more similarities with the rest of the world, making the study's results more generalisable (Nickum, 2010). Thus, the Chinese water industry provides an excellent laboratory for the examination of the issue we are focusing on — that is, the impact of regulatory risk on the returns of the water industry.

We apply the 'buffering effect' theory (Peltzman, 1976) and conduct panel regression analyses. We find that regulatory risk does affect systematic risk in the case of the water industry in China, with much depending on the type of regulatory change. Regulatory announcements intended to reduce market competition, increase water prices, and improve the quality of water services have significant impact on the systematic risk of China's water industry. However, those aimed at enhancing market competition and reducing water prices do not have significant associations with systematic risk. We also examine the effect of regulatory changes on individual water companies' systematic risks and find that most water companies are not significantly affected by these changes. The results further reveal that regulatory changes that have a significant impact at the industry level may not have the same effect at the individual company level.

The findings of this study contribute to an understanding of how investors can be attracted to participate in the water industry, not just in China but also worldwide, in the hope of providing a solution to water shortages. Further, it makes a scholarly contribution to the literature on empirical asset pricing. At this stage and in this area, there is a need to identify factors that may influence market systematic risk. It is not clear yet whether regulatory risk is one of those factors.

The remainder of the paper is organized as follows: Section 2 reviews the characteristics of the Chinese water industry and recent developments in regulatory policy making; Section 3 discusses the relationship between regulation and systematic risk of regulated industries and firms; Section 4 details our research method and data; and Section 5 presents the results and empirical findings. Finally, Section 6 concludes with the implications of our study and possible directions for future research.

The Regulation of China's Water Industry

Traditionally, the central role of the water industry to protect and preserve public health has encouraged the Chinese government to manage its water industry within the public sector (MacGillivray, *et al.* 2006). In the late 1990s, using borrowed experience from the UK and other European countries, the government started to pursue a massive program of privatisation of water utilities in the hope of improving systematic efficiency and attracting private funds. Although private participation in water and wastewater services in China was legislated by various laws as early as the 1980s, the government did not formally open its national urban utility market to domestic private players until 2002–03. However, private sector participation in the China water sector is a hot topic and has been discussed inside and outside of China because China's water crisis offers attractive business opportunities for foreign companies (Lee, 2007; Hutterer, 2008). According to Hutterer (2008), following a worldwide trend, the Chinese government officially opened the water distribution sector to privately owned companies in May 2004. Thereafter, domestic and foreign investors were actively engaged in a dozen urban water utilities, mainly through Build-Own-Transfer (BOT). Thus, global market leaders including two French companies, Suez and Veolia, and a UK company, Thames Water, have been active in the Asian market and have in many ways defined the terms by which private companies can operate in the Chinese market.

It is noted that being aware of the high potential of the water market in Shanghai and other parts of China, Thames Water became the sole owner and operator of the water treatment plant by buying the full shares of its joint venture partner in early 2002 (Lee, 2007; Hutterer, 2008). To date, China's private investors have managed to explore the water market using three approaches: 1) working in joint ventures with international companies, 2) working through a dedicated infrastructure fund, and 3) setting up Chinese owned private companies (Pinsent Masons, 2004). Among those, the third approach has been used most widely. It is typically carried out by converting public water companies into joint stock companies and selling their equities to the private sector through public offerings on the Shanghai and Shenzhen Stock Exchanges. Returns on these private investments are thus reflected in the behaviour of the prices and yields of their shares as quoted on the exchanges.

The landscape of China's water market has undergone an enormous change since the beginning of privatisation. Till the end of 1999, nearly 30 million people were served by the private sector in various forms. This number has been growing dramatically, and it is believed that contracts covering around 300 million people will have been awarded to private water and wastewater companies in China by 2012 (European Small and Medium-sized Enterprises Center (EU SME), 2013). These private water companies serve consumers by providing various products and services such as collecting, treating, conveyancing, and monitoring/analysing water and wastewater. Currently, China is not only the world's largest water market in terms of the number of people served by the private sector, but also the most dynamic market in terms of the rapidity of its development (Pinsent Masons, 2007). The absolute size of China's water market and the diversity of opportunities available have made it a global and regional driver, as well as a good subject for regulatory risk research.

However, it is worth pointing out that the transfer of ownership in privatisation does not alter the public goods nature of the water industry because the societal dependency on water is high (Savenije, 2002). Moreover, due to the peculiar characteristics of water privatisation, it is exposed to all of the traditional instances of market failure—for instance, natural monopoly conditions, negative externalities, and capital intensity (Pescetto, 2008). Therefore, regulatory arrangements have to be set up to improve the quality of services, to protect consumers against monopolistic exploitation as well as to reduce environmental cost. According to EU SME (2013), the Chinese government has been encouraging funds necessary for water infrastructure investments and incentivising consumers towards more efficient uses of water by introducing aggressive water pricing mechanisms. This process is consistent with the government's needs for both economic transformation and water service improvement in a country that is suffering from severe water shortages (Pinsent Masons, 2004).

China's water regulatory landscape ranges from controlling and preventing water pollution to mandating pricing and funding policies of water services. Similar to their overseas counterparts, the Chinese water companies are subject to a variety of regulatory jurisdictions (Beecher, 2009). However, differing from developed countries, China has a number of authorities involved in water governance at the central government level. In general, the State Council, the Ministry of Development and Reform Commission, and the Ministry of Finance take charge of regulatory schemes of water pricing and water funding, while the Ministry of Water Resources, the Ministry of Environmental Protection, and the Ministry of Housing, Urban and Rural Construction share the responsibility for managing water quality, water quantity, and environmental regulations (EU SME, 2013). For the purpose of our research, we examine only the impact of changes in central regulations, for all local regulators are required to follow the same overarching core principles and general practices set by Beijing.

The study uses the Chinese water market as a proxy to understand the effect of regulations on the riskiness of water businesses. China's water market is chosen for three reasons. Firstly, emerging countries have great needs for funds to build/update necessary water infrastructure and to preserve the environment. As a developing country, China has almost 20 per cent of the world's population and only about 6 per cent of global freshwater resources. Urbanisation and rising environmental awareness are driving rapid growth in urban water supply and the wastewater market, causing further water distress. However, investors are, in effect, more willing to invest in developed water markets due to their low political risks compared to emerging markets. Preqin (2011) reports that 47 per cent of investors target European assets, while 36 per cent focus on North American infrastructure. Therefore, it is crucial for both water investors and policymakers to fully understand the impact of regulatory changes. Despite the need for knowledge, little empirical research has been conducted in this area. For the few existing studies, researchers predominantly focused on the British water market. To date, investment characteristics of the water industries in the emerging world remain largely unknown.

Secondly, China's water market is not only one of the three largest water markets in the world, but it is also the largest market in terms of the number of people served by the private water sector (Pinsent Masons, 2009). It is estimated to be worth EUR 60–100 billion a year over the next ten years (European Small and Medium-sized Enterprises Centre (EU SME), 2013). The majority of the companies competing in the market are local companies. Foreign companies provide about 8 per cent of the total national water supply. Nevertheless, despite the prosperity of the water industry, China faces many challenges in its water efficiency, water technologies and funding (Dore, *et al.* 2010). The absolute size of China's water market and the diversity of opportunities available have made it a global and regional driver, as well as a good subject for regulatory risk research.

