AUSTRALIAN WATER EQUITIES: THE UNDERLYING FACTORS DRIVING RETURNS AND PROPERTIES AS DIVERSIFIERS

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ABSTRACT

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Abstract

Water is a renewable but scarce economic resource that affects all economic activities, from urban water consumption to industrial production and agriculture. The sufficiency of the world's water resources is threatened by population growth, urbanization and rising living standards, as well as drought caused by climate change. Under the cross pressure of these factors, Australia, one of the world's driest continents, has solved the water allocation problem by creating the world's most advanced water market. This Master's Thesis presents the Australian water industry and its special features and previous research literature with results. In the empirical part of the thesis, the returns of 11 companies operating in the Australian water market, the factors affecting returns and the possible diversification benefits of the shares were investigated in the review period from January 2000 to August 2022. The data included daily and monthly prices of shares and benchmark indices taken from Refinitiv DataStream. The study was carried out with linear regression using explanatory factors from previous research literature and previously unused rainfall and temperature variables. The diversification benefit of water shares was studied by comparing the expected returns and standard deviations of the market index and the investment portfolio expanded with water shares. The effect of climate change media attention and narratives on returns was investigated using ASVI data from Google search terms as a control variable. From the regression results, it was found that water industry stocks are weakly correlated with the market. Also, no correlation was found between the weather variables or the Google search terms used and the revenues of the water companies. Due to the weak market correlation, water stocks offer a diversification benefit by increasing expected returns and reducing portfolio risk.

Key words
Water economy, water investing, water resources

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TIIVISTELMÄ

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Työn nimi
Australian vesiosakkeet: Tuottojen ajurit ja piilevät tekijät hajautuksen mahdollistajina

Oppiaine
Taloustiede

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Pro Gradu -tutkielma

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84

Tiivistelmä

Vesi on uusiutuva mutta niukka taloudellinen resurssi, joka vaikuttaa kaikkeen taloudelliseen toimintaan urbaanista vedenkulutuksesta teolliseen tuotantoon ja maanviljelykseen. Maailman vesivarojen riittävyyttä uhkaa väestön kasvu, urbanisoituminen ja elintason nousu sekä ilmastonmuutoksen aiheuttama kuivuus. Näiden tekijöiden ristipaineessa Australia yhtenä maailman kuivimmista manteresta on ratkaissut veden allokointiongelman luomalla maailman kehittyneimmät vesimarkkinat. Tämä Pro Gradu -tutkielma esittelee Australian vesiteollisuuden ja sen erityispiirteet sekä aiemman tutkimuskirjallisuuden tuloksineen. Tutkielman empiirisessä osuudessa tutkittiin 11 Australian vesimarkkinoilla toimivan yrityksien tuottoja, tuottoihin vaikuttavia tekijöitä ja osakkeiden mahdollisia hajautushyötyjä tarkastelujaksolla tammikuusta 2000 elokuuhun 2022. Aineisto sisälsi Refinitiv DataStreamista noudetut osakkeiden ja verrokki indeksien päivittäiset ja kuukausittaiset hinnat. Tutkimus toteutettiin lineaarisella regressiolla käyttäen aiemman tutkimuskirjallisuuden selittäviä tekijöitä sekä aiemmin käyttämättömiä sade- ja lämpötilamuuttujia. Vesiosakkeiden hajautushyötyä tutkittiin vertaamalla markkinaindeksin ja vesiosakkeilla laajennetun sijoitusportfolion odotettuja tuottoja ja keskihajontoja. Ilmastonmuutoksen mediahuomion ja narratiivien vaikutusta tuottoihin tutkittiin käyttämällä Googlen hakusanojen ASVI dataa kontrollimuuttujana. Regressiotuloksista havaittiin, että vesiteollisuusosakkeet korreloivat heikosti markkinoiden kanssa. Myöskään säämuuttujien tai käytettyjen Google hakusanojen ja vesiyhtiöiden tuottojen välillä ei löydetty korrelaatiota. Heikon markkinakorrelaation vuoksi vesiosakkeet tarjoavat hajautushyötyä nostamalla odotettuja tuottoja ja vähentämällä salkun riskisyyttä.

Asiasanat
Vesitalous, vesisijoittaminen, vesiresurssit

Säilytyspaikka
Jyväskylän Yliopiston kirjasto

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1 INTRODUCTION

Water is a vital component of all life on Earth, covering over 70% of the planet's surface. However, less than 1% of this water is fresh water and only 0.007 % is located on rivers, lakes and underground aquifers suitable for human consumption and other purposes. Moreover, global water resources are unevenly distributed with over 60% of world's population having access to less than 30% of all available water. Several regions across Asia, parts of Europe, much of Africa and South America experience severe water distribution issues due to depreciating infrastructure or lack thereof. As the global megatrends such as climate change, population growth, urbanisation and growing living standards continue to impact the global water resources and availability, an estimated 2.6 billion people do not have an access to clean drinking water and, 3 billion people lack access to water, sanitation and hygiene (WaSH) services. Many projections by United Nations suggest that the number of people without safe drinking water will increase from 2.6 billion up to 3.9 billion by 2030, indicating that nearly half of the world population will be lacking safe drinking water. Water scarcity and shortages can impact on communities and lead to social and political instability within countries, geopolitical conflicts in between countries as well as to irreparable environmental damage.

Water-related problems are also strongly connected to two industries, agriculture and energy sector, which are fundamental for human survival. The soaring population and economic growth have led to water scarcity and shortages due increased demand for energy, agricultural products and a shift in consumption patterns towards meat and dairy based diets requiring irrigation in farming. The current demand for water surpasses the sustainable planetary boundaries of both conventional water sources of surface water extractions and non-conventional water resources like water reuse and desalination, and in many areas the growing gap in demand and supply is being bridged with groundwater extraction which only worsen the recharge of surface waters.

The global water industry is among the three biggest industry sectors in the world with the oil and gas and electrical power sectors measured in embedded capital. Water is not essential only for human survival but also for agriculture and technology manufacturing. From all global water consumption, agriculture consumes around 70%, with industrial production using 20% and domestic consumption using around 10%. The agricultural sector faces the pressure to meet the growing demand of food by growing world population. In agriculture, most of the consumed water is used for irrigation, livestock and dairy production and non-food production and water consumption is projected to increase as global diets change. Another substantial diver for agricultural water consumption is alternative uses of agricultural products for biofuels. The energy sector is the second largest water consumer, with water used for generating hydroelectricity, thermal power plant cooling, biofuel production, gas extraction and in fracking to produce shale gas. The global warming and changes in policies have shifted the energy sector towards alternative energy sources away from fossil fuels towards more carbon-neutral energy sources. This sift puts on pressure on water resources since biofuel farming, fracking and shale gas production requires large amounts of water and fracking may lead to contamination of surrounding ground because the water used for fracking contains a heavy load of chemical additives.

In a survey composed to companies included in the FTSE Global Equity Index Series, two-thirds of the companies surveyed replied considering water a significant risk factor in their business models and value chains. The Global Risk Report has identified water as a major source of risk for businesses in five consecutive years. The growing imbalance between water consumption and supply must be addressed, and significant investments are required to meet the challenges. Globally, up to $22 trillion of investments are needed in the water industry to meet the global water demand, and the Environmental Protection Agency (EPA) estimates that in United States alone, around $400 billion of investments in water infrastructure are required over the next 20 years to secure safe drinking water. An additional $384 billion will be needed by 2030 to upgrade existing water treatment utilities, infrastructure and distribution networks.

Within the last thirty years, private companies have participated in funding water utilities, infrastructure, and treatment services but the overall global participation rate is fairly low at 19%, while the rest 81% have remained government-owned utilities. Considering the tremendous need for finance in water industry, the public sector alone may not be able to finance all the required investments even in the industrialised countries. The water sector has a strong growth potential and there is a substantial need for private investments in the sector to address the imbalance between demand and supply and to provide the needed infrastructure, services and products to optimise the water use between sectors and to allocate the water resources to economically most profitable use.

Until very recent years, water and water-related services have been taken for granted in most industrialised countries and water and sanitation related challenges have been perceived mainly as a problem of developing countries. Despite being abundant, the growing stress on this precious and scarce resource due to climate change, population growth, urbanization, and aging infrastructure means that access to water has become increasingly challenging even in industrialised countries. The resource must be allocated efficiently between competing sectors while securing reliable and sufficient availability of water for people as a human right is addressed by the Sustainable Development Goals (SDGs) agreed by the United Nations in 2015 and to secure that sufficient amount of water is left in nature for natural services to function. To achieve this, Australia as the world's driest continents with high variations in rainfall and water resources, has faced all these challenges described above head-on and has developed an innovative solution in the form of a highly efficient water trading market. This market uses market mechanism determine the price of water and allocate it to most economically productive use, while taking into account the scarcity of water, its environmental impact and human right aspects.

While previous academic studies on the performance of the water industry have focused on the financial performance of markets in the United States, United Kingdom, or performance in globally, fewer studies have specifically focused on other individual countries. It is important to acknowledge that even though the challenges are global, the solutions must be found and executed locally. Additionally, while many of the existing studies have identified global warming as a significant driver of the water sector, few have incorporated this factor in their financial analysis as a variable. This study aims to introduce the key characteristics and drivers of the global water industry, with a focus on the Australian water market. The study will also aim to fill the gap in research literature and to examine the historical returns of Australian water companies in relation to the overall market and incorporate climate variables into the financial analysis to explore the impact of climate variability on the performance of the Australian water industry. Purpose is to see if variations in local climate patters are reflected in the returns of water sector. The study will also incorporate ASVI keyword search data into analysis to study whether the growing public awareness of climate change has influenced in the investor behaviour. Finally, the diversification value of Australian water companies is analysed.

The research questions are studied with linear regression model that is gradually extended with explanatory variables derived from existing literature and finally augmented with temperature and rain variables to capture the climate variability in Australia. The surprising key results are that none of the explanatory variables of overall market, energy sector, agriculture or climate variables turn out to be systemically and consistently statistically significant in explaining the excess returns of the selected water companies. The results are to some extent contradicting the previous literature. The low correlation with overall markets in linear regression suggest that investor may receive diversification benefit by investing in water sector. This is tested by forming portfolios with ASX:200 index representing the overall Australian market and selected water companies and selecting either the level o wanted risk or return. The results from diversification analysis confirm the impression from linear regression and investor can receive higher returns with lower risk by diversifying their portfolio with water stocks. This finding aligns with findings from previous literature. Finally, it is found that the keyword search data does not have explanatory power in explaining the returns of water stocks, indicating that even though climate change is gaining more media exposure, the water sector may still be somewhat unfamiliar to great audience.

The remainder of this study proceeds as follows. Chapter 2 introduces the general characteristics of global water sector and water as an economic good. Chapter 3 introduces the Australian water industry and the developed water markets. Chapter 4 provide a literature overview for existing literature regarding the investment opportunities in water sector and the historical returns. Chapter 5 introduce data and methods used in analysis and chapters 6 and 7 provide results from the analysis and discussion regarding the results.

2 WATER INDUSTRY

Water is an essential resource for life and economic activity, but it is finite and unevenly distributed around the world. As a result, the efficient use and management of water resources is crucial. This chapter explores the economic value of water as a resource and the global availability of water. It also examines some aspects of water pricing and the role it plays in economic value chains.

2.1 Global Water Resources

The total volume of global water reserves is estimated to be around 1 386 million km3, with 96.5% of this being saltwater located in the oceans. Only 35 million km3 or 2.5% of all water is freshwater, with 68.7% of this being in Arctic and Antarctic glaciers, and one-third being located in aquifers underground. Only 0.26% of fresh water is found in lakes and rivers, which is the main source for human water abstraction. (Meran, et al., 2021.)

In addition to conventional water sources in rivers, lakes and underground water bodies, alternative sources such as re-using treated municipal wastewater, agricultural drainage water, and desalination also exist. Desalination is a process of removing salt and other minerals from seawater to make it potable. There are approximately 16,000 operational desalination plants worldwide, producing 35 km3 of water, while other municipal reuse of treated water accounts for 380 km3 of water (UN, 2020)

Desalination, in particular, is receiving increasing attention as a source of water for water-scarce areas, although it is energy-intensive and can consume up to 23 times more energy than conventional water sources and cost four to five times more than surface water abstraction. (World Bank, 2016)

2.2 Water as an Economic Commodity

Economic theory classifies environmental goods and the services they provide into four categories: private goods, open-access resources, club goods, and public goods. These resources can further be categorized based on their rivalness and exclusiveness. (Meran, et al., 2021.)
Private goods, such as oil and gas, are characterized by rivalness meaning the consumers compete with each other to use the commodity and the ability to exclude access through property rights. Open-access resources, such as deep-sea fisheries, are shared and consumed competitively but cannot be excluded by property rights. Club goods, such as swimming baths, national parks, and golf club lanes, are paid for but do not reduce the opportunity for others to consume them. Public goods, are defined by the absence of rivalness and exclusion and thus cannot be consumed in rivalry and nobody can be excluded from using them. (Meran, et al., 2021.)

Water is typically considered a public good and a common-pool resource that provides open access to all, but with the common-pool approach comes the risk of overuse and exploitation known as the tragedy-of-the-commons. With common-pool resources and without an exclusion, all users can use the resource in their benefit while costs are distributed, often unevenly, to all users. (UN, 2021).

As an economic resource, as well as the common good, water is in unusual position compared to other resources due to the fact that the United Nations General Assembly declared water as a basic human right in Resolution 64/292 (2010). This creates a balance between ensuring adequate access to safe and drinking water at an affordable price for all, and sustaining the resource to prevent its overuse. (UN, 2010).

The main difference of water to other economic goods is the need to manage the water cycle in sustainable way and prevent overextrapolation of the resource. The scarcity of water resources is often the result of political decisions to prevent over-exploitation, rather than a scarcity of supply. (Meran, et al., 2021) Water is also subject to fluctuating regulations, such as trade and consumption restrictions during droughts. (BoM, 2021b).

Another distinction of water as economic good to other resources is the substantial need for infrastructure such as damns, treatment plants and pipes to be built in order to distribute the water as well as adequate infrastructure for sanitation and water purification. These resources are usually both excludable and rivalrous private goods with a price and potentially inaccessible to those in financial disadvantage. At the same time, there are also publicly owned water services, such as flood protection, that are non-rivalrous and non-excludable that cannot be priced. (UN, 2021)

In addition to its economic value, water and the environment provide other benefits that go beyond just economics. These values are traditionally measured and categorised based on the benefits they deliver to people. Water-related ecosystem services include water supply and purification, flood regulation, nutrient recycling, pollution absorption, sediment transport, coastal storm protection, and water erosion control and climate regulation. In addition, ecosystems and ecosystem services are dependent on the hydrological cycle and without it, other ecosystems would cease to function. However, water-related services (or ecosystem services in broader) are not often separated into their own category or distinct bundle of services in most economic studies and assessments, making it difficult to accurately quantify their overall value in monetary terms or otherwise. Thus, the estimations of the overall value of ecosystems vary greatly depending on the valuation method used, location where the assessment is done and in what kind of categories and clusters the ecosystem services are divided. (UN, 2021)

2.3 Global Water Consumption by Sectors

The estimates of total water consumption between different sectors vary from country to country but on average, the global consumption of water is distributed among three main sectors: agriculture (69%), industry (19%) (including energy and power generation), and municipalities (12%). (FAO, 2011) On the supply side, 81% of fresh water and wastewater treatment services are provided by government-owned authorities or public organizations, while only 19% are provided by private operators. Of these, only 10% are listed and publicly traded on stock markets. The water industry is fairly concentrated, with around 2,000 leading companies owning 55% of the global market, and the remaining 45% distributed among over 30,000 small and local operators. (Roca, et al., 2015.)

Since the agriculture is the biggest consumer of water, the market value of water is largely influenced by the relative profitability of agricultural activities and competition of agricultural activities that require irrigation, particularly the demand for high-value crops such as cotton or almonds. The relative profitability of agricultural goods is affected by factors such as the market price of the goods and geographical factors such as local weather patterns, soil fertility, and the water intensity of the crops. Increase in demand for high value crops that require a lot of irrigation, such as cotton or almonds, can drive the water price up. (BoM, 2021b)

In the energy and industrial sectors, water is both a resource for withdrawal and a source of consumption costs, which are determined by market prices and liabilities related to legislative obligations to water treatment costs under the risk of penalties. This leads to water being perceived primarily as a cost or risk, rather than a valuable asset. A study by the WWF and IFC (2015) found that businesses tend to focus on water-related operational costs and short-term impacts on revenue, the admiratives costs associated with water and the financial risks it carries, ignoring the value of water, the advantages associated with it and the potential for future innovation and growth. (WWF / IFC, 2015)

2.4 Water Pricing and Valuation

Water needs and management challenges vary greatly based on the income level of the country. Low-income countries in Africa face different challenges than high-income, urbanized countries such as Australia or the United States. For example, in low-income countries, the main challenge may be the lack of infrastructure, while in high-income countries, the focus may be on financing the maintenance of existing infrastructure. This means that water pricing policies must also differ based on the problems that need to be addressed.

In lower-income countries, the primary goal should be to ensure access to clean and safe water and sanitation services at an affordable price, while taking environmental considerations into account. In wealthier countries, the focus should be on preserving scarce resources and pricing policies that reflect the true economic value of water and allocate it to the most productive use. (UN, 2021)

The principles of valuing and pricing water are primarily based on economic principles. Traditional economic accounting tends to value water in the same way as other products, by using the recorded price or cost of production and distribution when an economic transaction takes place. However, this model often reflects the costs of recovery and distribution only, but fails to reflect the value delivered to the consumer and leads to under-pricing of water (UNDESA, 2012).

One example of the failure to price water correctly is seen in the World Bank's findings. According to the World Bank, global agricultural consumption accounts for 69% of all water consumption, but only contributes around 4% to global Gross Domestic Product (GDP). This suggests that the water used in agriculture has a very low value added to the global GDP and that a more efficient allocation of water could increase the global GDP significantly. (UN, 2021)

Accurately pricing water is challenging compared to other natural resources due to its unique characteristics. Water consumption is heavily regulated, both in terms of water quality and abstraction. Additionally, water pricing is difficult because in many cases, there are no free, competitive, and efficient markets to determine the price, as water processing, storage, and distribution is often controlled by monopolies. Furthermore, accurate water accounting is challenging due to losses in distribution (e.g., pipeline leakages) and large amounts of water being abstracted without any record of abstraction. (UNDESA, 2012)

2.4.1 Volumetric Pricing

Water pricing and financing infrastructure can be divided into three main categories: tariffs, taxes, and transfers. Tariffs are fees charged to users that generally increase with the amount of water used.

Tariffs may aim to recover the full cost of service provision, depreciation of the infrastructure, and profitability of invested capital, or just a portion of these costs. Any costs not covered by tariffs must be funded through taxes, transfers, or a combination of both. Domestic and industrial tariffs often include both a fixed fee and a variable fee based on factors such as volumetric consumption, which may increase with the amount of water consumed. Water tariffs for irrigation may include a volumetric fee, but they are often based on the crops produced or the size of the land under irrigation in hectares. (Andres, et al., 2019.)

The simplest form of monetary valuation of water is volumetric pricing, which calculates the price per cubic meter multiplied by the volume of water consumed, along with the costs of treatment and disposal of wastewater. Unfortunately, water consumption worldwide is often subsidized, ranging from 5% to 90%, leading to artificially low prices and inefficient water use. (McKinsey & Company, 2011)

2.4.2 Increasing Block Tariff

The Increasing Block Tariff (IBT) is seen as a potential solution to address the challenge of balancing water access for low-income households, environmental sustainability, and efficient use of water resources. In IBT, the water tariff starts low for the first unit consumed and increases with each subsequent unit, making the first unit of water more affordable for low-income households. The popularity of IBT relies on the assumption that low-income households consume less water than high-income households and low tariffs makes the water affordable for low-income households while more water consuming customers charged with higher prices subsidies the lower consumers. A survey conducted by Global Water Intelligence (GWI) and a study of the International Benchmarking Network for Water and Sanitation Utilities (IBNet) Tariff Database found that roughly half of registered global utilities use IBT pricing. The second most commonly used pricing method is uniform volumetric pricing, where the price is the same for all units consumed. (UN, 2021)

2.4.3 Other Methods for Pricing Water

Besides volumetric pricing and increasing block tariff, other methods of water pricing exist, each with its own focus and objectives. One such method is the Residual Value of Water, which calculates the difference between the value of the output produced and the costs of all non-water inputs to production. Another method is the Replacement Cost, which calculates the amount that an economic actor would have to pay to replace a current asset at its current worth. For example, the cost of replacing piped water to a household by delivering the same amount of water in bottled form. This method is commonly used when estimating the value of ecosystem services. The Contingent Valuation Model, which asks consumers of a particular good how much they would be willing to pay for that good, is also used. This method is particularly useful when determining the value of ecosystems and the services they provide in the absence of clear market prices, such as good water quality or biodiversity. Demand functions, which use econometric analysis to calculate the total economic value of abstracted water, also exist, but the challenge of this approach is that demand functions are difficult, if not impossible, to obtain. Lastly, tradable water rights attempt to create a functioning market environment to derive the value of water. (UN, 2021)

2.4.4 Non-monetary Valuation

Most methods used to value water and its services rely on a cost-benefit approach that focuses on financial costs, such as cash flows, capital, operational expenses, and cost recovery, and do not reflect the value delivered. The economic approach to water pricing has a tendency to overestimate the benefits while underestimating the costs, particularly in the form of indirect costs and environmental harm that are treated as externalities. In most pricing schemes worldwide, full cost recovery is the exception rather than the rule. (UN, 2021)

Water services and the environment contain values and services that cannot or should not be quantified in monetary terms. In economic studies, other dimensions of valuing water are often overlooked or not quantified, such as ecosystem services and biodiversity that support ecosystems and reduce risks. These values can be calculated and expressed in monetary terms, but they are often not recognized, leading to inadequate economic planning and a focus on short-term gains at the cost of long-term sustainability. (UN, 2021)

Adequate water pricing can help users understand the value of water and improve water use efficiency. Different goals, such as efficient use, cost recovery, and reallocation of water use, can be achieved by implementing different pricing policies, such as volumetric pricing, tradable water rights, and non-volumetric pricing. (Davidson, et al., 2019.)

3 WATER INDUSTRY IN AUSTRALIA

The Australian water market and service sector are dominated by the public sector, with 196 companies employing 27,000 people, delivering water and wastewater services to almost 20 million people daily. However, private sector participation has increased in recent years, with examples such as Sydney Water outsourcing 90% of its capital expenditure and 70% of operating expenditure to private operators. (Infrastructure Australia, 2019)

To establish efficient water markets where trading can take place and consumers and service providers can be well informed, sufficient market structures must exist. In Australia, national water issues are under the Bureau of Meteorology (BoM), which is responsible for tracking and providing data on climate trends and water issues dating back to year 1900 with subject of strict quality control. The data is available to all consumers and researchers. (BoM, 2021a) There are also 44 organizations across Australia providing data on water rights, allocation shares, and trade between legal entities, which are gathered by the BoM and standardized for easy comparison. (BoM, 2021b).

Water infrastructure in Australia is divided into urban and productive components. The urban components include household drinking water, wastewater services, stormwater management, and integrated services like water recycling, desalination and bulk water services on rural areas. The productive components include infrastructure for water storage, delivery, and metering, as well as water markets, provision licensing, and the allocation and trade of water from sources to consumers. The Australian water market can also be divided into major urban and rural areas. In rural areas, consumers rely strongly on localised systems such as local reservoirs, discrete rural water bores, septic tanks, and pumping stations. (Infrastructure Australia, 2019)

The performance of the Australian water industry is heavily influenced by climatic variations, such as annual rainfall and temperature, sources of water, the infrastructure characteristics such as the size of utilities, network density, the age and condition of the existing infrastructure as well as government policies and regulations. Droughts and prolonged periods of low rainfall can cause stress on water supply systems and lead to activation of alternative water sources such as desalination, ground water abstraction and water recycling. Water restrictions may be imposed in areas where subsiding is not possible. The alternative water sources like desalination and recycling have a significant impact operational cost due to the different operational costs of different sources of water. (BoM, 2021c).

Water pricing in Australia is considered affordable, but restrictions in pricing have caused water to be undervalued, resulting in a lack of investment and frugal water consumption among consumers. For various reasons, governments and policymakers have been reluctant to embrace the needed reforms to properly reflect the value of the water delivered and the costs to meet the current and future investment needs. More accurate water pricing would encourage operating efficiency, facilitate investments and support the participation of the private sector. It is estimated that water bills could rise by 50% in 10 years and double by 2040 without proper reforms to reflect the value of water delivered and investment needs. (Infrastructure Australia, 2019)

Residential water bills are typically utility specific combination of fixed charges and charges based on the average annual volumetric residential consumption, set by the government, regulatory body, or city council. The typical residential bill for water and sewage treatment covers only operating costs, not repair costs, and varies based on the size of the utility, customer base, available sources of water, density of the customer base and geographical location, among other factors. (BoM, 2021c).

The historical water bill pricing models have varied between regions, but majority of service providers have adopted a water pricing model with a fixed price component and a consumption-based component. The national median operating cost per property in the financial year 2019-20 was $974 for water and wastewater services covering only the operating costs. The combined operating cost of water and sewage services per property for periods of 2015-16 to 2019-20 varied between $537 in Adelaide and $1198 in Darwin. (BoM, 2021c)

3.1 Australia's Water Market and Trading

In Australia, water consumption and trading are measured using various units. At the consumer level, water consumption is typically measured in kilolitres (KL), which is equivalent to 1,000 litres of water or one cubic meter. At the national level, water consumption and trade are measured in megalitres (ML), which is equivalent to one million litres of water. When aggregated at the regional or national level, water is measured in gigalitres (GL), which is equivalent to 1,000 megalitres of water (BoM, 2021a)

3.1.1 Entitlements and Allocations

Water in the Australian water markets can be privately owned and traded in two forms: water entitlements and water allocations and the trade can take place within a water body as well as – with restrictions – in between different water bodies. Water access entitlements give an ongoing or perpetual right to exclusively access and use a specified share of water from a water system, water licences provide an ongoing or perpetual right to take or hold water from a specified system, and water allocations are a specified volume of water allocated to a water access entitlement in a given year. (BoM, 2021b)

The trade of both entitlements and allocations can take place between commercial users, including unrelated and related parties, or for environmental purposes to meet preservation goals. These environmental trades are not included in reported trade statistics. In the fiscal year 2019-2020, the turnover of traded allocations was estimated to be AUD 7 billion, with most of the trading taking place between agricultural users. However, recently, investors and water managers have also entered the market. Nationally, 95% of traded water is surface water, while only 5% is ground water. (BoM, 2021b).

For water markets to function effectively, the water systems must be hydrologically connected. The largest connected water body in Australia is the Murray-Darling Basin (MDB), which is divided into two parts: the Southern Murray-Darling Basin and the Northern Murray-Darling Basin. The Southern MDB, with its high degree of hydrological connectivity, provides a unique location for water market activity, as it allows for trading both within the system and between states. In fact, 93% of allocation trade and 51% of entitlement trade in terms of traded water occurs in the Southern MDB (BoM, 2021b). In contrast, the Northern MDB has a lower level of hydrological connectivity, resulting in significant variations in market prices and trading activity. The combined trade in these two areas is greater than the rest of the trade in Australia combined. (BoM, 2021b)

3.1.2 Price Factors

The prices of water trades in Australia are determined by the market mechanisms of demand and supply influenced by various factors, including weather patterns, purpose of water use, storage volumes, available allocations, commodity market conditions, and legislative arrangements. When dry weather conditions occur, the prices of both allocations and entitlements tend to increase, while carryover allocations from previous years and high-water storage levels tend to push prices down. (BoM, 2021a)

The supply of water available for trade is also influenced by natural variations such as rainfall, storage volumes, and carryover rights from previous years. A decrease in supply while demand remains unchanged leads to higher water prices and a decrease in traded volume. Conversely, an increase in demand while supply remains unchanged leads to higher prices and an increase in traded volume. Demand can be influenced by factors such as changes in agricultural prices and production sifts toward higher value commodities, investment in farming and farm infrastructure, and temperature. (BoM, 2021b)

Water entitlement prices are also impacted by the resource type (surface or ground water), imposed trade restrictions during droughts and the reliability class of the entitlement. The entitlements are divided into categories of high reliability, general reliability and low reliability. Higher reliability leads to higher prices, and prices can vary depending on the region. (BoM, 2021b)

Temperature also has a significant impact on water prices through increased irrigation needs during hot periods and higher demand for water in urban areas and for environmental purposes. The water price may increase substantially while the volume of traded water stays relatively unchanged. Due to the dry weather conditions experienced in 2019-20, a record-breaking allocation prices were experienced in Murray-Darling Basin when the prices of water allocations reached up to $900 per ML (BoM, 2021a).

In financial year 2019-20 the high security entitlements reached all time high record levels with median price of $8000 per ML in the Murrumbidgee and New South Wales Murray. Yet, there was a significant variation in median prices in high security water entitlements between different regions ranging from $1700 to $3500 per ML for general security entitlements, $3000 to $3500 per ML for medium security entitlements to $4500 per ML for high security entitlement in the Macquarie-Castlereagh system up to $6500 per ML in New South Wales Border system (BoM, 2021b).

Water trading in Australia serves as an important mechanism for allocating water to efficient use and is also a growing source of potential returns. In the Southern Murray-Darling Basin (MDB), the trading intensity of water rights was 138%, meaning that some of the allocation rights were traded in the markets more than once during the fiscal year. Approximately, 45% of all trades were for environmental purposes. (BoM, 2021b)

3.1.3 Inter-Regional Water Trade and Possibility for Arbitrage

The trading of water rights between regions is possible if the water bodies in question are hydrologically connected. During the 2019-20 financial year, the southern Murray-Darling Basin (MDB) saw a 27% rise in inter-regional water trade. The volume of trade increased due to the rise in trading rights as well as a rise in environmental transfers. However, restrictions on trading imposed due to severe drought conditions limited the potential volume of inter-regional trade (BoM, 2021b).