The Relationship between Regulatory Changes and Systematic Risk

As China's water industry was historically under the control of the public sector, the regulations were mostly self-imposed and limited in scope. Traditional state-owned water companies were barely affected by regulatory risk. However, the recent (since 2002) water privatisation movement has externalised and broadened the role of regulatory scrutiny and intervention, thus making regulatory risk one of the greatest strategic challenges/threats to the businesses on the Chinese water market (Dore, *et al.* 2010). The significant impact of regulatory risk on the water industry is, of course, not unique to the Chinese water businesses (MacGillivray, *et al.* 2006; Pescetto, 2008; Buckland, Williams and Beecher, 2015). Therefore, the results of our study may also be informative to stakeholders in the global water market.

Regulatory risk to China's water market can be caused by expected and unexpected announcements from the central regulators. It is the result of the uncertainty behind new and changing regulations over time (Ernst and Young, 2008). These regulations usually aim to influence strategic decisions of individual water companies. For example, Sawkins (1996) studies whether the revised regulatory arrangements consistently favoured water company shareholders over other water industry stakeholders. He finds that regulatory interventions do not affect investor expectations. Further, Antoniou and Pescotto (1997) conclude that regulatory announcements impact the measured beta risk of a specific utility's equity whereas Buckland and Fraser (2000, 2001) suggest that regulatory events are linked with changing systematic risk estimates in UK water companies.

Regulation is also clearly outlined in Grout and Zalewska (2006). Regulations on environmental protection, price control, investor protection, and market entry restrictions are all intended to facilitate the transfer of wealth and social responsibilities between stakeholders either as an end to itself or as a means to achieve specific objectives. In contrast, very few regulatory changes that apply to water companies aim primarily to transfer risks between parties, and hence few regulatory changes enable the risk effect to be isolated for empirical investigation (Grout and Zalewska, 2006). US water regulation is well documented by Beecher (2009). The US sector is fragmented and diverse in structure. So are the US regulatory authorities, while ownership of water utilities is securitised and exchange-listed (Beecher 2009; Buckland, Williams and Beecher, 2015). Such water regulation related literature has been made to address the risk and returns of regulations. In other words, the strand of literature that explicitly shows how investment risk of the regulated firms responds to water regulatory changes is small. Ergas *et al.* (2001) point out that regulatory decisions bring about risk cost to investors who have the ability to diversify some types of risk across a market portfolio. However, they also argue that investors only require compensation for those components of risk that cannot be diversified. Therefore, the question of the utmost importance here is whether regulatory decisions affect systematic risk of water companies traded on the Chinese stock market. An answer to this question would not only appeal to researchers but also interest policymakers. As systematic risk cannot be diversified away, regulators should compensate shareholders for bearing such risk (Paleari and Redondi, 2005).

Theoretical Framework and Empirical Literature

There has been a multitude of debates, in both theoretical and empirical literature, on how regulation affects risk in a public utility industry. Peltzman (1976) provides an important contribution to the understanding of the relationship between regulation and risk by proposing the 'buffering effect'. He argues that companies operating in competitive markets face more volatile profits that occur due to such factors as stranded costs, classic externalities, and increased demand volatilities. Comparatively, regulated companies often get maximum political support from regulators, which buffers the abnormal profits between shareholders and customers. A similar argument often made for the water industry is that because continuity of service is so important, regulators do not want regulated water companies to become bankrupt (Grayburn, Hern and Lay, 2002). In fact, in spite of privatisation, water provision is still subsidised by governments in order to ensure its universal availability in urban areas. Therefore, according to Peltzman's theory, water regulations tend to buffer downside returns and alleviate the investment risk on water companies.

The buffering effect theory is widely tested since its proposition. Most studies on infrastructure industries are supportive of its predication that price regulation buffers cash flows and reduces market risk. Employing the same sample of US electric utility companies, both Norton (1985) and Binder and Norton (1999) find supporting evidence for the buffering effect theory. Fraser and Kannan (1990) adopt a larger and more diverse sample of US infrastructure and financial firms and conclude that systematic risk of firms under regulation is uniformly lower than of their unregulated peers. Alexander, Mayer and Weeds (1996) extend the regulatory risk analysis to the global utility industry sectors. They find that asset betas are positively related to the degree of efficiency incentives, lending support to Peltzman's buffering theory. In follow-up studies, both Alexander, Estache and Oliveri (2000) and Grout and Zalewska (2006) corroborate the finding that non-US companies with high-powered regulation have higher betas than those with other regulatory regimes.

However, whilst the traditional view is that the buffering effect of regulation reduces the systematic risk to which a regulated utility is exposed, recent literature finds factors such as information asymmetry, regulation inconsistency, and regulatory lag of imperfect regulation mechanisms can actually increase the cost of capital for regulated utilities and therefore enhance their systematic risk (Grayburn, Hern and Lay, 2002). The universal validity of the buffering hypothesis is questioned empirically, too. Davidson, Rangan and Rosenstein (1997) partially reject Peltzman's buffering hypothesis in their examination of the US electric utility industry. They fail to detect lower systematic risk for intensely regulated firms during periods of falling or relatively stable factor prices. Gaggero (2012) challenges the conclusion of Alexander *et al.* (1996, 2000) by analysing the impact of regulatory regime on market risk for regulated companies in 200 countries. In contrast to the previous research, he finds no significant difference between low and high incentive schemes for various model specifications. Moreover, in the only study investigating an emerging market, Barcelos (2010) samples 67 Brazilian companies (electricity, telecommunication, commodities, domestic sectors) and finds that equity betas of regulated firms are not different from (or even higher than) those of their unregulated peers when controlling for the time-varying nature of betas as well as equity and time-specific factors. When further analysing the reaction of firms' market risk to specific regulatory changes, he finds evidence suggesting that the additional regulations do not reduce, but rather increase the regulated firms' betas, directly contradicting the buffering hypothesis.

Instead of comparing the systematic risks between regulated and unregulated firms, some researchers have analysed the time-series policy changes and their impact on firm risk. This approach has two advantages: a) the same firms can be observed over time; and b) potential biases from other risk factors are minimised (Rothballer, 2012). Thus far, the few studies that adopt this approach have yielded mixed results. There has been evidence from industries such as water, natural gas, and telecommunication suggesting the existence of the buffering effect across different countries (Buckland and Fraser, 2001; Chen and Sanger, 1985; Sidak and Ingraham, 2003). However, the disputing evidence has been equally strong. Nwaeze (2000) analyses three major policy changes in the US electric utility industry and finds a significant increase in earnings variability, systematic risk as well as negative abnormal returns around the events. The results indicate a reversal of the buffering effect. Paleari and Redondi (2005) explore the UK electricity distribution industry and find that as regulation gets stricter, companies' systematic risk will increase, and vice versa. Moreover, Antoniou and Pescetto (1997) and Pescetto (2008) conclude that while some regulations tend to affect their industry as a whole, others have a diverse impact on individual companies. This implies that regulation itself may be only a source of uncertainty, rather than an impacting factor on the systematic beta risk in a specific direction. Still, the literature remains unclear as to the existence of a regulation effect on systematic risk.

As an infrastructure industry, the water supply businesses tend to exhibit low volatility compared to other assets, which gives investors a low systematic risk (beta); meanwhile, the riskier stocks of technology developers in the water industry are more likely to offer investors an abnormal return (alpha) (Dickinson, 2010).

Recently, infrastructure investors are a key pillar in supporting water investment for the delivery of water infrastructure projects. In the 21st century, infrastructure could be represented as a new financial asset class due to its unique investment characteristics such as low correlation with other assets, long-term assets, low risk investments, inflation hedging properties, low competitive market structure, regulatory regimes and high barriers to entry (Bianchi and Drew, 2014; Panayiotou, 2017; PWC, 2018; Regan, Smith and Love, 2011; Rothballer and Kaserer, 2012). Thus, infrastructure investments are a more popular asset class for institutional investors as low risk investments due to their regular income and long-life return profile of infrastructure assets acting as a hedge to the long-term obligations of these institutions. It is noted that Bianchi and Drew (2014) find that listed infrastructure assets exhibit commonalities with global listed stocks and exposure to the global utilities industry like energy, oil and gas, and water. It is noted that as an infrastructure industry, the water supply businesses tend to exhibit low volatility compared to other assets, giving investors a low systematic risk (Dickinson, 2010; Jin, *et al.* 2014).

However, compared with other infrastructure industries, water businesses are largely overlooked by researchers. The few studies that examine the impact of regulatory changes on water firms focus on the British water market possibly because of its long history of water privatisation and the existence of a central government body — the Office of Water Services (see for example, Klein, 1996; Sawkins, 1996; Antoniou and Pescotto, 1997; Cooper and Currie, 1999; Morana and Sawkins, 2000; Buckland and Fraser, 2001; Grout and Zalewska, 2006; Pescetto, 2008). Much literature has been done in the US (see for example, Beecher, *et al.* 1995; Aubert and Reynaud, 2005; Beecher, 2009; Crew and Kahlon, 2014). To the best of our knowledge, there has been no empirical investigation of this issue in Asian countries' water industries. Thus, it is noted that this study is the first to examine regulatory risk in China's water industry. Moreover, the lack of uniform verification of regulation effect in the current literature has made it especially difficult for stakeholders to capture the risk associated with changing water regulations. Hence, the objective of this paper is to examine this unexplored area and improve the understanding of the links between regulation and the risks faced by regulated water firms.

Methodology and Data

Methodology

There are generally two approaches in the research of regulatory risk. The first approach tests 'regulatory system risk' — the risk related to the form of regulation. Such studies focus on betas across sectors and compare the effects of different regulation regimes. The second approach assesses 'regulatory intervention risk' — the risk associated with a particular event or action taken by a regulator. These studies examine the impact of regulation announcements on firms' time-varying betas (Grayburn, Hern and Lay, 2002). Our paper follows the methods of Buckland and Fraser (2001) and Pescetto (2008) to combine the above two approaches by classifying and measuring the impact of regulatory interventions on the systematic risks of the same group of companies over a period of time.

We use a two-step procedure to verify whether regulatory risk exists in China's water industry. In the first step, we estimate the systematic risk of water companies based on the Capital Asset Pricing Model (CAPM). The CAPM is used here not only for its academic attractions (it has been widely used to estimate the impact of regulatory risk of regulated utilities), but also due to its consistency with the modelling approach of regulators and water companies in most countries (Alexander, Mayer and Weeds, 1996; Buckland and Fraser, 2001). Assuming a fixed risk-return relationship, we have the following expression:

$$R_{it} = R_{ft} + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it} \quad (1)$$

Where R_{it} is the continuously compounded return on a risky asset *i*; R_{ft} is the continuously compounded return on a risk-free asset; R_{mt} is the excess return (in excess of the risk-free rate) on the market portfolio; β_i is the measure of the systematic risk of asset *i*; ε_{it} is a random error term.

It is, however, a stylised fact of empirical finance that betas are not stable over time (Antoniou and Pescetto, 1997; Buckland and Fraser, 2001; Grout and Zalewska, 2006; Paleari and Redondi, 2005). Considering the uncertainty surrounding the privatisation of the water industry, the changes in the political and economic environments in China and, particularly, the development of quality, health, and environmental issues relating to the supply of water and sewage services during the sample period, a model that assumes constant systematic risk and does not capture the dynamic behavior of asset returns would be inappropriate. Instead, for the purpose of analysing the sensitivity of betas to regulatory factors, we transfer Equation (1) to Equation (2):

$$r_{it} = a + \beta_{it} r_{mt} + \psi_{it} \quad (2)$$

where *r* denotes respective excess returns (returns in excess of the risk-free rate) and, assuming markets are efficient, β_{it} denotes a time-varying beta, and ψ_{it} is a random error term. Our aim is to extract from Equation (2) a time series of betas for each of the water companies in our sample.

Following the method of Buckland and Fraser (2001) and Paleari and Redondi (2005), we employ the Kalman Filter procedure for the maximum likelihood estimation of beta. The Kalman Filter procedure utilises a state-space model to extract and incorporate information from the conditional variance of prior returns in modelling the evolution of model parameters. It is a dynamic and recursive algorithm. It allows time-varying parameters to be stochastic and uses all available information in estimation. We allow the time-variation of the betas to follow the process that is described as follows:

$$r_{it} = \beta_{i,t}\, r_{mt} + \mu_{it} \tag{3}$$

$$\beta_{i,t} = \beta_{i,t-1} + \nu_{i,t} \tag{4}$$

where β is an AR(1) process with a first-order auto-correlation coefficient equal to 1, and μ_{it} and ν_t are independent white noise error terms. Equation (3) is now termed as the measurement equation. Equation (4) is the state equation describing the time-varying behavior of the parameter β_t.

In the second step, further tests for the impact of regulatory intervention risk on China's water companies are conducted by regressing betas on different types of regulation announcement events. As mentioned above, the water industry in China is mainly influenced by regulations coming from the six regulatory bodies at the central government level. In line with Pescetto (2008), we group all the water-related regulation announcements made by these regulators based on their expected impact on competition, prices, and quality of services. Specifically, there are five types of regulatory announcements that are expected to cause increased competition ($COMP^+$) within the industry, decreased competition ($COMP^-$) within the industry, increased water prices ($PRICE^+$), decreased water prices ($PRICE^-$), and increased quality of services ($QUAL^+$). The equation estimated is as follows:

$$\beta_{it} = \gamma_0 + \gamma_1 COMP^+_t + \gamma_2 COMP^-_t + \gamma_3 PRICE^+_t + \gamma_4 PRICE^-_t + \gamma_5 QUAL^+_t + e_{it} \tag{5}$$

where β_{it} is the time-variant systematic risk of water company *i*; $COMP^+_t$, $COMP^-_t$, $PRICE^+_t$, $PRICE^-_t$, and $QUAL^+_t$ are dummy variables equal to one during the week of each regulatory announcement and zero otherwise; e_{it} is a random error term. The parameters $\gamma_1,\ldots,\gamma_5$ detect changes in the water industry's systematic risk as a result of particular types of regulatory announcements. We use panel data analysis, to be specific, a (firm) fixed effects model. This model assumes that each firm has its own individual characteristics which may influence the independent variables. The fixed effects regression controls the effects of those time-invariant characteristics, and thus the estimated coefficients are not biased.

Using Equation (5), the following hypotheses about the effects of each group of announcements on the water industry's systematic risk are tested:

i. announcements that are expected to increase (decrease) competition are also expected to increase (decrease) β ($\gamma_1 > 0$, $\gamma_2 < 0$);

ii. announcements that are expected to increase (decrease) the price of services are also expected to decrease (increase) β ($\gamma_3 < 0$, $\gamma_4 > 0$);

iii. announcements that are expected to increase quality threshold of services are expected to increase β ($\gamma_5 > 0$).