When water bodies are connected, the presence of this connection creates opportunities for trading water rights between different regions. Due to the variations in relative water productivity, an opportunity for arbitrage arises by trading water rights from a region with higher prices to another with lower prices. The water systems in northern Murray-Darling Basin have the potential to sell water rights at higher prices to regions downstream in the southern MDB due to differences in water prices, demand, and the relative productivity of water and agricultural activities. (BoM, 2021b)

In the summer of 2019-20, allocation prices in the lower MDB reached a record high of over $900 per ML but in the longer term, allocation prices have seen significant variations depending on environmental conditions. During the Millennium Drought in 2008-09, the average monthly trading prices for water allocation rights averaged $500 per ML, while during wet conditions between 2010-2012, prices dropped as low as $10 per ML (BoM, 2021b)

3.2 Sources of Water Supply and Resources

Water can be sourced from two main sources: surface water and groundwater. Surface water storages typically recharge quickly from usage, while groundwater storages recharge slowly. Reason for this is that groundwater formation may take tens of thousands of years. The recharge rate of groundwater varies greatly by country, region, and depends on factors such as rainfall, size of water bodies, interconnections between them, and geological structures (BoM, 2021a).

3.2.1 Natural Sources of Water in Australia

In Australia, surface water is the main source of extracted water in most areas and groundwater is a critical source in dry regions, but is less utilized. The trade of groundwater is generally more limited compared to surface water due to the hydro-geological differences between the two water sources. (BoM, 2021b)

To meet the demand for water consumption, Australia has over 500 major water storages, several thousand small storages, and two million farm dams, with a total storage capacity of around 81,000 GL. These large storages are necessary to balance the water supply during variations in rainfall and high temperatures. At the start of the financial year 2019-20, the combined storage water for direct water supply was 50,500 GL, but due to dry weather conditions, it reached its lowest level in over a decade (BoM, 2021a)

In last three financial years, water storage levels have been decreasing significantly. In January 2020, the storage levels in the northern MDB area were only 5%. The area-averaged rainfall in Australia during the consumptive period of 2019-20 was 347 mm, which was below the historical mean of 457 mm. During the 2019-20 financial year, Australia experienced its driest 24-month period in recorded history (1900-2020) (BoM, 2021a)

Australia experienced its third-driest year in recorded history in the financial year 2019-20, and these above-average temperatures likely increased water demand in all sectors while decreasing the supply (BoM, 2021b) Despite reduced water extraction, the low rainfall in the Murray-Darling Basin over the previous three years meant that groundwater levels did not fully recover. In Southwest Australia, groundwater levels have been declining for the past 40 years due to declining rainfall (BoM, 2021a).

3.2.2 Desalination and Water Recycling

Due to rising water demand of growing population, aging infrastructure, and decreasing availability of conventional sources, alternative sources of water must be considered. Desalination and water recycling are two such options. Desalination includes various methods of transforming seawater into potable water. In Australia, there are 270 desalination plants, most of which are small-scale, with a total combined capacity of 880 GL per year. (BoM, 2021a)

In Perth, desalination is a major source of drinking water, accounting for 47% of all drinking water and the figure is growing due to declining rainfall and declining groundwater levels. During the financial year 2019-20, the desalination plant in Perth operated in full capacity. In other cities such as Adelaide, Melbourne, and Sydney, desalination plays a smaller role in their water supply. For example, the desalination plant in Sydney was built in 2012 and it commenced the operation for the first time in January 2019. (BoM, 2021a).

Water recycling, where wastewater is treated to a suitable standard for agricultural irrigation, non-potable domestic use, industrial use, or public place irrigation, is being used as another alternative water source where conventional sources cannot meet demand. Recycled water offers a steady supply and is available year-round because it is produced from the wastewater streams of cities. In 2019-20, the use of recycled water increased compared to the previous year in all major cities except South East Queensland and Melbourne. (BoM, 2021a)

3.3 Sectoral Water Demand in Australia

The sectoral consumption of water in Australia is similar to the global average. On a global scale, agriculture is estimated to consume 70%, industrial usage takes up 20%, and municipal consumption accounts for 10% of all water consumption. During the period of 2019-2020, total water consumption in Australia was 14,270 GL, with 67% consumed by agriculture, 22% by industry, and 11% by urban areas. Of the total water used, 75% came from surface water sources, 20% from groundwater, 4% was desalinated water, and 1% was from inter-regional transfers. (BoM, 2021a) The total water entitlements issued across Australia were 39,382 GL. (BoM, 2021b).

3.3.1 Agricultural Consumption

Agriculture is the largest consumer of water in Australia, using around 68% of the total extracted water. In the 2018-19 fiscal year, the estimated overall gross value of production for agriculture requiring irrigation was $16.4 billion, with fruits and nuts contributing around $4.5 billion, vegetables contributing $3.3 billion, cotton contributing $2.3 billion, dairy farming contributing $2.2 billion, and nurseries, cut flowers, and cultivated turf contributing $1.3 billion. (ABS, 2020).

The demand for irrigation water in agriculture is primarily driven by the relative profitability of farmed goods, which is influenced by the cost of production, water prices, and variations in farmed commodity prices as well as the elasticity of the farmed good. Farmers with single-year crops and small margin have high elasticity in water demand and are more likely and capable to switch to farm from one crop to another. On the other hand, farmers with multi-year crops, such as vines and trees, have low elasticity in water demand and are highly willing to pay for water to protect their multi-year investments. (BoM, 2021b).

The differences in the life cycle of farmed goods, the need to protect multi-year investments, and variations in rainfall have placed a premium on water prices in Australia, both for high reliability water entitlements and allocation rights. Droughts and other weather events tend to increase water prices, particularly when farmers are motivated to pay a premium to protect their investments, particularly in multi-year crops such as grapes. The differences in relative productivity and riskiness between single-year and multi-year crops ensure the functioning of water markets, where low productivity single-year crop farmers are motivated to sell their rights to higher productivity crop farmers and to gain profits. (BoM, 2021b)

For example, the shift in rice production can be seen as a measure of changes in farming elasticity and relative productivity of agricultural goods. In the 2011-12 fiscal year, 56,000 hectares were used for rice production, but by 2018-19 this had dropped to only 3,800 hectares due to the increase in water prices and low margins for rice. The low market prices of rice and high value of water and water rights have incentivized some irrigators to sell their water rights instead of continuing to farm low-value crops. (BoM, 2021b)

During the 2019-2020 fiscal year, water storage levels were low and weather conditions were dry, causing even high reliability water shares to not receive their maximum allocations. In Victoria, water allocations received around 80% of the maximum amount. In New South Wales, extreme drought conditions decreased the water storages to critical level leading to restrictions in water usage and an increase in water prices, causing farmers to reduce the area of annual crops. In contrast, water extraction volumes increased by 22% in New South Wales due to dry weather conditions and high volumes of carry-over rights from previous years. (BoM, 2021a)

In South Australia, the absence of major rural water storages has resulted in a heavy reliance on groundwater extraction. During the economic period of 2019-20, the groundwater extraction increased dramatically, ninefold from 51 GL to 470 GL. The water consumption in agriculture in Western Australia increased by 35% compared to the previous year, reaching the highest in six years. The Northern Territory and Tasmania, however, had the lowest water consumption in agriculture, with a decrease of over 30% from the previous years. Despite this, both Tasmania and Northern Territory rely almost entirely on groundwater extraction, at 99% and 98% respectively. This variation in water consumption can be attributed to the low levels of surface water availability due to dry weather conditions, which has led to an increasing demand for groundwater to supplement the shortage. (BoM, 2021a).

3.3.2 Urban Consumption

In the period 2019-2020, the water consumption for urban use was 3,125 GL, constituting 22% of all water consumption. Of this, 78% came from surface water, 9%

from groundwater, and 13% was desalinated water. In 2019-2020, the average annual volume of residential water consumption in major cities was 213 KL. In most major cities, water consumption decreased by 1% on average compared to the previous year. Regional differences in water consumption are heavily influenced by factors such as temperature, climate, rainfall, housing density, regional restrictions, and water prices. (BoM, 2021a)

Most urban areas heavily rely on surface water from reservoirs and to a lesser extent, groundwater extraction. The exception to this is the city of Perth, where 47% of water comes from groundwater due to declining annual rainfall. These sources are heavily influenced by seasonal and annual rainfall, leading cities to develop alternative water sources, such as desalination, water recycling, rainwater harvesting, and expanding catchment areas. In 2019-2020, due to dry weather conditions, water restrictions were in place in Sydney and Melbourne, resulting in an increased reliance on desalinated water, with the contribution of desalination at an all-time high. The two desalination plants located in Perth have been operating at full capacity for the past three years. (BoM, 2021a).

The costs of urban water consumption are divided between total water supply and wastewater treatment. The bulk water supply makes up 21% of total costs, while water treatment accounts for 11%, water transport 24%, wastewater transport 24%, wastewater treatment 16%, and retail 4%. The household sector consumes 12% of all water in Australia while bearing 51% of the costs. (Infrastructure Australia, 2019)

The public sector consists of 196 businesses delivering water and wastewater services, serving approximately 20 million customers daily. The total value of urban water infrastructure is estimated to be around $170 billion in financial terms for 2017-2018, with an estimated $4.5 billion capital expenditure needed. The sector generates an estimated annual revenue of $15 billion, representing 0.75% of Australia's GDP. (UWRC, 2020)

To ensure the financial efficiency of the public sector water providers, most have been corporatized. However, the public sector is facing challenges in meeting the diverse needs of consumers while also providing affordable water services, charging the true cost of water to meet investment needs, and promoting water efficiency. This is partially because of strong overlapping with variative roles of the government, states and cities and small communities. There are also inefficiencies in providing sufficient financing for rural development needs, and the regulatory environment for the water sector in Australia lacks system-wide planning and local policy restrictions that prevent the use of the most efficient solutions to meet the investment needs on aging infrastructure. (UWRC, 2020)

Due to the spread-out responsibilities of different agencies, poor decision-making, planning, and investment project management in infrastructure is prevalent. One notable example of this is the investment in desalination plants during the millennium drought, when it was decided to build desalination factories in five major cities with a total budget of $10 billion. Most of these plants have not been operational or have contributed very little to local water volumes. (UWRC, 2020)

In addition to these problems, the public sector is facing declining populations in some rural areas, making it difficult or impossible to finance maintenance and renewal of aging infrastructure through water prices. There are also deficiencies in the availability of trained professionals and challenges to keep up with changing regulations in rural areas, as well as difficulties in measuring the performance of rural facilities and tracking expenditure and water consumption. (UWRC, 2020)

3.3.3 Industrial Consumption

The industrial sector water consumption was 1,595 GL, accounting for 11% of total water consumption in Australia during 2019-20, with a 5% increase compared to the previous year. This consumption includes water use across various industries, including electricity production, manufacturing, and mining. Electricity production mainly relies on surface water, using large-scale power plants that have high-security water entitlements, while the mining sector primarily uses groundwater or desalinated water sources. (BoM, 2021a)

3.3.4 Environmental Consumption

The Australian government implements various initiatives to preserve water bodies and promote environmental sustainability. One such measure is the acquisition of water rights through direct purchases from markets or efficiency measures for environmental preservation purposes such as infrastructure improvements and leak reduction. Under the Murray-Darling Basin Plan (incorporated in The Water Act 2007 in 2008), the government purchased 2,750 GL worth of water rights for environmental preservation in the period of 2019-20. (BoM, 2021b)

Another way of preserving water is the implementation of trade restrictions. These restrictions limit the volume of water rights that can be transferred from one water system to another, especially during low water availability to prevent harm to the environment and to help ensure a steady supply of water to current and future entitlements. (BoM, 2021b).

Water systems that are not interconnected can experience significant differences in water prices due to variations in demand, supply, and productivity of water use. Trade restrictions can limit the volume of water transferred from upper water stream to lower water stream, driving up the water prices in the lower stream. In November 2019, the price premium for paid water in the lower Murray-Darling Basin reached up to $300 per ML compared to the prices in the upper MDB. (BoM, 2021b)

3.3.5 Water Efficiency and Losses

The Bureau of Meteorology defines "Real Loss" as the loss of water that includes leaks in water systems, overflows from potable water mains, service reservoirs, and service connections before reaching the customer meter. The real loss is measured in litres per service connection per day, and does not include metering errors, unauthorized consumption, or unbilled authorized usage, such as firefighting water usage. (BoM, 2021c).

The estimate of real losses can be influenced by the accuracy of water metering, the condition of mains and infrastructure, and water pressure in the infrastructure. In the 2019-20 financial year, the national average of real losses across all utilities was 70.9 litres per service connection per day before reaching consumers. The highest level of real losses was reported by Cassowary Coast Regional Council, with 472.4 litres per service connection per day. (BoM, 2021c)

Given that the average Australian consumes approximately 82,000 litres of water per year, and the average water price for consumers is $3.28 per kilolitres and $0.28 per kilolitre for industry, the losses in monetary terms as well as in terms of real water loss are significant both economically and environmentally. (Infrastructure Australia, 2019)

3.4 Global Megatrends and the Future of the Water Industry

The water industry in Australia, like the rest of the world, is facing challenges from global megatrends such as global warming, population growth, economic development, urbanization, and migration to cities due to declining rainfall in rural areas. The United Nations has developed the Sustainable Development Goal (SDG) Indicator 6.4.2 to measure the sustainability of water use and assess whether freshwater meets the basic needs of human needs and economic purposes. (BoM, 2021a).

The indicator measures water stress as the ratio of total consumed freshwater by major economic sectors to the renewable freshwater resources, after accounting for environmental water needs. At a national level, Australia is faring well according to this indicator, but it does not take into account sub-national variations. In Australia, there are significant regional differences and variations in water stress. (BoM, 2021a)

3.4.1 Population Growth and Urbanisation

In Australia, the population has been growing rapidly, particularly in major urban areas, and this trend is expected to continue. According to the Australian Bureau of Statistics, population growth in capital cities is projected to outpace the growth of the respective state's balanced water resources. An analysis of the water industry in 2010 estimated that water consumption in Australia's six largest cities would increase by 39% by 2026 and 64% by 2056. However, these estimates were based on population growth that was 18% lower than the latest estimates from the ABS. (Infrastructure Australia, 2019)

Australia faces similar challenges to other countries in the world, with increasing population growth in urban areas and a decline in rural regions. The aging infrastructure requires increasing maintenance and renewal costs, while new infrastructure needs to be built to meet the demands of the growing urban population for water and sanitation services. (UWRC, 2020)

As global population continues to urbanize and standards of living rise, demand for Australian agricultural products is increasing, putting pressure on already scarce water resources. At the same time, existing infrastructure is aging and reaching the end of its lifecycle in many parts of the country. This is due to the fact that in many parts of the country, the infrastructure was designed and built several decades ago for a different population than todays. (Infrastructure Australia, 2019; UWRC, 2020).

3.4.2 Global Warming and Climate Change

Global warming and climate change will increasingly alter the urban environment due to rising temperatures, decreased water inflows, and increased flooding risks. Growing urban populations will increase demand for both fresh water and wastewater services in major urban areas, while rural and remote regions will face significant challenges in meeting water needs due to drier weather conditions. (UWRC, 2020)

The water sector is heavily dependent on rainfall, water storage, and groundwater resources, and higher temperatures pose twofold risks. On one hand, higher temperatures cause water loss through evapotranspiration, and on the other hand, extended periods of higher temperatures simultaneously increase water consumption. (Australian Infrastructure Audit 2019)

In 2019 alone, droughts affected over 100 million people, resulting in over 2,000 deaths and causing indirect economic losses of $10 billion. During the same period, floods impacted over 103 million people, resulting in 5,110 deaths and causing economic losses of $36.8 billion. (CRED, 2020) In the coming years, climate change will result in significant variability in water availability, leading to seasonal or absolute water scarcity in various regions around the world and increased competition for water between agriculture and other water-consuming sectors. (Greve, et al., 2018.)