Pescetto's (2008) approach attributes any resulting differences in the systematic risk to regulatory announcements. However, Alexander, Mayer and Weeds, (1996) argue that the observed variation on water companies' betas can be a result of other factors that may or may not be relevant to regulatory announcements. Hence, it is necessary to control the effects of these alternative factors so that we can identify the real impact of regulation on systematic risk (Chalmeau, 2013). The existing literature has established strong links between CAPM beta and accounting variables (Beaver, Kettler and Scholes, 1970; Logue and Merville, 1972). Therefore, we develop Equation (6) based on Equation (5) and evaluate the effect of regulation announcement events on the systematic risk of the water industry while controlling for the main financial determinants including financial leverage (ratio of total debts to current assets), operating efficiency (ratio of revenue to total assets), profitability (ratio of net incomes to assets), liquidity (quick ratio), and firm size (natural logarithm of total assets) (Chalmeau, 2013). The system of equations estimated is as follows:

$$\beta_{it} = \gamma_0 + \gamma_1 COMP^{+}{}_{t} + \gamma_2 COMP^{-}{}_{t} + \gamma_3 PRICE^{+}{}_{t} + \gamma_4 PRICE^{-}{}_{t} + \gamma_5 QUAL^{+}{}_{t} + \gamma_6 c_{it} + e_{it} \quad (6)$$

Equation (6) shares the same variables as Equation (5) except for variable c_{it} which is a vector of firm-level controls. The parameter γ_6 detects changes in water companies' systematic risk due to their financial positions.

The Chinese water administrative systems are complex and suffer from fragmentation across ministries. According to the Organisation for Economic Co-operation and Development (OECD) (2009), the central and local governments can have different and sometimes conflicting goals. The sampled water firms are based in different provinces in China and are therefore governed by varying local water authorities. Given that the firms operate in diverging regulatory environments, it is important to examine whether the five types of announcement events have the same impact on the industry.

Therefore, in addition to the fixed effect panel regression analysis, the following regression is also estimated (Pescetto, 2008):

$$\beta_{it} = \eta_0 + \eta_1 COMP^{+}{}_{t} + \eta_2 COMP^{-}{}_{t} + \eta_3 PRICE^{+}{}_{t} + \eta_4 PRICE^{-}{}_{t} + \eta_5 QUAL^{+}{}_{t} + \eta_6 c_{it} + \kappa_{it} \quad (7)$$

where β_{it} is the systematic risk of company i in year t; the parameters $\eta_1, \ldots, \eta_5$ detect changes in each company's systematic risk due to particular types of regulatory announcements; η_6 is a vector of the coefficients of controlled variables; κ_{it} is a random error term. The regulatory announcement variables and controlled accounting variables are defined as above.

In the final step, we investigate the overall effect of regulatory changes on the industry's systematic risk and examine whether the buffering effect of regulation applies to the Chinese water industry. Instead of sorting the regulatory announcements into five groups of regulatory intervention events, we create a new dummy variable. When at least one regulatory event is made in a particular week, the dummy variable is considered to be one, and zero otherwise. Equation (8) below measures the overall impact of regulation on the systematic risk of the whole industry:

$$\beta_{it} = \chi_0 + \chi_1 ANNO_t + \chi_2 c_{it} + \theta_{it} \quad (8)$$

where β_{it} is the systematic risk of water company i in year t; $ANNO_t$ indicates the occurrence of a regulatory announcement; c_{it} represents the controlled accounting variables; θ_{it} is a random error term. This regression investigates the joint explanatory power of all kinds of regulatory announcements on the systematic risk of China's water industry. If regulatory change is a risk factor, the coefficient of the regulatory announcement variable should be significant after controlling for the accounting variables.

Data

Our study sample consists of 19 Chinese water companies (see Appendix A) that trade publicly on the Shanghai and Shenzhen Stock Exchanges. These companies provide direct water and sewage services to customers, and these services constitute their main source of revenue. As most of the water companies are conglomerates covering multiple segments of the water industry such as utilities, infrastructure, sewage, and water treatment, our sample serves as a good benchmark of China's water market.

We obtain panel data for all the 19 firms from DataStream covering the period from January 1, 2002 to December 31, 2013 (12-year period). We choose to use this sample period as China's water market was, in fact, not open to the private sector until 2002. Our sample contains weekly stock prices and various financial data on balance sheets. We use the MSCI China Index and the one-month China Interbank Offered Rate as estimates of market return and risk-free return, respectively. Any official news directly relating to regulatory changes in China's water industry is considered as regulatory announcements (see Appendix B for a distribution of announcements and Appendix C for representative samples). The six publishing regulatory bodies in China include State Council, the Ministry of Development and Reform Commission, the Ministry of Finance, Ministry of Water Resources, the Ministry of Environmental Protection, and the Ministry of Housing, Urban and Rural Construction. We collect publicly available information from each regulator's website.

Results

Exhibit 1 shows some descriptive statistics for the controlled accounting variables used in this study. The controlled accounting variables are financial leverage ratio, operating efficiency ratio, profitability ratio, liquidity ratio, and firm size. Table 2 shows that the mean of financial leverage ratio is 0.754, the maximum is 2.474 and the minimum is 0.000. The mean of operating efficiency ratio is -1.212, the maximum is 0.480 and the minimum is -7.264. The mean of profitability ratio is 2.438, the maximum is 11.068 and the minimum is 0.000. The mean of liquidity ratio is -0.425, the maximum is 2.366 and the minimum is -3.467. The mean of firm size is 5.437, the maximum is 9.559 and the minimum is 0.000. It is noted that the largest positive mean (5.437) is for firm size whereas the operating efficiency ratio has the lowest positive mean (-1.212).

Exhibit 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Financial leverage ratio	228	0.754	0.542	0.000	2.474
Operating efficiency ratio	228	-1.212	0.887	-7.264	0.480
Profitability ratio	228	2.438	1.398	0.000	11.068
Liquidity ratio	228	-0.425	0.854	-3.467	2.366
Firm size	228	5.437	2.145	0.000	9.559

Notes: This table reports the descriptive statistics of the five controlled accounting variables. These controlled variables are financial leverage ratio, operating efficiency ratio, profitability ratio, liquidity ratio, and firm size.

We estimate the effect of the five types of regulatory announcements on the systematic risk of China's water industry using Equation (5) and report the results in Exhibit 2. The results support our predictions that regulatory announcements that are expected to lead to decreased competition (COMP-), price change (PRICE+ and PRICE-), and increased quality of services (QUAL+) have significant impact on the industry's systematic risk. The significantly negative effect of COMP- suggests that when a regulator takes steps to reduce market competition, water companies are likely to gain greater power on the market which, in turn, results in higher price levels and profit margins. Subsequently, investors perceive reduced riskiness in the industry. As expected, the PRICE+ group of announcements has a significantly negative impact on perceived systematic risk. It makes intuitive sense that when policymakers encourage water companies to set higher prices, the companies would have more success in covering their costs and making profits, leading to a perception of low risk level within the industry. On the other hand, the significantly positive effect of PRICE- indicates that when water companies' ability to adjust their own pricing policy is restricted by the authorities, investors become skeptical of the companies' profitability and require high returns to compensate for the high risk level. The positive sign of the quality coefficient (QUAL+) means that the requirement to improve the quality threshold of services increases the industry's systematic risk. The water industry is extremely capital intensive. Improving the quality of services often involves large expenses in upgrading existing and/or investing in new tangible assets. This negatively affects returns and increases the riskiness of the companies.

Exhibit 2: The effects of competition, pricing, and quality of service announcements on China's water industry's systematic risk without the controlling variables

Regressor		Coefficient	*t*-value	Adj. R^2
Constant	γ_0	0.804	(67.22)**	0.52
$COMP^+$	γ_1	0.011	(0.88)	
COMP-	γ_2	-0.051	(-3.97)**	
$PRICE^+$	γ_3	-0.057	(-4.72)**	

Exhibit 2: continued

Regressor		Coefficient	t-value	Adj. R^2
$PRICE^-$	γ_4	0.032	(2.72)**	
$QUAL^+$	γ_5	0.035	(4.43)**	

Notes: ** indicates statistical significance at the 5% level. Robust standard errors are used in the calculation of t-values.