Australia faces similar challenges as the rest of the world. Climate change will be the single most significant factor influencing future freshwater availability in Australia, with impacts seen in extreme variations in rainfall, temperature, and the number of days of extreme heat and droughts. Southern regions of Australia are already experiencing progressive drying that cannot be solely explained by natural variability in rainfall. (Infrastructure Australia, 2019)

In Southeast and Southwestern regions, a significant decline in rainfall has been recorded over the past half-century, particularly during winter seasons. In Southwestern Western Australia, a decline of 26% in rainfall has been recorded over the past two decades compared to the long-term average. The decline in average winter rainfall has caused a 50% decline in water runoff over the past 50 years, impacting cities like Sydney, Melbourne, Perth, and Adelaide, and is expected to worsen in the future. (Infrastructure Australia, 2019)

Climate change is expected to reduce streamflow into bulk water storage while variations in rainfall patterns will place greater reliance on rain events, especially during the warmer, drier months. The warm, dry weather tends to increase water consumption by agriculture and communities, leading to over-extraction of water sources. (Infrastructure Australia, 2019)

The number of rainy days is also expected to decrease, with rainfall concentrated on fewer days and becoming more intense, increasing the risk of flooding in most areas of Australia. This is partly because lower rainfall reduces soil's ability to absorb water and increased heat strengthens this phenomenon. The higher temperatures also increase the risk of bushfires, and when combined with flooding, can severely damage water quality. (Infrastructure Australia, 2019)

This was evident during the bushfires of 2019-2020 when around 47% of agriculture and forest land in the Upper Murray River area were burned, and subsequent storms and rainfall caused sediment levels flowing into local watersheds to increase over five-fold, resulting in fish deaths, acidification, and decreased water quality. (Biswas, et al., 2021.)

3.5 The Future Growth Predictions of the Water Industry

The precise estimations of growth in future water consumption vary from study to study, but all studies point towards significant growth in future demand. The global water consumption is expected to grow, driven by increased demand in the industry and energy sectors as well as domestic use. One of the most difficult sectors to predict is agricultural water use, which is expected to increase and may face growing competition with other sectors. Predictions for the growth of water consumption vary, but the annual rate of growth is estimated to be around 1% with a 20% to 30% increase in overall consumption by 2050. (Burek, et al., 2016.)

The Food and Agriculture Organization of the United Nations (FAO) predicts that global food production will need to grow 60% by 2050, with irrigation-based food production needing to grow over 50% thus increasing the water demand in agriculture. On the other hand, the growth in water demand for agriculture may be hindered by technological advancements in farming techniques and increased crop resilience. (FAO, 2017) The Organisation for Economic Co-operation and Development (OECD) predicts a 55% increase in global water consumption between 2000 and 2050, with a 200% to 400% increase in water demand for manufacturing and a 140% increase in thermal power generation. (OECD, 2012)

In Australia, the water industry is likely to grow through the renewal of aging urban water systems and the adoption of water-saving technologies for both urban and industrial use. The existing infrastructure, mostly built in the first three quarters of the 20th century, was designed and built for very different scale of use and distribution than today's needs and is reaching the end of its life. Significant investment will be required to replace the aging infrastructure, but public sector funding may be insufficient. Private sector involvement may be necessary, but accurate cost-benefit analysis and financial calculations are needed to assess the risks and returns of long-term, capital-intensive and illiquid water investments. (Infrastructure Australia, 2019)

4 LITERATURE OVERVIEW

The objective of this study is to evaluate the historical returns of Australia's private water sector and compare its performance to the overall market to determine the presence of any excess returns. Additionally, the study aims to analyse the key drivers that impact the returns of the water sector and assess the potential future returns and development in light of climate change.

This literature review will present the prior research findings on the historical performance of the water industry and the key factors contributing to this performance. Much of the research literature on the water sector and industry focuses on the topics of privatisation on water utilities and their financial performance in late 90’s and early 2000’s.

The more recent studies focus on Socially Responsible Investing (SRI) and Environmental, Social and Governance (ESG) investing, which can be viewed as the practice of SRI principles, with the water sector being considered a subcategory of SRI and ESG investing. This may be due to the fact, that the Forum for Sustainable and Responsible Investing categorizes some water-related mutual funds as socially responsible funds. (Alvarez & Rodriguez, 2015)

Research in environmental studies and water management and purification from an engineering perspective is excluded from this literature review as it is not the primary focus of this study.

4.1 Investment Instruments and Opportunities in Water Industry

There is no single unanimously accepted definition of water industry or it’s subsectors and it can be described as a broad and fragmented sector, encompassing a range of activities from water purification and distribution to piping, smart metering, program development, technology development, and production of water purification chemicals. The industry is characterized by a large number of relatively small companies operating in different sub-sectors, and many companies categorized as "water companies" also operate in other fields such as gas and oil utilities, generating only a small portion of their revenue from water-related operations. (Jin, et al., 2014.)

Until the early 1990s, the water sector, specifically water purification and distribution, was considered a public sector due to the ownership of the necessary infrastructure by governments and public agencies. However, starting in the 1990s, an increasing number of countries began to deregulate the water sector and privatize water companies, transferring ownership from public to private entities. (Jin, et al., 2014.)

Since the partial privation, the water sector can be considered an attractive investment opportunity due to its monopolistic nature (Roca, et al., 2015.) which provides steady and predictable demand for water utilities and water and sewage infrastructure. (Jin, et al., 2014.) The water sector's monopolistic nature insulates it from the impact of macroeconomic volatility in the markets, leading to a stable expected growth rate and high dividend yield. (Jin, et al., 2014.) A study of eleven company variables by Roca et al. found that over the last 25 years, water utilities have outperformed all other industry groups in terms of total return. (Roca, et al., 2015.)

In the early stages of water industry privatisation, most investors were large corporations, but as awareness of the impact of climate change on water resources has increased, more individual investors have become interested in the sector. The relative stability of the water industry, described as recession-resistant due to its monopolistic nature and the necessity of water, is a key factor in its growing appeal. (Jin, et al., 2014.) Other drivers of steady growth expectations include the growth of the world economy, urbanization, and water shortages caused by climate change. (Roca, et al., 2015.

Investors have multiple options for participating in the water sector. One way is by directly investing in water projects through municipal bonds and debt instruments. These options are considered low-risk due to the fixed interest rate and low likelihood of losing the principal, but may be seen as less attractive due to the lower returns and long maturities. Another avenue for investment is through private equity, which provides access to funding for water projects that may not be available to individual investors. (Jin, et al., 2014.)

As the water markets developed and the water companies were listed in stock markets, the investors gained the opportunity to participate in the sector through the stock market by investing in individual water-related companies. These companies provide benefits such as accessibility to both institutional and private investors, low level of risk, steady growth in dividends, and high liquidity and easy entry and exit to the market. However, the extensive and fragmented nature of the water industry, with companies operating in various sub-fields, makes it challenging for investors to choose the right stocks to invest in. (Jin, et al., 2014.)

Along with the listed companies, grew the need for investors to keep track of developments in the water industry to make informed investment decisions and to invest the sector as a whole. To address this need, several indices and Exchange Traded Funds (ETFs) were created to monitor the sector as a whole. In

2003, the American Stock Exchange (AMEX) introduced the Palisades Water Index (ZWI), which was followed by the Power Shares Global Water ETF and Power Shares Water Resources ETF. Other ETFs followed, including the Claymore S&P Global Water, which tracks the S&P Global Water Index, and First Trust ISE Water, which tracks the ISE Water Index. In 2006, the Dow Jones and Swiss Sustainable Asset Management company (SAM) introduced the WOWAX index, which tracks 20 companies mainly engaged in water-related operations, and the SAM Sustainable Water Fund certificate, which tracks WOWAX. (Roca, et al., 2015; Tularam & Reza, 2016)

Compared to other markets and economic goods, the water industry is characterized by its natural monopolistic nature and significant reliance on infrastructure. As an investment opportunity, the sector typically demands a large amount of fixed capital that cannot be easily liquidated, resulting in a substantial asset-in-place risk that cannot be reversed. This creates a significant liquidity risk in the industry and therefore, investors require high returns to compensate for this risk. (Roca, et al., 2015.)

4.2 The Performance of the Water Sector

The water sector has been the subject of academic study, with much of the literature focusing on the economic performance of water utilities in the United Kingdom. Shaoul (1997) analysed the efficiency improvements in costs and outputs and surplus distribution of privatized water utilities, concluding that privatization did not result in increased efficiency and that the consumer surplus was transferred to unknown beneficiaries. (Shaoul, 1997)

Ogden and Watson (1999) investigated the trade-off between stakeholder management (customer service) and shareholder returns and profitability in privatized water utilities, finding that providing customer service is costly and negatively correlated with current profits, but positively correlated with shareholder returns. (Ogden & Watson, 1999)

Saal and Parker (2000) evaluated the price performance and total factor productivity (TFP) of privatized water and sewage companies before and after privatization. They found that while privatization resulted in reductions in labour costs, the overall productivity did not improve, taking into account the quality of service provided. (Saal & Parker, 2000)

The study by Buckland & Fraser (2000) investigated the risks and returns of ten privatized English and Welsh water and sewage utilities. By utilizing the Capital Asset Pricing Model (CAPM) and the Kalman filter, the authors found significant time variation in systematic risk and substantial variations in abnormal returns. Their results revealed that there were excess returns in the initial phase of privatization, but these excess returns have since diminished. (Buckland & Fraser, 2000)

Armitage (2012) analysed the borrowing behaviour of UK water companies to meet their dividend demands and found that investors have a strong demand for dividends in the water industry and the dividends are expected, despite unsustainable financing practices. (Armitage, 2012)

The performance of the water sector on a global scale has also been the subject of several studies. On a global level, Geman and Kanyida (2007) compared the performance of the WOWAX water index to three other commodity indices and found that water is a promising investment option compared to the other commodity indices. (Geman & Kanyida, 2007) Other studies have looked at the risk-adjusted investment performance and diversification value of water-related mutual funds (Alvarez & Rodriguez, 2015), the idiosyncratic risk and returns of four water-related exchange-traded funds (ETFs) (Tularam & Reza, 2016), the historical performance of same four water-related ETFs in various benchmark methods (Rompotis, 2016), the bond fund risks between states with and without scarce water resources (Álvarez & Rodriguez, 2017), and the returns and volatility of four water indices and four water-related ETFs before, during, and after the 2008 global financial crisis. (Reza, et al., 2018.)

Roca et al. (2015) explored the performance of the global water market and the diversification benefits it may offer to investors. Their study aimed to answer three crucial questions: what are the risk-adjusted returns of the water sector, what is the relationship between water markets and stock and bond markets, and finally, a comparison between a traditional portfolio of stocks and bonds versus a water-enhanced portfolio to determine if investments in the water sector provide diversification value. The daily returns of the World Water Index (WOWAX), consisting of 20 of the largest publicly listed water companies worldwide, were analysed to capture the essence of global water markets and its movements. The companies in the index are required to have a primary source of revenue from the water sector, including water operations such as utilities and infrastructure, water treatment, and is considered one of the best representations of the global water sector. The study evaluated both the performance of the water sector as an individual asset class and as part of a portfolio, and the portfolio performance and risk characteristics were measured using the Sharpe ratio. The results showed that the water sector outperformed the stock and bond assets, while having lower risks and providing diversification value for investors. (Roca, et al., 2015.)

The focus of water market studies on the UK and US is likely due to the fact that these countries were among the pioneers in privatizing their water utilities. As a result, the first water-related indices and investment vehicles in the form of mutual funds and exchange-traded funds (ETFs) emerged in the US stock markets in the late 1990s.

In recent years, a significant branch of research has focused on the connection between the water, energy and food sectors and to the performance of water sector, known as the WEF-nexus (sometimes referred to as the WEA-nexus with "agriculture" replacing "food"). These recent studies have shifted from examining the individual impacts of these sectors to exploring their joint contribution. Global warming or climate change is widely recognized as a major contributor to the current scarcity of water resources and its future returns. (Peri, et al., 2017; Vandone, et al., 2018; Piñeiro-Chousa, et al., 2020.)

Interestingly, almost all existing economic studies have identified climate change as a significant contributor for the current scarcity of water resources and named it as significant impactor of the future returns of the sector, but none have incorporated variations in weather patterns, such as rainfall anomalies or extended periods of high temperatures, into their models for calculating future returns. It is a suggestion of this thesis that these factors should be considered in future analyses, as they can have a substantial impact on the water sector's performance.

4.3 Performance of Water-Related Mutual Funds and Exchange Traded Funds (ETFs)

Exchange-Traded Funds (ETFs) are investment vehicles traded on stock markets that allow an investor to gain exposure to a basket of securities that track a specific benchmark index. This makes it possible to access the whole market or sector with a single transaction. In the context of water investments, different ETFs follow different indices, replicating the performance of the water sector. (Tularam & Reza, 2016).

The study by Alvarez & Rodriguez (2015) assessed the risk-adjusted performance of water-related ETFs and open-end mutual funds that invest in water-related securities, as well as their diversification benefits. The risk-adjusted performance was evaluated using Jensen's Alpha, which measures the difference between a fund's expected return and its actual return for a given level of risk. The performance of the water funds was benchmarked against the Standard & Poor's (S&P) Global Water Index containing 50 companies from water sector and the S&P 500 index. The findings showed that the sample of water-related mutual funds neither outperformed nor underperformed the market. (Alvarez & Rodriguez, 2015)

Tularam & Reza (2016) conducted a study on the idiosyncratic risk and return of the same four water-based ETFs as Alvarez & Rodriguez (2015) using the Markov Switching Model. Contrary to the results of Alvarez & Rodriguez (2015), the results revealed that the beta value of water investments was less than one, indicating a lower systematic risk compared to the markets on average. This had a positive impact on the returns of water ETFs. The study also found that the water sector demonstrated greater regime stability compared to the equity markets. (Tularam & Reza, 2016)

Contrary to the findings of Tularam & Reza (2016), Rompotis (2016) conducted a study on the performance of four US-listed water-related ETFs and found that three out of four of the studied ETFs underperformed the benchmark market index. The alphas were either in close tandem with the overall markets or lost just slightly. The conclusion was that passively managed ETFs, which aim to replicate the benchmark index as closely as possible, do not provide excess returns. The study suggests that water ETFs should be considered as part of Socially Responsible Investing (SRI). Rompotis suggest that SRI funds tend to underperform, requiring investors to accept lower returns. (Rompotis, 2016)

4.4 The Water-Energy-Food Nexus

Studies on the water industry have increasingly focused on the interplay between the energy and food sectors and their impact on the financial performance of the water sector. The study of the Water-Energy-Food (WEF) nexus is crucial because it highlights the interconnections between these sectors. As explained by Peri, et al. (2017), a shock in one sector can quickly propagate to another if these sectors are highly correlated. This interdependence has often been overlooked in previous studies that have primarily focused on the water sector alone. By understanding the WEF nexus, policymakers can make informed decisions, while investors can consider it as a factor when evaluating assets and projecting future returns. It is also important to note that regional weather patterns can significantly vary, so conducting a WEF nexus analysis locally is necessary when making investment decisions. (Peri, et al., 2017.)