Though in the expected direction, the coefficient of increased competition ($COMP^+$) does not reach statistical significance at conventional levels. This may be due to three reasons. First, as the most capital-intensive infrastructure industry, the entry threshold to the water market is remarkably high. New entrants are faced with many challenges at both financial and political levels, while existing water firms are in a strong position to compete. New private investors have limited options in the ways that they participate in the water industry and are most likely to enter the market when public water companies are converted into joint stock companies (Pinsent Masons, 2004). The capital-intensive and monopolistic nature of the water industry means that the existing investors would not be too concerned about new players being invited into the water market due to governments' regulatory measures to enhance market competition. Hence, regulatory announcements that aim to increase competition may not be perceived by investors as damaging for the whole industry. Second, it is assumed that investors are typically more experienced with a competitive market than with a heavily regulated industry. Thus, they associate less uncertainty with regulatory announcements that promote market competition (Antoniou and Pescetto, 1997). Lastly, creating an open market and enhancing competition has been a theme underlying China's water privatisation. Regulatory announcements that emphasize market competition may be predictable or even expected by investors. Therefore, investors may be less sensitive to these announcements than to the other types of regulatory changes.

Following the method of Pescetto (2008), the results presented in Exhibit 2 only consider the effects of various types of regulatory announcements on the systematic risk of the water industry. However, in a real financial world, systematic risk is affected by other factors such as accounting variables; in fact, the accounting variables are commonly believed to be determinants of systematic risk (Chalmeau, 2013).

To better observe the effect of regulatory announcements, we control financial leverage, operating efficiency, profitability, liquidity, and firm size. As reported in Exhibit 3, three types of regulatory announcements — decreased competition ($COMP^-$), increased price ($PRICE^+$), and increased quality of services ($QUAL^+$) continue to show significant influence on the water industry's systematic risk, while the relationship between the increased competition ($COMP^+$) group of announcements and systematic risk remains insignificant. However, it is interesting that regulatory announcements demanding lower water prices ($PRICE^-$) no longer bear a significant association with systematic risk. This may be because water prices in China have been very low and are markedly below the operational costs (World Bank, 2007).

The water industry still heavily relies on government subsidies. It has been the regulators' priority to introduce more aggressive pricing mechanisms in order to encourage preservation of water and to generate revenue to invest in water infrastructure and environmental protection. It is noteworthy that the water prices have been rising in recent years and several government documents have been released to emphasise the necessity of this process (EU SME, 2013; OECD, 2009). Water investors interpret regulatory announcements that restrict higher profitability within this large political context and may not be particularly reactive to such news. Another possible explanation is that a low water price increases the barrier to entry, and this stabilises water companies' returns and reduces the associated uncertainty. Hence, investors would not be particularly threatened by regulations that require companies to keep water prices/revenue low.

Exhibit 3: The effects of competition, pricing, and quality of service announcements on China's water industry's systematic risk after controlling for accounting variables

Regressor		Coefficient	*t*-value	Adj. R^2
Constant	γ_0	-0.557	(-14.61)**	0.61
$COMP^+$	γ_1	0.011	(0.95)	
COMP-	γ_2	-0.025	(-2.03)**	
$PRICE^+$	γ_3	-0.043	(-4.12)**	
$PRICE^-$	γ_4	0.012	(1.15)	
$QUAL^+$	γ_5	0.020	(2.88)**	

Notes: **, * indicate statistical significance at the 5% and 10% levels, respectively. Robust standard errors are used in the calculation of *t*-values.

Overall, the results show that regulatory intervention efforts that aim to increase water prices ($PRICE^+$) and improve quality of water services ($QUAL^+$) significantly affect the industry's systematic risk at the 5 per cent level, whether or not we control for the accounting variables. It is theorised that these two types of regulatory announcements are mostly in accordance with the stated main priorities of the government — raising water prices for financially and environmentally sustainable water infrastructure and providing better water and wastewater services to consumers (OECD, 2009). Given the repeated and reinforced messages from the regulators, investors tend to believe that regulatory announcements that allow higher water prices would subsidise their high costs for operation, increase profit margins, and reduce systematic risk. Similarly, announcements that require improved quality of services may lead to the belief that operational costs would surge due to greater environmental and quality obligations, making the water industry more risky. Investors have been more inclined to react to regulatory announcements that are consistent with the momentum of water reforms. In other words, the effect of regulatory intervention measures may be moderated by investors' perception of the overall political environment.

Exhibit 4: The effects of competition, pricing, and quality of service announcements on the systematic risks of individual Chinese water companies

Regressor		β_1		β_2		β_3		β_4		β_5	
COMP+	η_1	0.081	(0.97)	-0.008	(-0.39)	-0.015	(-0.63)	-0.023	(-1.53)	0.070	(2.16)**
COMP-	η_2	0.019	(0.97)	-0.005	(-0.14)	0.037	(1.04)	0.041	(1.43)	-	-
PRICE+	η_3	-0.058	(-2.43)**	-0.043	(-1.54)	-0.036	(-1.65)*	-0.014	(-0.86)	-0.269	(-12.86)**
PRICE-	η_4	0.024	(0.56)	-0.003	(-0.27)	-0.003	(-0.12)	-0.007	(-0.47)	-0.007	(-0.24)
QUAL+	η_5	0.013	(0.45)	0.010	(0.80)	-0.009	(-0.40)	0.021	(2.60)**	0.006	(0.40)
		β_6		β_7		β_8		β_9		β_{10}	
COMP+	η_1	0.001	(0.09)	-0.013	(-0.81)	0.026	(1.73)*	0.071	(1.13)	0.001	(0.03)
COMP-	η_2	-0.040	(-1.67)*	0.018	(1.51)	-0.025	(-0.61)	-0.074	(-1.35)	-	-
PRICE+	η_3	-0.025	(-1.93)*	-0.015	(-0.93)	-0.079	(-2.61)**	-0.130	(-1.64)	-	-
PRICE-	η_4	-0.001	(-0.12)	-0.003	(-0.63)	0.033	(1.27)	0.070	(1.18)	0.062	(3.41)**
QUAL+	η_5	0.013	(2.07)**	0.002	(0.52)	0.023	(1.59)	0.067	(1.78) *	-0.026	(-1.44)
		β_{11}		β_{12}		β_{13}		β_{14}		β_{15}	
COMP+	η_1	0.016	(1.24)	0.003	(0.14)	0.005	(0.41)	0.034	(1.04)	-0.012	(-0.84)
COMP-	η_2	-0.036	(-0.99)	-0.006	(-0.32)	0.049	(1.46)	-0.039	(-1.45)	0.016	(0.90)
PRICE+	η_3	-0.029	(-2.34)**	-0.039	(-1.74)*	-0.038	(-2.18)**	-0.036	(-2.70)**	0.006	(0.47)
PRICE-	η_4	-0.005	(-0.49)	0.031	(2.00)**	0.029	(3.89)**	-0.026	(-2.18)**	-0.021	(-1.68)*
QUAL+	η_5	0.021	(1.84)*	0.005	(0.51)	-0.005	(-0.39)	0.015	(0.63)	0.037	(2.70)**
		β_{16}		β_{17}		β_{18}		β_{19}			
COMP+	η_1	-0.026	(-1.21)	-0.010	(-0.90)	-0.022	(-0.85)	-0.018	(-0.65)		
COMP-	η_2	-0.007	(-0.27)	0.013	(0.54)	-0.028	(-0.73)	-0.001	(-0.03)		
PRICE+	η_3	0.003	(0.09)	-0.026	(-1.85)*	-0.031	(-1.93)*	-0.038	(-1.49)		
PRICE-	η_4	0.018	(0.63)	0.014	(2.06)**	0.013	(0.74)	-0.014	(-0.59)		
QUAL+	η_5	0.003	(0.15)	0.013	(1.75)*	0.018	(1.28)	0.048	(2.23)**		

Notes: **, * indicate statistical significance at the 5% and 10% levels, respectively. Robust standard errors are used in the calculation of *t*-values. $\beta_1, \ldots, \beta_{19}$ denotes the systematic risk of Company Number 1 to 19. See Appendix A for a complete list of companies.

Exhibit 4 presents the results from testing the effects of competition, pricing, and quality of service announcements on the systematic risk of each water company. It can be seen that when we do not control the unique characteristics (fixed effects) of individual water companies as in the panel regression analyses, the regulatory announcements demonstrate mixed influences on the 19 sampled water companies. While announcements that are expected to decrease competition, increase water prices, and improve quality of services have a significant impact on the industry as a whole, this influence does not necessarily transfer to individual water companies. It is possible that due to the inconsistent and sometimes conflicting policies between central and local authorities (OECD, 2009), water companies are somewhat shielded from direct impact resulting from central policy changes. Moreover, Exhibit 4 shows that most companies are significantly affected by two or fewer types of regulatory announcements, suggesting that investors consider the water industry as a very stable market with little uncertainty. In conclusion, regulatory risk should be perceived more as an industry-wide issue, and individual water companies are not easily threatened or benefited by regulation changes. It is noted that our analysis of the systematic risk of each water company in China can be comparable with that of water utilities of Australia. Our results, therefore, can serve as a benchmark of regulators' methodology and equity beta values used by Australian jurisdictional regulators in regulating water utilities such as Sydney Water and Melbourne Water (Lewis and Zheng, 2018; NERA, 2011; Quach, Corcoran and Morrison, 2017).

Exhibit 5 provides insight into the regulatory intervention risk by revealing the overall impact of regulation on the industry's systematic risk. The coefficient of ANNO is found to be insignificant, suggesting that the regulatory announcements have no joint explanatory power on the systematic risk of China's water industry. Given our previous findings, this result is hardly surprising. The five types of regulatory announcement have shown diverging impacts on the industry's systematic risk. When we conduct an aggregated analysis, the effects naturally average each other out. Consistent with Antoniou and Pescetto (1997) and Pescetto (2008), we do not detect lower systematic risk being associated with regulation announcement events, failing to provide support to Peltzman's buffering effect theory.

Exhibit 5: The overall effect of regulatory announcements on China's water industry's systematic risk

Regressor	Coefficient	*t*-value	Adj. R^2
Constant	-0.575	(-15.11)**	0.61
ANNO	0.006	(1.17)	

Notes: ** indicates statistical significance at the 5% level. Robust standard errors are used in the calculation of *t*-values.

Conclusion

China has initiated a movement of water industry privatisation since the beginning of the 21st century. This has greatly shaped the landscape of China's water market. Being one of the three largest water markets in the world, China's private water sector serves the greatest number of consumers and is considered a global and regional driver. Within this context, regulatory scrutiny and intervention play increasingly important roles in the operation of water businesses and are recognized as determinants of the performance of the water industry. However, despite the urgent need for knowledge of regulatory risk in relation to China's water industry, no empirical effort has been made in this area. In fact, literature that explicitly examines the riskiness of water regulation in a global context is also scarce. In order to address this research gap, our paper explores the impact of regulatory announcements on the systematic risk of China's water industry.

Our study sample is composed of 19 companies whose primary revenue is generated by providing water and/or wastewater services in China. We analyse the industry's regulatory risk by regressing water companies' time-varying betas on different types of regulation announcement events. The results show that regulatory actions from China's central government do not have a significant impact on the systematic risk of the whole industry, failing to confirm Peltzman's buffering effect theory. However, the observation that regulatory announcements have no overall effect on the industry's systematic risk does not necessarily mean that the systematic risk is unaffected by regulatory efforts. The insignificant finding may be due to the effects of different types of regulatory announcements cancelling each other out. When we classify the regulatory announcements into five groups, we find that regulatory announcements that are expected to reduce market competition, increase water prices, and improve the quality of water services have a significant impact on the systematic risk of China's water industry with or without controlling for accounting variables. However, regulatory efforts to enhance market competition and reduce water prices do not have significant associations with systematic risk. These findings partially support our hypothesis that regulatory announcement events affect the water industry's systematic risk. They suggest that not all regulatory efforts can achieve the same effect on systematic risk. It is theorised that investors are not easily threatened by regulators' efforts to enhance market competition or reduce water prices, possibly due to the unique characteristics of the industry — namely, high capital intensity, significant barriers to entry, and a desperate shortage of operating funding. Investors tend to be more responsive to regulatory efforts that are designed to reduce market competition, increase water prices, and improve quality of water services perhaps because these announcements are more in line with the monopolistic nature of the industry and government's stated priorities of efficient water services and consumption. We therefore conclude that investors interpret regulatory announcements within a larger political environment and are more likely to perceive regulatory changes consistent with regulators' long-term objectives to be effective measures. Our further analyses reveal that most individual water companies are not significantly affected by regulatory changes. This means that although investors view certain types of regulatory changes as being effective on the industry's systematic risk, their effects may not be transferrable at a company level.

Our study has several implications. Though regulatory announcements in general do not affect water industry's systematic risk, policymakers need to be aware of the potential outcomes of their actions. Specifically, their attempts to decrease market competition and increase water prices would reduce the perceived riskiness of the water industry, while regulatory efforts to improve the quality threshold of water services make the industry appear of more risk to investors. Moreover, it is important to remember that regulatory changes that have an impact at the industry level may not have the same effect at an individual company level. As mentioned earlier, our research is the first to examine regulatory risk in a developing country's water industry, more research in this field is urgently needed. Future studies can investigate the underlying mechanisms of how regulatory changes affect individual companies, e.g. examining the role of local water authorities. Development of an overall index of regulation (such as the 'Polynomics Regulation Index 2012' for the telecommunication industry — a highly detailed measurement of regulation intensity) may alleviate some of the challenges in studying this highly defragmented industry.

References

Alexander, I., Estache, A. and Oliveri, A. (2000) 'A few things transport regulators should know about risk and the cost of capital', *Utilities Policy*, 9:1, pp. 1–13.

Alexander, I., Mayer, C. and Weeds, H. (1996) 'Regulatory structure and risk and infrastructure firms: An international comparison', *World Bank Policy Research Working Paper*.

Antoniou, A. and Pescetto, G. M. (1997) 'The effect of regulatory announcements on the cost of equity capital of British Telecom', *Journal of Business Finance and Accounting*, 24:1, pp.1–26.

Aubert, C. and Reynaud, A. (2005) 'The impact of regulation on cost efficiency: An empirical analysis of Wisconsin Water Utilities', *Journal of Productivity Analysis*, 23, pp. 383- 409.

Asia Society (2009) Asia's Next Challenge: Securing the Region's Water Future, https://asiasociety.org/files/pdf/WaterSecurityReport.pdf.

Barcelos, L. C. (2010) 'Essays on regulatory risk issues', Doctor of Public Administration, Getulio Vargas Foundation, Brazil.