Both Peri et al. (2017) and Vandone et al. (2018) conducted separate studies on the Water-Energy-Food nexus, as no prior studies were available on the topic. Peri et al. (2017) analysed the interrelationships between the financial performance of the water, energy and food sectors (WEF nexus) using a multivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to study the volatility spillovers between indexes in these three sectors. The study was conducted with daily price data of selected indexes representing the three sectors from 2001 to 2013, both regionally and globally. The results showed positive cross-volatility from water to agriculture, meaning that an increase in agriculture index leads to an increase in the water index. This could be attributed to water being an input for food production, and increased food production increases demand for water. In contrast, negative cross-volatility was observed from energy to water, as an increase in energy costs decreases the returns in the water sector. This can be attributed to energy being an input of water sector. (Peri, et al., 2017; Vandone, et al., 2018.)

Vandone et al. (2018) also studied the impact of agriculture and energy price trends on the performance of water sector companies. Using the S&P Global Water Index from November 2001 to March 2014, the study found that agriculture and energy were significant risk factors contributing to the stock prices of water companies. Both the agriculture and energy beta coefficient were found to be positive and contributing positively on water sector returns. The study also found that agriculture had higher beta than the energy beta, suggesting that agriculture was the largest contributor to the water sector, while energy was the second largest. This founding aligns with the findings of Peri et al. (2017) in regards to food sector but contradicts in case of energy sector energy sector by pointing that energy sector is not only an output of water sector but also a driver for water demand. Vandone et al. (2018) explains this finding with the facts that alternative energy production techniques such as shale-gas extraction are water intensive technologies and the increase in energy consumption may increase the usage of these energy sources thus also driving the water consumption up. (Vandone, et al., 2018.)

Pineiro-Chousa et al. (2020) studied the influence of investor attention on the stock returns of water companies and how the energy and food sectors impacted these returns. Using monthly stock returns of companies in the S&P Global Water Index from 2008 to 2019, the study found that changes in agriculture prices tended to positively impact the water sector, while changes in energy prices tended to negatively impact it. The results align with the findings of Peri et al. (2017) and Vandone et al. (2018). The study also found that active investor attention had a negative impact on the stock returns of water companies, with increased public awareness on water consumption and scarcity leading to more sustainable water consumption and decreased water returns. (Piñeiro-Chousa, et al., 2020.)

Overall, the findings from these studies suggest that the interplay between the water, energy, and food sectors can have a significant impact on the financial performance of the water sector. The results indicate that changes in agriculture prices tend to positively impact the water sector, while changes in energy prices tend to have a negative impact.

5 DATA AND METHODOLOGY

This study has two goals. First, to analyse which factors drive equity returns of the Australian water companies. This gives important information regarding differences in behaviour of the water stock and "conventional" stocks. However, the most interesting result is whether weather conditions or general interest in climate change and weather conditions have any impact on the Australian water equity returns. The second research problem is to test the possible gains the Australian water equities may offer to a diversified Australian equity portfolio.

To assess the expected return of individual companies operating in the Australian water sector and compare their performance with the overall markets. To assess the expected return of a mutual fund or common stock, the Capital Asset Pricing Model (CAPM) is commonly used. This model, developed by Jack Treynor in 1961-2, William Sharpe in 1964, and John Lintner in 1965 (Treynor, 1961), (Sharpe, 1964), (Lintner, 1965), is a single-factor model that considers both the systematic risk of the overall markets and the expected return of the overall market portfolio in determining the expected future returns of the selected asset.

Although the original CAPM model has been criticized for its oversimplification, it has been further developed to better capture market movements. These developments include the three-factor model by Fama and French (Fama & French, 1992), the four-factor model by Mark M. Carhart (Carhat, 1997), and the five-factor model by Fama and French (Fama & French, 2015).

Studies on water industry and its financial performance have applied the Fama & French three-factor model (Jin, et al., 2016.) on analysing the performance of 76 companies included in five major water indices, and Rompotis (2016) which applied five variants of CAPM model to analyse the returns of water-related ETF's. (Rompotis, 2016) However, data required to apply the five-factor model is not available solely for Australia (French, 2022), and alternative time-series methods must be used.

Vandone et al. (Vandone, et al., 2018.) and Reza et al. (Reza, et al., 2018.) successfully applied generalized autoregressive conditional heteroskedasticity (GARCH) models in analysing water industry returns, and such a model could be used in the quantitative part of this study. The MIDAS method, which allows analysis of time series with different intervals, may also be considered depending on the interval of the weather data used. (Coles & Hawkins, 2011).

As pointed out in literature overview, the previous studies on the financial performance of the water sector have focused on mainly the global performance of the industry rather than performance on a single country. Furthermore, none of the previous studies have incorporated climate change variables in their analysis methods, despite identifying climate change as a key driver for the future performance of the water industry. This study aims to fill this gap in research by incorporating climate variables perhaps for the first time in the assessment of the financial performance of the water industry.

The research questions and working hypothesis of this thesis are as follows:

1. Are climate variables significant factors in explaining water company returns in Australia?

   Null Hypothesis [H_0]: Rainfall and temperature do not have an impact on the returns of water companies.
   Work Hypothesis [H_1]: Rainfall and temperature do have an impact on the returns of water companies.

2. Has public awareness of climate change translated into informed investment decisions in Australian water sector and can Google searches regarding drought, water and climate change, warming used as an explanatory variable to water company returns in Australia?

   Null Hypothesis [H_0]: Google searches can't be used to explain water company returns in Australia.
   Work Hypothesis [H_1]: Google searches can be used to explain water company returns in Australia.

3. Do water equities provide diversification benefit to an Australian equity portfolio?

   Null Hypothesis [H_0]: Water equities do not provide diversification benefit to an Australian equity portfolio.
   Work Hypothesis [H_1]: Water equities do provide diversification benefit to an Australian equity portfolio.

5.1 Data

5.1.1 The Water Companies

The possible Australian water companies for the study were searched from the Australian Stock Exchange (ASX) website (Australian Stock Exchange (ASX), 2022) by selecting the "utilities" category and by searching for companies that have "water" in their name. The initial search resulted in 62 potential stock-listed companies that could be classified as water companies. From this list, the selected companies were chosen through a process of elimination. Companies that did not fit the definition of a water company were excluded from the analysis. The selection criteria included that the company must primarily operate in Australia and must be mainly engaged in the water sector. Companies that were excluded from the sample operated in multiple utility sectors such as oil, mining, gas, energy, or related sectors. Companies operating in leisure and food production were also excluded. In total, 11 companies were selected for econometric analysis, and the selected companies are listed in TABLE 1.

The criteria for defining a "water company" were less systematic and more subjective than desired. However, the available pool of companies indicated that applying overly strict criteria would have resulted in a sample size that was either too small or non-existent. It was also noted that align with previous research literature, it was easier to exclude companies that were not "water companies" rather than define clear, inclusive criteria to define which companies do constitute as "water companies". The selection method might have ignored companies such as those that provide chemicals for the water industry or companies that provide pipes and valves for the water industry.

From the selected companies, daily and monthly share price time series were extracted from Refinitiv DataStream, yielding a total of 36,921 daily observations and 1,704 monthly observations. For compactness, the companies are referred to in the text with the second part of the ticker (e.g., REH for ASX:REH).

TABLE 1 Selected companies and the number of observations

Company name	Ticker	Starting day	Daily Obs.	Monthly Obs.
Reece Ltd	ASX:REH	31.12.1999	5,914	273
Waterco Limited	ASX:WAT	31.12.1999	5,914	273
GWA Group Ltd	ASX:GWA	31.12.1999	5,914	273
Phoslock Environmental Technologies Ltd	ASX:PET	16.8.2002	5,229	241
Alterra Ltd	ASX:1AG	16.5.2008	3,729	172
Alterra Ltd	ASX:1AGBER	5.9.2008	3,649	168
Purifloh Ltd	ASX:PO3	30.12.2010	3,045	141
Duxton Water Ltd	ASX:D2O	16.9.2016	1,554	72
DE Mem Ltd	ASX:DEM	7.4.2017	1,409	65
Clean Teq Water Ltd	ASX:CNQ	2.7.2021	304	14
Rubicon Water Ltd	ASX:RWL	2.9.2021	260	12
Total			**36,921**	**1,704**

5.1.2 Index and Interest Rate Data

For the econometric analysis, three indices were chosen to represent the overall market, the energy sector, and the food sector. The selected indices were: the S&P/ASX 200 Index to represent the overall market, the S&P/ASX 200 Energy Index to represent the energy sector, and the Australia-DS-Food Producer Price Index to represent the food and agriculture sector. For brevity, these indices will be referred to as the "Market Index", "Energy Index", and "Food Index" in the text.

Two government interest rates were used as control variables. The selected interest rates were the RF AUSTRALIA GVT BMK BID YLD 2Y - RED YIELD interest rate and the RF AUSTRALIA GVT BMK BID YLD 10Y - RED YIELD. Both the daily and monthly time series data were extracted from Refinitiv DataStream. The daily data included 17,677 observations for the indices and 11,828 observations for the interest rates. The monthly data included 816 observations for the indices and 546 observations for the interest rates. The selected indices and interest rates are listed in TABLE 2.

TABLE 2 Selected indices, interest rates and the number of observations

Index name	Starting day	Daily Obs	Monthly Obs.
S&P/ASX 200 Index	31.12.1999	5,914	273
S&P/ASX 200 Energy Index	31.3.2000	5,849	270
Australia-DS-Food Producer Price Index	31.12.1999	5,914	273
Total		**17,677**	**816**

(continues)

TABLE 2 (continues)

Interest Rates	**Starting day**	**Daily Obs**	**Monthly Obs.**
RF AUSTRALIA GVT BMK BID YLD 2Y - RED. YIELD	31.12.1999	5,914	273
RF AUSTRALIA GVT BMK BID YLD 10Y - RED. YIELD	31.12.1999	5,914	273
Total		**11,828**	**546**

5.1.3 Weather Data

To control the potential impact of weather variations on the performance of water companies, two weather-related time series were obtained from the Bureau of Meteorology's Climate Change Trends and Extremes database. The extracted time series were Mean Temperature, which measures the variation of the mean average temperature compared to the 1961-1990 average, and Rainfall Anomaly, which measures the deviation of rainfall compared to the 1961-1990 average. The monthly data was collected for the entire Australian region and covered the period from January 2000 to July 2022. The time series contained 271 observations for Mean Temperature and 271 observations for Rainfall Anomaly. (Australian Government Bureau of Meteorology)

5.1.4 ASVI Data

To control the potential influence of investor awareness of environmental concerns on the performance of water companies, ASVI (Acronym Sensitive Value Investing) method was employed. The ASVI search word variables are specific search terms or phrases that are utilised on Google Search, and the data records the frequency of how frequently the particular search word or phrase is entered on Google Search. (Jun, et al., 2018.)

The data is indexed into time series, with the highest number of searches receiving a value of 100, and other searches have being scaled in relation to this. The ASVI search word data was obtained from Google trends, with the selected region being Australia, and the utilised search terms being were *Warming*, *Climate Change*, *Drought*, and *Water*. The data is available from 2004 onward. (Google Trends, 2023)

5.2 Methods for Analysis

5.2.1 The Logarithmic Returns

The empirical testing of Work Hypothesis was started by first computing the logarithmic excess returns for the 11 stocks and 3 indices. The interest rate used in the calculations was the 2-year RF AUSTRALIA GVT BMK BID YLD 2Y - RED. YIELD interest rate set by the Australian Central Bank, which is for brevity referred as "Interest Rate" further in the text. The excess returns were calculated with formula (1).

$$R_{it} = 100 * Log\left(\frac{P_t}{P_{t-1}}\right) - \left(\frac{R_f}{365}\right) \tag{1}$$

Where:
E_s is the excess return of an asset
P_t is the asset value at time t
P_{t-1} is the asset value at time t-1
R_f is the risk-free interest late
Log is natural logarithm

Additionally, the yield curve's steepness was calculated by subtracting the 2-year Central Bank interest rate from the 10-year interest rate. The steepness of the yield curve was calculated with formula (2.)

$$Slope = R_{f\ 10\,yr.} - R_{f\ 2\,yr.} \tag{2}$$

Where:
$R_{f\ 10\,yr.}$ Is the Central Bank's 10-year interest rate
$R_{f\ 2\,yr.}$ Is the Central Bank's 2-year interest rate

5.2.2 The Linear regressions

The first stage of this empirical study aimed to estimate the excess returns of the water industry's stocks using linear regression model based on the Capital Asset Pricing Model (CAPM). The model included regressors Market Index, the Interest Rate by the Australian Central Bank, and the slope of the yield curve.
Based on existing research literature, the time series are assumed to be heteroscedastic and therefore heteroscedastic-robust standard errors are used. The estimations were conducted using both daily and monthly data for the full time series. The Models 1, 3, 4 and 5 follow Liow & Huang (2006), Liow et al., (2006) and Josepha et al., (2015) in placing the interest rate on both sides of the equation. The Regression Model 1 was estimated with formula (3)

(3) $$R_{it} = \alpha + \beta_i market_t + \beta_i interest_t + \beta_i slope_t$$

Where:
R_{it} is excess return of an asset
α is intercept
$\beta_i market$ is excess return of S&P/ ASX 200 Index
$\beta_i interest$ is Central Bank's 2-year Interest Rate
$\beta_i slope$ is steepness of the interest yield curve

The second estimation further extends the CAPM estimation by changing the explanatory variables of the linear regression model, which now included the Market Index, the Energy Index, and the Food Index as suggested by Peri et al. (2017); Vandone et al. (2018) and Pineiro-Chousa et al. (2020). The daily and monthly data were divided into two sets: one covering the full period and the other starting from January 2012. The estimations were conducted for both daily and monthly data for both the full period and the subset starting from 2012. The Regression Model 2 was estimated with formula (4)

(4) $$R_{it} = \alpha + \beta_i market_t + \beta_i energy_t + \beta_i food_t$$

Where:
R_{it} is the excess return of an asset
α is the intercept
$\beta_i market$ is excess return of S&P/ ASX 200 Index
$\beta_i energy$ is excess return of S&P/ ASX 200 Energy Index
$\beta_i food$ is excess return of Australia-DS-Food Producer Price Index

The third linear regression model estimation further extends the CAPM estimation of the performance of the water sector was with the following explanatory factors: the excess return of Market Index, Energy Index, Food Index, the Interest Rate, and the Slope of the yield curve. Both daily and monthly data were used, with estimations made for the full period as well as a subset starting from January 2012. The Regression Model 3 was estimated with formula (5)

(5) $$R_{it} = \alpha + \beta_i market_t + \beta_i energy_t + \beta_i food_t + \beta_i interest_t + \beta_i slope_t$$

Where:
R_{it} is the excess return of an asset
α is the intercept
$\beta_i market$ is excess return of S&P/ ASX 200 Index
$\beta_i energy$ is excess return of S&P/ ASX 200 Energy Index
$\beta_i food$ is excess return of Australia-DS-Food Producer Price Index
$\beta_i interest$ is Central Bank's 2-year Interest Rate
$\beta_i slope$ is steepness of the interest yield curve

The fourth linear regression model aimed to answer the first research question by testing the hypothesis that variations in weather conditions impact the performance of the water sector. The previous linear regression model was further extended with two weather components: the mean temperature variation, which captures the difference in mean average temperature from 1961-1990 in all Australia, and the rainfall anomaly, which measures the deviation in rainfall compared to the mean average of 1961-1990. The fourth estimation was based on monthly data only, as weather data is only available in monthly intervals. The full time series as well as a subperiod starting from 2012 were analysed in this estimation. Regression Model 4 was estimated with formula (6)

$$R_{it} = \alpha + \beta_i market_t + \beta_i energy_t + \beta_i food_t + \beta_i interest_t + \beta_i slope_t + \beta_i temp_t. + \beta_i rain_t \tag{6}$$