Beaver, W., Kettler, P. and Scholes, M. (1970) 'The association between market determined and accounting determined risk measures', *Accounting review*, 45:4, pp. 654–682.

Beecher, J. (2009) 'Water pricing and the cost of service in the United States', paper prepared for OECD, Institute for Public Utilities, Michigan State University.

Beecher, J. G., Dreese, R. and Stanford, J.D. (1995) ‘Regulatory implications of water utility privatization’, The National Regulatory Research Institute, Columbus, OH, U.S.A.

Bianchi, R., Drew, M., and Walk, A. (2014) 'Is Infrastructure an Asset Class? An Asset Pricing Approach', CSIRO-MONASH Working Paper No 2014–11.

Binder, J. J. and Norton, S. W. (1999) 'Regulation, profit variability and beta', *Journal of Regulatory Economics*, 15:3, pp. 249–266.

Buckland, R., and P. Fraser (2000) 'Abnormal returns in the UK water industry since privatization', Working Paper No. 00-10, Aberdeen Papers in Accountancy, Finance and Management, University of Aberdeen, Scotland.

Buckland, R. and Fraser, P. (2001) 'Political and regulatory risk in water utilities: Beta sensitivity in the United Kingdom,' *Journal of Business Finance and Accounting*, 28:7–8, pp. 877–904.

Buckland, R., Williams, J. and Beecher, J. (2015) 'Risk and regulation in water utilities: A cross-country comparison of evidence from the CAPM', *Journal of Regulatory Economics*, 47:2, pp. 117–145.

Chalmeau, O. (2013) Determinants of European telecommunication operators systematic risk, Paper presented at the 24th European Regional Conference of the International Telecommunication Society, Florence, Italy, https://www.econstor.eu/dspace/bitstream/10419/88495/1/773115358.pdf

Chen, A. H. and Sanger, G. C. (1985) 'An analysis of the impact of regulatory change: The case of natural gas deregulation', *Financial Review*, 20:1, pp. 36–54.

Cooper, I. and Currie, D. (1999) The Cost of Capital for the UK Water Sector, Regulation Initiative Working Paper, Number 28, http://dx.doi.org/10.2139/ssrn.320761

Crew, M. A. and Kahlon, R. S. (2014) 'Guaranteed return regulation: a case study of regulation of water in California', *Journal of Regulatory Economics*, 46, pp. 112–121.

Davidson, W. N., Rangan, N. and Rosenstein, S. (1997) 'Regulation and systematic risk in the electric utility industry: A test of the buffering hypothesis', *Financial Review*, 32:1, pp. 163–184.

Dickinson, C. (2010) 'Water: source of life, source of returns', Structured Products, 7:1, pp. 20–22.

Dore, D., Peiyuan, G., Nette, A.-S. and An, J. (2010) *Water in China: Issues for responsible investors*, Responsible Research Pte Ltd, Singapore.

Ergas, H., Hornby, J., Little, I. and Small, J. (2001) 'Regulatory Risk', ACCC Regulation and Investment Conference, Manly, pp. 26–27, http://dx.doi.org/10.2139/ssrn.1928292

Ernst and Young (2008) Strategic Business Risk: 2008 the Top 10 Risks for Business, EYGM Limited, http://www.nws.com.hk/newsletter/RiskHorizon/issue1/doc/issue1/Ref%206%20Strategic%20Business%20Risk%202008%20the%20Top%2010%20Risks%20for%20Business.pdf.

European Small and Medium-sized Enterprises Center (EU SME) (2013) 'The Water Sector in China', Beijing.

Fraser, D. R. and Kannan, S. (1990) 'Deregulation and risk: Evidence from earnings forecasts and stock prices', *Financial Management*, 19:4, pp. 68–76.

Gaggero, A. A. (2012) 'Regulation And Risk: A Cross-Country Survey of Regulated Companies', *Bulletin of Economic Research*, 64:2, pp. 26–238.

Grayburn, J., Hern, R. and Lay, H. (2002) A report for the national audit office on regulatory risk, Pipes and Wires, National Audit Office, UK.

Grout, P. A. and Zalewska, A. (2006) 'The impact of regulation on market risk', *Journal of financial economics*, 80:1, pp. 149–184.

Hutterer, J. (2008) China's Water Market — Opportunities for Foreign Investors, China Aktuell, 2, pp. 157–177, http://www.grasshopperinvestments.com/downloads/67_Der_chinesische_Wassermarkt.pdf

Jamasb, T., Mota, R., Newbery, D. and Pollitt, M. (2005) 'Electricity sector reform in developing countries: A survey of empirical evidence on determinants and performance', Working paper, World Bank Policy Research, No. 3549.

Jin, Y., Li, B., Roca, E. and Wong, V. (2014) 'Investment returns in the water industry: A survey', *International Journal of Water*, 8:2, pp. 183–199.

Klein, M. (1996) 'Economic Regulation of Water Companies', Working Paper, World Bank Policy Research No.1649, http://documents.worldbank.org/curated/en/282871468766218628/pdf/multi-page.pdf.

Kobrin, S. J. (1979) 'Political risk : A review and reconsideration', *Journal of International Business Studies*, 10, pp. 67¬–80.

Lee, S. (2007) 'Private sector participation in the Shanghai water sector,' *Water Policy*, 9:4,

pp. 405–423.

Lewis, D. and Zheng, H. (2018) 'How could water markets like Australia's work in China?', *International Journal of Water Resources Development*, pp. 1–21, https://www.tandfonline.com/doi/pdf/10.1080/07900627.2018.1457514?needAccess=true

Logue, D. E. and Merville, L. J. (1972) 'Financial policy and market expectations', *Financial Management*, 1: 2, pp. 37–44.

MacGillivray, B. H., Hamilton, P. D., Strutt, J. E. and Pollard, S. J. T. (2006) 'Risk analysis strategies in the water utility sector: An inventory of applications for better and more credible decision making', *Critical Reviews in Environmental Science and Technology*, 36:2, pp. 85–139.

Morana, C., and Sawkins, J. W. (2000) 'Regulatory uncertainty and share price volatility: The English and Welsh water industry's periodic price review', *Journal of Regulatory Economics*, 17, 87-100.

Nickum, J. (2010) 'Water policy reform in China's fragmented hydraulic state: Focus on self-funded/managed irrigation and drainage districts', *Water Alternatives*, 3:3, pp. 537–551.

Norton, S. W. (1985) 'Regulation and systematic risk: The case of electric utilities', *Journal of Law and Economics*, 28:3, p. 671–686.

Nwaeze, E. T. (2000) 'Deregulation of the electric power industry: The earnings, risk, and return effects', *Journal of Regulatory Economics*, 17:1, pp. 49–67.

Olstein, M., Jennings J., Geist R., and King, R. (2009) Improving water utility capital efficiency, Water Research Foundation, http://www.waterrf.org/PublicReportLibrary/91257.pdf

Organisation for Economic Co-operation and Development (OECD) (2009) OECD reviews of regulatory reform: China 2009, France, Paris.

Paleari, S. and Redondi, R. (2005) 'Regulation effects on company beta components', *Bulletin of Economic Research*, 57:4, pp. 317–346.

Panayiotou, A. (2017) 'Infrastructure as a Financial Asset Class', doctoral thesis, University College London.

Peltzman, S. (1976) 'Toward a more general theory of regulation', *Journal of Law and Economics*, 19, pp. 211–246.

Pescetto, G. M. (2008) 'Regulation and systematic risk: The case of the water industry in England and Wales', *Applied Financial Economics*, 18:1, pp. 61–73.

Pinsent Masons. (2004) Pinsent Masons Water Yearbook 2004 – 2005, London.