Where:
R_{it} is the excess return of an asset
α is the intercept
$\beta_i market$ is excess return of S&P/ASX 200 Index
$\beta_i energy$ is excess return of S&P ASX 200 Energy Index
$\beta_i food$ is excess return of Australia-DS-Food Producer Price Index
$\beta_i interest$ is Central Bank's 2-year Interest Rate
$\beta_i slope$ is steepness of the interest yield curve
$\beta_i temp.$ is mean temperature variation
$\beta_i rain$ is rainfall anomaly

The fifth linear regression model aimed to answer the second research question by examining the impact of ASVI keyword search behaviour on the performance of the water sector. The third linear regression model was augmented with the ASVI search word variables, capturing the frequency of specific search terms related to the water industry in the footsteps of Piñeiro-Chousa et al. (2020). The unit root of the ASVI time series was tested with Dickey-Fuller test and stationary series was used. The regression was performed on monthly data only and the estimation was made for period starting from 2004 onwards. Regression Model 5 was estimated with formula (7)

$$(7) \quad R_{it} = \alpha + \beta_i market_t + \beta_i energy_t + \beta_i foot_t + \beta_i interest_t + \beta_i slope_t + \beta_i ASVI\ climate + \beta_i ASVI\ drought + \beta_i ASVI\ warming + \beta_i ASVI\ water$$

Where:
R_{it} is the excess return of an asset
α is the intercept
$\beta_i market$ is excess return of S&P/ASX 200 Index
$\beta_i energy$ is excess return of S&P/ASX 200 Energy Index
$\beta_i food$ is excess return of Australia-DS-Food Producer Price Index
$\beta_i interest$ is Central Bank's 2-year Interest Rate
$\beta_i slope$ is steepness of the interest yield curve
$\beta_i ASVI\ climate$ is ASVI indexed keyword for "climate change"
$\beta_i ASVI\ drought$ is ASVI indexed keyword for "drought"
$\beta_i ASVI\ warming$ is ASVI indexed keyword for "warming"
$\beta_i ASVI\ water$ is ASVI indexed keyword for "water"

5.2.3 Portfolio Diversification Analysis

To answer the third research question whether water equities provide diversification benefits to an Australian equity portfolio, a diversification study was conducted. The previous research (Roca, et al., 2015.) has suggested that the water sector may provide diversification value for investors. The linear regression results from this study support this finding as water stock returns exhibit weak correlation with the overall market returns, which raises the question of whether they decrease the overall portfolio risk.

All available stocks with data for the entire period were selected for diversification study. Their monthly returns and standard deviations were calculated and aggregated to the annual expected return. The portfolio optimization was implemented by setting different levels for the target return, and the comparisons were made to the ASX 200 Index, which was used as the benchmark for the overall market. The diversification benefits were measured in terms of standard deviation at the selected level of return, and calculated using formula (7) with given restrictions.

$$(7) \quad \min_{\omega} \omega' \Omega \omega$$

subject to the following restrictions
$\omega' R = \bar{r}$
$\omega' I = 1$

Where:
ω is the weight vector of investment shares
Ω is the covariance matrix between investment returns
R is the vector of expected returns on investment items
I is a unit vector
$\bar{r}$ is the target return of the investment portfolio

6 RESULTS

The purpose of this study was to analyse the historical performance of individual companies operating in the Australian water sector and compare their performance with the overall markets. Particularly, the study aimed to fill gap in existing research by incorporating climate variables into the economic analysis. To test the working hypothesis of the study, the logarithmic excess returns of the 11 stocks and the 3 indices were computed.

After computing the logarithmic returns, the data was analysed through regression models based on the Capital Asset Pricing Model (CAPM), which assumes that the overall market performance is a significant factor in determining stock performance. The regression analysis started with simple Ordinary Least Squares (OLS) models and gradually incorporated additional control variables, including those that have been identified in previous research studies. The weather variables were the only exception among the selected variables not incorporated by previous studies.

Based on the findings on the logarithmic returns and regression models, a further evaluation of the diversification potential of water companies for investors was conducted. This was done by calculating the expected annual return of the Market Index and incorporating the water companies into the investor's portfolio. The adequate weights for water stocks were calculated first by setting the risk level to level of Market Index. The portfolio diversification was also analysed by setting the wanted risk level and by calculating the corresponding portfolio weightings. The results of analysis are presented in the following paragraphs.

6.1.1 The Logarithmic Index Returns

The study analysed the daily and monthly logarithmic returns of the Market, Energy, and Food Producer Price indices. The statistics of the daily and monthly logarithmic returns for the entire time period are presented in TABLE 3 and TABLE 4, respectively. On daily data, the Market Index had the smallest negative daily return of -10.20 and the highest positive return of 6.76. The standard deviation was 1.0009 and the average daily return was 0.0039. The Energy Index had a slightly higher negative daily return of -22.33, being slightly over twice as much as the Market Index, and the highest positive return of 9.19, being only 1.5 times greater as the Market Index, a slightly positive mean average daily return of 0.0118, and a higher standard deviation of 1.55, making it riskier than the Market Index, particularly towards negative. The Food Producer Price Index had the lowest daily return of -24.67, being roughly 2.5 times higher than the Market Index. The Food Producer Price Index had the highest return of 31.26, being over six-fold compared to the highest return of Market Index, a negative mean average daily return of -0.019, and the highest standard deviation of 1.77, making it the most volatile of the indices.

On monthly data, the Market Index had the lowest negative return of -23.82, which was more than twice as much as its daily data, and the highest return of 9.48, which was slightly higher than its daily data. The average return was 0.0013, with a standard deviation of almost 4. The Energy and Food Indices also showed similar trends, with the Energy Index having the lowest return of -47.78 and the Food Index having the lowest return of -44.40, both of which were almost twice as much as their daily data. The average monthly return for the Energy Index was 0.17 with a standard deviation of 6.77, which is over four-fold compared to the daily data, yet, making it the most attractive investment opportunity among the indices, while the Food Index had a negative average return of -0.50 with a standard deviation of 8.82, which is almost five-fold compared to the daily data.

Overall, the monthly data showed that negative returns were more significant, with mean average returns being slightly negative or close to zero and higher standard deviations, making the indices less attractive as investment opportunities. Among the indices, the Energy Index provided the most significant returns of 0.17 on monthly data, making it the most attractive investment opportunity.

TABLE 3 Daily logarithmic stock and index returns for 2000 – 2022

Ticker	Min	Max	Avrg.	Std.Dev.
REH	-12.629	15.886	0.043	1.654
WAT	-30.155	19.399	0.005	1.988
GWA	-19.190	16.600	-0.012	2.141
PET	-71.767	58.987	-0.001	4.819
1AG	-41.589	86.682	-0.086	6.428
1AGBER	-69.326	138.621	-0.063	13.098
PO3	-91.634	146.782	-0.151	11.153
D2O	-15.980	13.005	0.026	1.738
DEM	-20.068	31.583	-0.084	4.720
CNQ	-14.399	27.917	-0.032	5.323
RWL	-11.786	14.564	-0.107	3.230
Stock average	-36.229	51.820	-0.042	5.117

(continues)

TABLE 3 (continues)

Ticker	Min	Max	Avrg.	Std.Dev.
Market Index	-10.204	6.766	0.004	1.001
Energy Index	-22.326	9.193	0.012	1.556
Food Index	-24.667	31.264	-0.019	1.773
Index average	-19.066	15.741	-0.001	1.443

TABLE 4 Monthly logarithmic stock and index returns for 2000 - 2022

Ticker	Min	Max	Avrg.	Std.Dev.
REH	-23.428	19.963	0.849	6.246
WAT	-35.187	32.442	0.029	8.329
GWA	-31.661	33.729	-0.336	8.036
PET	-51.432	58.578	-0.068	17.071
1AG	-64.483	68.959	-1.866	22.327
1AGBER	-110.127	69.309	-1.357	29.279
PO3	-91.850	234.536	-3.295	40.134
D2O	-16.240	14.049	0.582	4.715
DEM	-38.614	44.721	-1.693	15.243
CNQ	-27.500	37.483	-3.954	17.549
RWL	-14.753	27.294	-3.203	13.121
Stock average	-45.934	58.278	-1.301	16.550
Market Index	-23.824	9.483	0.001	3.938
Energy index	-47.782	24.965	0.174	6.769
Food Index	-44.397	28.492	-0.498	8.816
Index average	-38.668	20.980	-0.107	6.508

6.1.2 The Logarithmic Stock Returns

The logarithmic returns were also calculated on stock data. The analysis shows that, on a daily basis, PO3 had the highest negative return of -91.63 and the highest positive return of 146.78. Meanwhile, RWL had the lowest negative return at -11.79. Out of the 11 stocks, only REH, WAT, and D20 produced positive average daily returns, with an average return of 0.02, while the rest of the stocks had an average negative return of -0.07. The average standard deviation of positively performing stocks was 1.79, while negatively performing stocks had a much higher average standard deviation of 6.36, being over 3.5 times greater than with positively performing stocks. The analysis of daily returns suggests that on average, the water industry does not provide positive returns and that the industry appears to be a risky investment, with substantial variation in returns.

On a monthly basis, RWL had the lowest negative return at -14.75 and 1AGBER had the highest negative return at -110.13. D20 had the lowest positive monthly return of 14.05, and PO3 had the highest positive return at 234.54. The same three stocks, REH, WAT, and D20, produced positive monthly average returns, while the rest of the companies had negative average returns. Positively performing stocks had an average monthly return of 0.49 with a standard deviation of 6.43, while negatively performing stocks had an average negative monthly return of -1.97 with a standard deviation of 20.34. Positive returns for positively performing stocks are around four times higher compared to negatively performing stocks, and the volatility is only one-third of that of negatively performing stocks. It is also noteworthy, that the average standard deviation of positively performing stocks is lower compared to the Energy and Food Indices. In conclusion, the three positively performing water stocks, REH, WAT, and D20, may provide diversification value for an investor's portfolio as their average standard deviation is in the same regime as the Energy and Food Indices in daily data and lower in monthly data.

6.2 The Linear Regression Results

The study continued by utilizing ordinary least squares (OLS) regression to analyse stock market returns in CAPM framework. The Regression models used for analysis were progressively augmented with additional explanatory variables. Based on existing research literature, the time series are assumed to be heteroscedastic and therefore heteroscedastic-robust standard errors are used.

6.2.1 Regression 1

The study continued with a linear regression analysis (Regression model 1) to explain the excess returns of water stocks by considering three explanatory variables: Market Index, Interest Rate, and the Slope of the interest yield curve. The analysis was conducted using daily data over the entire period, and the results are summarized in TABLE 7 in appendix. The first regression's adjusted R^2 value ranges from a low of 0.001 for WAT to a suspiciously high 0.500 for 1AGBER, with a moderate average value of 0.074. Except for GWA with a value of 0.176, the model provides a moderate fit, suggesting low explanatory power.

The results show that the Market Index was a statistically significant variable at the 5% significance level for three stocks (REH, GWA, and PET) while other variables were not statistically significant for these companies. This is an exceptional result implying that most of the water equity returns do not correlate with the market return. Regarding possible diversification gains this is good news. Interestingly, the Market Index was only significant for the stocks that were previously suggested to provide diversification value in the logarithmic returns analysis. On the other hand, the 2-year government interest rate was significant for stocks PO3 and DEM, while the slope of the yield curve was significant for stocks D20 and CNQ. If the level of statistical significance is loosened up to 10%, both the Slope and Interest Rate becomes statistically significant for DEM and CNQ. These results indicate that interest rate and the Slope of the yield curve play some role in explaining the returns for these specific stocks aligning with previous studies.

6.2.2 Regression 2

To gain further insights, the linear Regression Model 2, containing three index explanatory variables, Market Index, Energy Index, and Food Index, was used. The data was analysed using both daily and monthly data, divided into two periods, the full period 2000-2022 and the sub-period 2012-2022. The results of Regression 2 are presented in TABLES 8 to 11 in appendix.

The adjusted R^2 measure of Regression model 2 continued to show poor results for daily data from 2000-2022 with a range from 0.000 for WAT, 1AG, PO3, and D20 to 0.500 for 1AGBER, averaging 0.068. Over the sub-period 2012-2022, the lowest value was 0.000 for D20 and highest was 0.194 for GWA, with an average of 0.028. Notably, both 1AG and 1AGBER had negative adjusted R^2 values of -0.001. For monthly data over the whole period, the overall fit slightly improved with lowest value of 0.023 for PET and 1AG and highest value of 0.315 for RWL averaging 0.063. Over the sub-period of 2012-2022, the fit of the model remained fairly same as for the full period, with a low of 0.022 for PO3 and a high of 0.315 for RWL, averaging 0.061. REH and GWA also improved, with values of 0.125 and 0.149, respectively. In the full period of monthly data, D20 and CNQ had negative adjusted R^2 values.

The results of Regression 2 are consistent with those of Regression 1, where the Market Index was a statistically significant explanatory variable at the 5% significance level only for stocks REH and GWA, both in daily and monthly data and over the full and sub-periods. An interesting anomaly was found in the case of PET, where the Market Index was significant for the full period in both daily and monthly data but not for the sub-period. The Energy Index was significant in daily data for the sub-period.

Out of the three stocks analysed, only REH, GWA, and PET had two statistically significant variables in either daily or monthly data or in the full or sub-periods. For instance, REH had statistically significant values for the Market Index and Energy Index in daily data from 2012 onwards, and for the Market Index and Food Index in monthly data from the sub-period 2012-2022. GWA had statistically significant values for the Market Index and Food Index in daily data for the full period, and for the Market Index and Energy Index in daily data from 2012 onwards.

For the remaining stocks, the results were unsystematic. For example, WAT had a statistically significant value only for the Market Index variable in monthly data covering the full period, and 1AG did not have any statistically significant variables, while 1AGBER received significant value only for the Food Index in monthly data for the full period. PO3 received a statistically significant value only for the Food Index in daily data from 2012 onwards, while D20, DEM, CNQ, and RWL had no statistically significant variables in regression 2 at all.

If the restriction of statistical significance is again loosened up to 10%, the consistency of the results improves on daily data for both the full period 2000-2022 and the sub-period 2012-2022 but not in monthly data. With 10% significance level, D20 receives statistical significance for Market Index on daily data for full period, while PO3 receives statistical significance for Market Index on daily returns for the sub period only and CNQ receives statistical significance for Market Index on daily data for both full period as well as sub period. As an improvement of the fir of the model, GWA receives statistical significance for Food Index in daily returns for the sub period and both DEM and CNQ receives statistical significance for the Interest Rate and the Slope.

6.2.3 Regression 3

Regression model 3 further extends the analysis of water stock excess returns by incorporating five explanatory variables (Market Index, Energy Index, Food Index, Interest Rate, and Slope) using both daily and monthly data. The data was again divided into two periods: the full period 2000-2022 and the sub-period 2012-2022, and regression was performed on all four data series. The results of Regression 3 are presented in TABLES 12 to 13 in appendix.

The results of Regression model 3 continued to show poor performance in terms of the adjusted R^2 measure for daily data from 2000-2022, with values ranging from 0.000 for WAT and 1AG to 0.499 for 1AGBER, with an average of 0.074. In the sub-period 2012-2022, the model's performance decreased with the lowest value being 0.002 for WAT and the highest being 0.194 for GWA, with an average of 0.031. Again, both 1AG and 1AGBER had negative adjusted R^2 values of -0.001. In the full period of 2000-2022, the fit of the model was similar to daily data, with a low of 0.011 for PO3 and a high of 0.258 for RWL, averaging 0.039. Over the sub-period, the monthly data showed a decrease in the overall fit of the model compared to daily data, with the lowest positive value of 0.000 for PET and the highest value of 0.258 for RWL, averaging 0.033. Notably, four stocks received negative R^2 values: 1AGBER (-0.013), PO3 (-0.001), D20 (-0.052), and CNQ (-0.229).

The results of Regression 3 were consistent with those of Regressions 1 and 2, with the Market Index continuing to be a statistically significant explanatory variable at the 5% significance level for stocks REH and GWA in both daily and monthly data and over both the full and sub-periods. PET exhibited similar behaviour as in previous regressions, with the Market Index being a significant explanatory factor for the full period in both daily and monthly data, but not for the sub-period 2012 onwards. PET also received a statistically significant value for the Energy Index in daily data from 2012 onwards, as seen in Regression 2. Like in Regression 2, REH, GWA, and PET remained the only stocks with two statistically significant variables at 5% level in either daily or monthly data or in the full or sub-periods. For example, REH continued to receive statistically significant values for the Market Index and Energy Index in daily data from 2012 onwards, and for the Market Index and Food Index in monthly data from the sub-period (2012-2022). GWA continued to receive statistically significant values for the Market Index and Food Index in daily data for the full period, and for the Market Index and Energy Index in daily data from 2012 onwards.

The results for the remaining stocks remained separate and unsystematic. For example, a change from previous regressions was seen in DEM, which received statistically significant values for the Interest Rate in all four data series. CNQ and D20 both received significance for the Slope in daily returns for the full and sub-periods, but not in monthly data. RWL and 1AGBER continued to not receive statistically significant variables, as seen in Regression 2. Finally, 1AG received statistical significance only for the Market Index in monthly returns for the full period.

The results of the Regression 3 analysis show improved statistical significance when the significance level is relaxed to 10%. The largest improvement can be seen in the results for DEM and CNQ. DEM demonstrates statistical significance in the Slope of the interest yield on daily returns for both periods, but not for monthly returns. Meanwhile, CNQ receives statistical significance at the 10% level for the Interest Rate in both periods for daily data. PO3 also shows a less systematic improvement, where the Market Index becomes statistically significant for daily returns in the sub-period. Additionally, GWA demonstrates up to three statistically significant explanatory factors in daily returns for the sub-period.

6.2.4 Regression 4

Regression model 4 strive to answer the first research question on whether climate variables are significant factors explaining water company returns. The null hypothesis [H_0] is that rainfall and temperature do not have an impact on the returns of water companies. The analysis is conducted by augmenting Regression model 3 with two weather variables and incorporating in total seven explanatory variables (Market Index, Energy Index, Food Index, Interest Rate, Slope, Temperature, and Rain) using only monthly data due to the availability of weather data for Temperature and Rain on a monthly basis only for whole Australia. The data was again divided into two periods, and regression was performed for both data series. The results from Regression 4 are presented in TABLES 16 and 17 in appendix.

In terms of the adjusted R^2 measure in Regression 4 shows the strongest average explanatory power compared to the previous models. Over the full period 2000-2022, the adjusted R^2 ranges from a low of 0.002 for 1AG to a high of 0.475 for CNQ, with an average of 0.110. Only D20 has a negative adjusted R^2 of -0.083. Over the sub-period 2012-2022, the lowest adjusted R^2 is 0.001 for 1AG and the highest is 0.182 for REH. Three stocks, D20, CNQ, and RWL, have negative adjusted R^2 values (-0.107, -1.298 and -2.050, respectively).

The results of Regression 4 are consistent with the previous regressions, with the Market Index remaining a statistically significant explanatory variable at 5% level for REH and GWA in both the full and sub periods. REH is the only stock to receive two statistically significant variables, with the Food Index being significant in the sub period 2012-2022 but not in the full period.

For the remaining stocks, PET received a statistically significant value at the 5% for the Market Index only in the full period but not in the sub period. No other stocks received statistically significant variables. It is notable that among all the analysed stocks, only Temperature received a statistically significant value for 1AG in the sub period 2012-2022.

The results of the regression analysis show limited improvement upon relaxing the statistical significance level from 5% to 10%. In the case of WAT, the Interest Rate only becomes statistically significant for the sub-period, while the Food Index only becomes significant for 1AG in the sub-period. The Market Index does show statistical significance for 1AGBER over the whole period, but not in the sub-period. The most consistent improvement can be seen in DEM, where the Interest Rate becomes statistically significant at the 10% level for both periods.

Overall, assuming the companies are correctly categorised as water companies, the results suggest that the variables suggested by previous literature, namely, the Energy Index, Food Index, and Interest Rate, are not significant explanatory variables in these models. Additionally, Regression model 4 performs the poorest in explaining the excess returns among all models so far.

Since to the best of knowledge, previous research literature has not used weather variables to explain excess returns in the water industry, no comparison to previous research findings can be made. The extension of weather variables to capture the impact of weather variations on the stock performance of water companies provides a surprising and counterintuitive result. The weather variables, Rain and Temperature, do not have a statistically significant impact on water stock returns. This result is striking and contradicts observations made in Chapter 3.1 regarding Australia's Water Market and Trading and the opportunity for arbitrage due to different water prices in different regions and a working market mechanism that reflects the "true value" of water and allocates it to the most profitable usage.

Three possible explanations arise for why weather variations and thereby water levels are not reflected in water stock returns. Firstly, the water pricing mechanism in Australia may not work accordingly, resulting in different price for different users and therefore only part of the consumers experience variations in water prices during droughts. Water used in agriculture may require less processing and can be extracted directly from water bodies. Though agricultural sector face competitive water prices on the market because there is no need for the water processing, the changes in water levels and prices are not transmitted to the returns on water stocks. For the urban consumers, the water pricing may be more rigid due legislation than for agricultural sector and cannot fluctuate as in free markets and therefore urban consumers face restrictions in water consumption rather than experiencing price variation. It is possible that in this case the public sector absorbs some of the raising costs that are not passed to urban consumers.

Secondly, there may be price variation in water prices and it affects to all companies operating on water sector but companies operating in the secondary water sector are somehow able to may absorb variations in water prices without it influencing their returns, which is unlikely since their purpose is to maximize profits. Lastly, the third explanation is related to investor behaviour: Either investors are willing to accept lower returns during droughts which also seems unlikely since investors generally are not perceived as altruistically behaving or more likely, there may be some inefficiency in water stock pricing, and the information is not perfectly transmitted to share prices. This would contradict either the efficient market hypothesis (EMH) or the underlying assumption in general economic theory that investors are rational. In either case, if the water stocks are undervalued, this may provide investors excess returns or diversification value.

6.2.5 Regression 5

The final regression model (Regression model 5) extended the Regression model 3 by incorporating ASVI keyword data from Google searches. The regression aimed to answer the second research question whether awareness on climate change has an impact on investor behaviour and if Google searches can be used to explain water company returns in Australia. The null hypothesis [H_0] tested was that google searches don't have an explanatory power. The research question was modelled in the footsteps of Piñeiro-Chousa et al. (2020). The used keywords were *drought*, *water*, *climate change* and *warming.*

The results from Regression 5 aligned with previous regressions by showing weak correlations with overall markets. The results are presented in TABLE 18 in appendix. From original regressors of Regression Model 3, only Market Index receives a statistically significant results at 5% significance level for stocks REH, GWA and PET and with 10% significance level, for 1AGBER. From the index regressors, Energy Index and Food Index receive statistical significance at 10% level for REH with values of 0.055 and 0.053, respectively. From the other original regressors, only Interest Rate received statistical significance for DEM at 10% level.

Regarding the ASVI keyword variables, the results are contradictory with findings of Piñeiro-Chousa et al. (2020); From all tested water company stocks, only keyword *water* receives statistically significant result at 10% significance level for WAT with significance of 0.064. Besides this exception, none of the used keywords is statistically significant leading us to keep the null hypothesis in power and concluding that at least these keywords are not good predictors for investor behaviour. The result is unexpected, given the increasing awareness and media coverage of climate change within past 10 years and the fact, that climate change has been identified as one of the key drivers of future development for water sector in recent studies regarding water industry as stated in the literature overview. The non-existing correlation between the Google searches and water stock performance could be seen as confirmation for investor irrationality or challenges in information transmission to stock prices as described in results of Regression model 4. It may be that the general public is aware of climate change to extent but the investors have not yet fully found the sector and the companies operating on it.

6.3 Portfolio Diversification Analysis Results

In the final part of this study, the benefits of diversifying a stock portfolio with water stocks in the footsteps of Roca et al. (2015) were assessed to answer the third research question with the null hypothesis [H_0] Water equities do not provide diversification benefit to an Australian equity portfolio. To test the hypothesis, all stocks with available data for the entire period were selected and their monthly returns and standard deviations were calculated and aggregated to the annual expected return. These results are displayed in TABLE 5.

The market index had an expected annual return of 4.98% with a standard deviation of 4.06. The diversification value of the stocks was calculated by forming different combinations of the market index and stocks and calculating the portfolio's standard deviation. The portfolio weights, expected returns, and standard deviations are shown in TABLE 6.

Three portfolios were created to evaluate the diversification benefits:

1. The first portfolio included the Market Index and all stocks, with an expected return set to 4.98%. By including all the stocks in the portfolio, the standard deviation of the portfolio decreased from 4.06 to 3.84, reducing risk and providing diversification benefits.
2. The second portfolio consisted of the Market Index and only the stocks with positive monthly returns. The expected return increased to 10%, while the standard deviation of the portfolio decreased to 3.76, further reducing the investors' risk.
3. The third portfolio consisted solely of water company stocks. The expected return of this portfolio rose to 14.31% with a standard deviation of 5.00.

TABLE 5 Monthly returns and expected annual returns for 2000 - 2022

	REH	**WAT**	**GWA**	**1AG**	**1AG-BER**	**Market Index**
Mean monthly return	1.01 %	1.32 %	-0.09 %	-0.92 %	-0.68 %	0.41 %
Expected annual return	12.13 %	15.80 %	-1.14 %	-11.09 %	-8.19 %	4.98 %
Standard deviation	6.42	6.52	8.78	21.68	28.00	4.06

TABLE 6 Portfolio weights and Std.Dev. with selected expected returns

Stock	**Portfolio Weights**		
REH	3 %	22 %	41 %
WAT	9 %	32 %	59 %
GWA	9 %	0 %	0 %
1AG	4 %	0 %	0 %
1AG BER	0 %	0 %	0 %
Market Index	76 %	46 %	0 %

Expected annual return	4.98 %	10.00 %	14.31 %
Variance	14.77	14.12	24.97
Standard deviation	3.84	3.76	5.00

The results from diversification of the investment portfolio are surprising while aligning with the findings of Roca et al. (2015) that water stock may provide diversification value by providing higher returns while decreasing the idiosyncratic risk of the portfolio. In conclusion, the results of this study suggest that diversifying a portfolio with water stocks can reduce risk, increase expected returns, and provide diversification benefits, which is consistent with the findings of previous research in the field.

7 CONCLUSIONS

Water is a necessity for human life secured in the UN Declaration of Human Rights. At the same time, water is also a renewable, but scarce economic resource that affect almost all economic activities, from urban water consumption to industrial production and agriculture. Global water resources are threatened by increased consumption due to population growth, urbanization, rising living standards and climate change. Due to these facts, scarce water resources must be allocated to the most economically productive purposes. In Australia, water scarcity has already partially materialized and the situation can be assumed to worsen in the future. Australia has solved the water allocation problem by creating advanced water market to allocate water efficiently.

This master's thesis has analysed the Australian water industry trough literature overview and empirical analysis. Previous research literature has focused on the water industry as an investment opportunity mainly from a global and comprehensive perspective, and the conclusions have been contradictory. Some of the research literature has found empirical evidence that the water industry can generate excess returns compared to the overall market and offer the investor a diversification benefit, while some studies have not found similar evidence. Recent studies in water industry have had in common that they have all recognized climate change as an important driver of change in the sector, but so far studies have not included climate variables in the empirical analysis. This study aimed to address this aspect.

The empirical part of the thesis examines the performance of 11 water companies operating in the Australian market over the period from January 2000 to August 2022. The data included both daily and monthly observations of the selected stocks retrieved from Refinitiv Datastream. Stock returns in relation to the overall market were analysed by OLS linear regression using the explanatory variables suggested by existing research literature. The model started with simple CAPM based regression gradually extending the model with additional explanatory variables including the climate variables of rainfall and temperature with the purpose of answering the first research question of whether weather variables can be used to explain the stock returns of Australian water companies.

The results from linear regression showed that most of the variables used, including weather variables, were not statistically significant at the 5% significance level. The explanatory power of the models for the performance of water companies was also modest, even when the level of statistical significance was relaxed to 10% level. The beta coefficients appear to change slightly when comparing daily and monthly returns, but there is no discernible pattern in how they change.

The regression models employed in this study produced mediocre results when evaluating adjusted R^2 and 5% statistical significance. While some improvement was seen when the statistical significance level was relaxed to 10%, the overall explanatory power of the models remained low or extremely low.

These results indicate that the regression models are unlikely to provide a practical economic advantage for investors seeking excess returns in the Australian stock markets and water sector. The results from regression analyse and the low correlation with the overall markets does suggest possibility for diversification benefit.

As presented in chapter 2.3, most Australian water companies are government-owned and not publicly traded. Among the private water companies that operate in the primary water sector, only a small number are publicly available for investors. This aligns with the previously stated observation that only 10% of private water companies are listed on stock markets and none of the selected companies operate in the primary water industry, that is, water purification and distribution.

One possible reason for the poor performance of the regression models is that most of the companies analysed in this study operate in the secondary water sector and are influenced by other market factors not captured by the regression models used. Another possible reason for the poor performance of the regression models is that along operating in the secondary water industry, many of the companies also operate outside Australia and therefore local weather variables have no explanatory power for the overall returns of the stock.

By observing the performance of ASX 200 index, it stood out that the performance of the Australian market in relation to the standard deviation of returns remains low. This may be a characteristic of the Australian market and one explanation for the poor performance of water companies. The economic recovery from the 2008-2009 collapse has been slow, and the ASX 200 index only reached pre-collapse levels around 2019. This sluggish recovery may be partially due to the lack of quantitative easing in Australia during the COVID-19 pandemic compared to the substantial quantitative easing provided in Europe and United States where economic recovery has been stronger. The share prices of a few water companies, REH, WAT, PET and D2O, began to rise in 2019, possibly due to the bushfires of 2019-2020. It is noteworthy that, with the exception of REH, the share prices of these water companies continued to rise during the COVID-19 pandemic.

The second research question of diversification benefits of water sector was implied by existing research literature as well as the results from regression analysis. The diversification benefit of the water stocks was analysed by calculating the expected annual returns of the shares and forming differently weighted portfolios from the ASX:200 index representing the overall market and water shares. The diversification benefit was measured by the standard deviation of the return. The surprising result was that by adding water companies in the portfolio, the Australian investor may both increase the expected returns and lower the riskiness of portfolio, aligning with the similar results of Roca et al. (2015). This finding would suggest that all rational investors should include water companies in their portfolio.