Pinsent Masons. (2007) Pinsent Masons Water Yearbook 2007 – 2008, London.

Pinsent Masons. (2009) Pinsent Masons Water Yearbook 2009 – 2010, London.

Preqin (2011) Infrastructure Spotlight, http://docs.preqin.com/newsletters/inf/Infra_Spotlight_September_2011.pdf

PWC (2018) Investing in the ASEAN infrastructure asset class, Infrastructure Series Report 3, https://www.pwc.com/sg/en/publications/assets/cpi-report-3-infrastructure-asset-class.pdf.

Quach, B., Corcoran, A. and Morrison, S. (2017) 'A report for Icon Water: Equity beta for a benchmark Australian water network service provider', Icon Water, ACT.

Queensland Competition Authority (2011) Cost of Capital for Water Infrastructure Company, http://www.qca.org.au/getattachment/72db9205-0b2b-42d9-82bd-a41cab4b4775/NERA-Economic-Consulting-%E2%80%93-Final-Report-Weighted-A.aspx.

Regan, M., Smith, J. and Love, P. (2011) 'Infrastructure Procurement: Learning from private-public partnership experiences 'down under'', *Environment and Planning C: Government and Policy*, 29:2, pp. 363–378.

Rothballer, C. (2012) 'Infrastructure investment characteristics: Risk, regulation, and inflation hedging', Doctor of Economics, Technische Universitat Munchen.

Rothballer, C. and Kaserer, C. (2012) 'The risk profile of infrastructure investments: Challenging conventional wisdom', *Journal of Structured Finance*, 18:2, pp. 95¬–109.

Savenije, H. H. G. (2002) 'Why water is not an ordinary economic good, or why the girl is special.', *Physics and Chemistry of the Earth*, Parts A/B/C, 27:11–22, pp. 741–744.

Sawkins, J. W. (1996) 'Balancing Multiple Interests in Regulation: An Event Study of the English and Welsh Water Industry', *Journal of Regulatory Economics*, 9:3, pp. 249–268.

Schouten, M. and Schwartz, K. (2006) 'Water as a political good: Implications for investments' *International Environmental Agreements: Politics, Law and Economics*, 6:4, pp. 407–421.

Sidak, J. G. and Ingraham, A. T. (2003) 'Mandatory unbundling, UNE-P, and the cost of equity: Does TELRIC pricing increase risk for incumbent local exchange carriers?' *Yale Journal on Regulation*, 20, pp. 389–406.

Sullivan, C., Cohen, A, Jean-Marc Faurès, J. and Santini, G. (2008) 'The Rural Water Livelihoods Index', FAO Working Paper.

United Nations Environment Programme Finance Initiative (2006) Financing water: Risks and opportunities, United Nations Environment Programme Finance Initiative, http://www.unepfi.org/fileadmin/documents/WRR_Issues_Paper.pdf.

World Bank (2007) Water Supply Pricing In China: Economic Efficiency, Environment, and Social Affordability, http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/PolicyNoteWaterpricingandaffordabilityFINALEN.pdf.

Appendix A

List of water companies

	Company	Timespan	Beta
No. 1	Anhui Grotong Hi-Tech Pipes Industry	2004 - 2013	0.649
No. 2	Anhui Water Resources	2003 - 2013	0.904
No. 3	Beijing Capital	2002 - 2013	0.872
No. 4	China Gezhouba Group	2002 - 2013	0.748
No. 5	Chongqing Water Group	2010 -2013	0.903
No. 6	Fujian Zhangzhou Development	2002 -2013	0.820
No. 7	Grandblue Environment	2002 - 2013	0.606
No. 8	Guangdong Golden Dragon Development	2002 - 2013	0.896
No. 9	Heilongjiang Interchina Water Treatment	2002 - 2013	0.233
No. 10	Jiangsu Jiangnan Water	2011 - 2013	0.543
No. 11	Jiangxi Hongcheng Waterworks	2004 - 2013	0.780
No. 12	Qianjiang Water Resources	2002 - 2013	0.859
No. 13	Shanghai Chengtou Holding	2002 - 2013	0.782
No. 14	Sichuan Guangan AAA Public	2004 - 2013	0.792
No. 15	Sound Environmental Resources	2002 - 2013	0.634
No. 16	Tianjin Capital Environmental Protection Group	2002 - 2013	0.820
No. 17	Wuhan Sanzhen Industry Holding	2002 - 2013	0.797
No. 18	Xinjiang Urban Construction Group	2003 - 2013	0.894
No. 19	Zhongshan Public Utilities Group	2002 - 2013	1.029

Notes: Beta is a constant figure calculated from Equation (1) $R_{it} = R_{ft} + \beta_i (R_{mt} - R_{ft}) + \varepsilon_{it}$. Ordinary Least Squares estimation is used.

Appendix B

Frequency distribution table of the five types of regulatory announcements made by China's central water regulators: January 2002 – December 2013

Year	COMP^{+}	COMP^{-}	PRICE^{+}	PRICE^{-}	QUAL^{+}	Total
2002	1	2	3	-	-	6
2003	-	1	1	-	-	2
2004	2	-	-	-	-	2
2005	2	-	-	-	5	7
2006	2	1	1	1	3	8
2007	-	-	2	-	-	2
2008	-	2	2	-	-	4
2009	-	-	3	-	1	4
2010	1	-	1	2	-	4
2011	3	-	-	2	3	8
2012	1	-	-	-	4	5
2013	1	-	-	1	2	4
Total	13	6	13	6	18	56

Notes: COMP^{+} denotes announcements that are expected to have a positive effect on competition; COMP^{-} denotes announcements that are expected to have a negative effect on competition; PRICE^{+} denotes announcements that are expected to have a positive effect on prices; PRICE^{-} denotes announcements that are expected to have a positive effect on prices; and QUAL^{+} denotes announcements that are expected to have a negative effect on quality.

Appendix C

Samples of regulatory announcements made by China's central water regulators: January 2002 – December 2013

1.	Announcements that are expected to have a positive effect on competition (COMP+)
	May 19, 2009 (State Council). Fasten the reform of public utility services; expand the scope of business permits for water and wastewater services.
	January 01, 2011 (State Council). Attract private funds by encouraging municipal-owned companies to invest in the water industry directly and indirectly.
2.	Announcements that are expected to have a negative effect on competition (COMP-)
	December 10, 2006 (Ministry of Water Resources). Water projects must be supervised and permitted by the Ministry of Water Resources and local water authorities.
	April 9, 2008 (Ministry of Water Resources). The supply of water for any projects must be approved and implemented by relevant government bodies.
3.	Announcements that are expected to have a positive effect on prices (PRICE+)
	April 19, 2010 (Ministry of Development and Reform Commission). Develop a sustainable pricing mechanism by implementing hierarchical water prices.
	August 31, 2011 (State Council). Promote hierarchical water prices; include additional wastewater costs in water tariff.
4.	Announcements that are expected to have a positive effect on prices (PRICE-)
	May 28, 2011 (State Council). Set reasonable water prices in the development of water grids in rural areas.
	January 7, 2013 (Ministry of Development and Reform Commission and Ministry of Water Resources). Carefully and fully consider local economic development and consumers' ability to pay when setting water prices.
5.	Announcements that are expected to have a negative effect on quality (QUAL+)
	May 28, 2012 (Ministry of Housing, Urban, and Rural Construction). Apply stricter criteria to drinking water quality; drive higher standards; use more advanced technologies in drinking water treatment.
	October 2, 2013 (State Council). Apply stricter standards in wastewater management; increase investments in the processing of wastewater.