In recent years climate change has received an increasing coverage and attention in news, social media and among general public. In Australia's case, the harsh reality of climate change culminated in the 2019-20 bushfires burning over

30,000 square kilometres of land, killing an estimated billion animals and possibly causing the extinction of some species, causing billions of economic losses and affecting millions of people. The third research question aimed to study if this media attention has an impact on performance of water stock returns. The hypothesis was investigated using ASVI search word data from Google Search as control variables in the fifth regression model. The results were surprising for no correlation was found between the Google search terms used and stock returns. This finding suggests that the news and risks regarding climate change has not translated into attention to water companies or water sector broader.

An important conclusion is that investing in the water industry is still a relatively new phenomenon, and investors have not yet fully embraced it. Water industry and related problems are often associated with developing countries, such as Africa, rather than developed countries. In the case of developing countries the reason why investors have not found them as attractive investment opportunities might partially be explained by low purchasing power. Also, factors such as corruption, political instability, and weak property rights and protection may discourage significant investments in fixed infrastructure for long periods. It's worth noting that Africa is not a monolithic entity and it's worth differentiating between countries in terms of investment environments and economic systems. It is also worth noting that water-related challenges are not only a problem for developing countries, but developed countries are increasingly facing water-related challenges with aging infrastructure that was designed decades ago for very different purposes and for very different numbers of users.

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APPENDICES

APPENDIX 1 Regression result tables from regressions 1 to 5

TABLE 7 Regression 1 results with daily data for 2000 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.030	0.078	0.704		0.031	0.000
	market index	0.294	0.028	0.000	***		
	gvt. 2y rate	-0.191	5.354	0.972			
	slope	8.690	20.752	0.675			
WAT	(Intercept)	0.004	0.083	0.957		0.001	0.108
	market index	0.015	0.033	0.648			
	gvt. 2y rate	-5.141	5.422	0.343			
	slope	31.415	27.058	0.246			
GWA	(Intercept)	-0.050	0.098	0.609		0.176	0.000
	market index	0.898	0.037	0.000	***		
	gvt. 2y rate	1.963	6.275	0.755			
	slope	9.739	27.090	0.719			
PET	(Intercept)	0.077	0.250	0.759		0.024	0.000
	market index	0.744	0.146	0.000	***		
	gvt. 2y rate	-6.582	17.037	0.699			
	slope	-13.928	69.705	0.842			
1AG	(Intercept)	1.000	0.000	0.000	***	0.000	0.189
	market index	0.000	0.000	0.319			
	gvt. 2y rate	-0.104	0.104	0.318			
	slope	0.182	0.183	0.319			
1AGBER	(Intercept)	1.000	0.000	0.000	***	0.500	0.000
	market index	0.000	0.000	0.318			
	gvt. 2y rate	0.000	0.000	0.318			
	slope	0.000	0.000	0.318			
PO3	(Intercept)	0.916	0.013	0.000	***	0.035	0.000
	market index	-0.003	0.003	0.306			
	gvt. 2y rate	9.832	1.147	0.000	***		
	slope	1.133	4.291	0.792			
D20	(Intercept)	0.688	0.041	0.000	***	0.002	0.084
	market index	-0.008	0.011	0.442			
	gvt. 2y rate	3.387	5.599	0.545			
	slope	-27.179	13.744	0.048	***		
DEM	(Intercept)	0.999	0.003	0.000	***	0.006	0.010
	market index	0.000	0.001	0.906			
	gvt. 2y rate	1.371	0.637	0.032	**		
	slope	-3.107	1.769	0.079	*		

(continues)

TABLE 7 (continues)

CNQ	(Intercept)	1.288	0.200	0.000	***	0.018	0.036
	market index	0.036	0.031	0.238			
	gvt. 2y rate	-26.898	15.204	0.078	*		
	slope	-128.834	54.998	0.020	**		
RWL	(Intercept)	0.676	0.227	0.003	***	0.022	0.032
	market index	-0.045	0.023	0.054	*		
	gvt. 2y rate	23.422	17.434	0.180			
	slope	30.285	57.021	0.596			

Significance level: * 10% ** 5% *** 1%

TABLE 8 Regression 2 results with daily data for 2000 – 2022

Stock	**Coefficients**	**Estimate**	**Std. Error**	**Prob.**		**Adj. R2**	**Prob.**
REH	(Intercept)	0.043	0.021	0.040	**	0.034	0.000
	market index	0.326	0.039	0.000	***		
	energy index	-0.012	0.023	0.599			
	food index	-0.013	0.023	0.563			
WAT	(Intercept)	0.006	0.026	0.817		0.000	0.563
	market index	-0.018	0.053	0.733			
	energy index	0.031	0.030	0.296			
	food index	-0.005	0.028	0.860			
GWA	(Intercept)	-0.014	0.025	0.576		0.178	0.000
	market index	0.904	0.053	0.000	***		
	energy index	-0.035	0.029	0.222			
	food index	0.054	0.027	0.048	**		
PET	(Intercept)	-0.006	0.066	0.931		0.025	0.000
	market index	0.638	0.150	0.000	***		
	energy index	0.085	0.081	0.294			
	food index	0.012	0.105	0.905			
1AG	(Intercept)	1.000	0.000	0.000	***	0.000	0.702
	market index	0.000	0.000	0.323			
	energy index	0.000	0.000	0.325			
	food index	0.000	0.000	0.321			
1AGBER	(Intercept)	1.000	0.000	0.000	***	0.500	0.000
	market index	0.000	0.000	0.327			
	energy index	0.000	0.000	0.320			
	food index	0.000	0.000	0.335			

(continues)

TABLE 8 (continues)

PO3	(Intercept)	0.972	0.003	0.000	***	0.000	0.679
	market index	-0.005	0.005	0.387			
	energy index	0.000	0.003	0.927			
	food index	0.001	0.002	0.726			
D20	(Intercept)	0.642	0.012	0.000	***	0.000	0.312
	market index	-0.039	0.021	0.066	*		
	energy index	0.017	0.010	0.104			
	food index	0.012	0.013	0.367			
DEM	(Intercept)	0.996	0.002	0.000	***	0.001	0.248
	market index	0.003	0.003	0.376			
	energy index	-0.002	0.002	0.172			
	food index	0.001	0.002	0.731			
CNQ	(Intercept)	0.834	0.021	0.000	***	0.002	0.318
	market index	0.060	0.036	0.098	*		
	energy index	-0.010	0.013	0.449			
	food index	-0.023	0.021	0.266			
RWL	(Intercept)	0.855	0.022	0.000	***	0.008	0.174
	market index	-0.040	0.026	0.126			
	energy index	0.003	0.013	0.789			
	food index	-0.020	0.022	0.359			

Significance level: * 10% ** 5% *** 1%

TABLE 9 Regression 2 results with daily data for 2012 – 2022

Stock	**Coefficients**	**Estimate**	**Std. Error**	**Prob.**		**Adj. R2**	**Prob.**
REH	(Intercept)	0.038	0.030	0.196		0.089	0.000
	market index	0.665	0.066	0.000	***		
	energy index	-0.098	0.031	0.002	***		
	food index	-0.045	0.037	0.227			
WAT	(Intercept)	0.040	0.031	0.203		0.002	0.020
	market index	0.056	0.067	0.404			
	energy index	0.032	0.027	0.233			
	food index	-0.001	0.040	0.978			
GWA	(Intercept)	-0.024	0.037	0.521		0.194	0.000
	market index	1.073	0.089	0.000	***		
	energy index	-0.095	0.037	0.009	***		
	food index	0.080	0.046	0.078	*		

(continues)

TABLE 9 (continues)

PET	(Intercept)	0.048	0.087	0.583		0.013	0.000
	market index	0.161	0.175	0.358			
	energy index	0.236	0.077	0.002	***		
	food index	0.073	0.111	0.512			
1AG	(Intercept)	-0.090	0.111	0.419		-0.001	0.716
	market index	0.228	0.225	0.312			
	energy index	-0.075	0.108	0.488			
	food index	-0.094	0.125	0.450			
1AG-BER	(Intercept)	-0.092	0.256	0.719		-0.001	0.813
	market index	0.176	0.470	0.708			
	energy index	-0.068	0.246	0.781			
	food index	0.144	0.272	0.595			
PO3	(Intercept)	-0.094	0.216	0.663		0.002	0.043
	market index	0.682	0.399	0.087	*		
	energy index	0.057	0.235	0.807			
	food index	-0.513	0.258	0.047	**		
D20	(Intercept)	0.642	0.012	0.000	***	0.000	0.312
	market index	-0.039	0.021	0.066	*		
	energy index	0.017	0.010	0.104			
	food index	0.012	0.013	0.367			
DEM	(Intercept)	0.996	0.002	0.000	***	0.001	0.248
	market index	0.003	0.003	0.376			
	energy index	-0.002	0.002	0.172			
	food index	0.001	0.002	0.731			
CNQ	(Intercept)	0.834	0.021	0.000	***	0.002	0.318
	market index	0.060	0.036	0.098	*		
	energy index	-0.010	0.013	0.449			
	food index	-0.023	0.021	0.266			
RWL	(Intercept)	0.855	0.022	0.000	***	0.008	0.174
	market index	-0.040	0.026	0.126			
	energy index	0.003	0.013	0.789			
	food index	-0.020	0.022	0.359			

Significance level: * 10% ** 5% *** 1%

TABLE 10 Regression 2 results with monthly data for 2000 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.900	0.363	0.014	**	0.125	0.000
	market index	0.704	0.163	0.000	***		
	energy index	-0.112	0.098	0.256			
	food index	-0.025	0.083	0.764			
WAT	(Intercept)	0.045	0.499	0.928		0.027	0.017
	market index	0.411	0.196	0.037	**		
	energy index	-0.009	0.108	0.936			
	food index	0.015	0.123	0.903			
GWA	(Intercept)	-0.341	0.458	0.457		0.149	0.000
	market index	0.821	0.157	0.000	***		
	energy index	-0.082	0.083	0.326			
	food index	0.131	0.095	0.170			
PET	(Intercept)	-0.068	1.094	0.950		0.023	0.036
	market index	0.870	0.385	0.025	**		
	energy index	0.019	0.208	0.928			
	food index	-0.261	0.256	0.310			
1AG	(Intercept)	-1.886	1.739	0.280		0.023	0.078
	market index	0.804	0.726	0.269			
	energy index	-0.154	0.309	0.620			
	food index	0.508	0.360	0.160			
1AGBER	(Intercept)	-1.510	2.353	0.522		0.033	0.038
	market index	1.837	0.926	0.049	**		
	energy index	-0.127	0.510	0.803			
	food index	-0.305	0.512	0.552			
PO3	(Intercept)	-3.676	3.368	0.277		0.024	0.096
	market index	1.908	1.206	0.116			
	energy index	-0.225	0.740	0.761			
	food index	0.652	0.774	0.401			
D2O	(Intercept)	0.539	0.604	0.376		-0.035	0.895
	market index	0.054	0.260	0.836			
	energy index	0.014	0.100	0.892			
	food index	0.038	0.143	0.792			
DEM	(Intercept)	-1.542	2.053	0.456		0.022	0.231
	market index	0.669	0.647	0.305			
	energy index	0.164	0.315	0.605			
	food index	-0.520	0.459	0.261			

(continues)

TABLE 10 (continues)

CNQ	(Intercept)	-2.139	7.879	0.792		-0.007	0.447
	market index	1.765	1.849	0.365			
	energy index	-0.298	0.952	0.762			
	food index	0.326	1.012	0.755			
RWL	(Intercept)	-3.030	3.574	0.425		0.315	0.141
	market index	1.860	1.574	0.276			
	energy index	0.485	0.861	0.591			
	food index	0.169	1.001	0.871			

Significance level: * 10% ** 5% *** 1%

TABLE 11 Regression 2 results with monthly data for 2012 – 2022

Stock	**Coefficients**	**Estimate**	**Std. Error**	**Prob.**		**Adj. R2**	**Prob.**
REH	(Intercept)	0.693	0.588	0.241		0.173	0.000
	market index	1.164	0.304	0.000	***		
	energy index	-0.275	0.155	0.078			
	food index	-0.372	0.150	0.014	**		
WAT	(Intercept)	0.837	0.520	0.110		0.025	0.107
	market index	0.000	0.163	0.998			
	energy index	0.116	0.083	0.167			
	food index	0.148	0.114	0.197			
GWA	(Intercept)	-0.449	0.798	0.575		0.112	0.000
	market index	0.844	0.321	0.010	**		
	energy index	-0.076	0.135	0.575			
	food index	0.094	0.185	0.612			
PET	(Intercept)	0.986	1.651	0.552		0.007	0.277
	market index	0.617	0.553	0.267			
	energy index	0.184	0.265	0.489			
	food index	-0.502	0.395	0.207			
1AG	(Intercept)	-2.105	1.857	0.259		0.009	0.246
	market index	0.019	0.808	0.982			
	energy index	-0.088	0.328	0.788			
	food index	0.787	0.443	0.078			
1AGBER	(Intercept)	-2.286	2.710	0.401		0.002	0.352
	market index	1.380	1.100	0.212			
	energy index	-0.070	0.571	0.902			
	food index	-0.317	0.619	0.609			

(continues)

TABLE 11 (continues)

PO3	(Intercept)	-2.579	3.650	0.481		0.014	0.190
	market index	1.289	1.236	0.299			
	energy index	-0.117	0.737	0.874			
	food index	0.923	0.815	0.260			
D20	(Intercept)	0.539	0.604	0.376		-0.035	0.895
	market index	0.054	0.260	0.836			
	energy index	0.014	0.100	0.892			
	food index	0.038	0.143	0.792			
DEM	(Intercept)	-1.542	2.053	0.456		0.022	0.230
	market index	0.669	0.647	0.305			
	energy index	0.164	0.315	0.605			
	food index	-0.520	0.459	0.261			
CNQ	(Intercept)	-2.139	7.879	0.792		-0.007	0.447
	market index	1.765	1.849	0.365			
	energy index	-0.298	0.952	0.762			
	food index	0.326	1.012	0.755			
RWL	(Intercept)	-3.030	3.574	0.425		0.315	0.141
	market index	1.860	1.574	0.276			
	energy index	0.485	0.861	0.591			
	food index	0.169	1.001	0.871			

Significance level: * 10% ** 5% *** 1%

TABLE 12 Regression 3 results with daily data for 2000 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.024	0.076	0.751		0.034	0.000
	market index	0.325	0.039	0.000	***		
	energy index	-0.012	0.023	0.606			
	food index	-0.013	0.023	0.573			
	gvt. 2y rate	0.366	5.231	0.944			
	slope	9.442	20.556	0.646			
WAT	(Intercept)	0.003	0.083	0.968		0.000	0.170
	market index	-0.022	0.053	0.674			
	energy index	0.033	0.030	0.270			
	food index	-0.003	0.028	0.915			
	gvt. 2y rate	-5.090	5.589	0.362			
	slope	32.023	27.065	0.237			

(continues)

TABLE 12 (continues)

GWA	(Intercept)	-0.059	0.099	0.549		0.178	0.000
	market index	0.905	0.053	0.000	***		
	energy index	-0.035	0.029	0.221			
	food index	0.054	0.027	0.047	**		
	gvt. 2y rate	2.774	6.374	0.663			
	slope	11.166	27.235	0.682			
PET	(Intercept)	0.082	0.251	0.744		0.024	0.000
	market index	0.637	0.150	0.000	***		
	energy index	0.085	0.081	0.291			
	food index	0.012	0.104	0.905			
	gvt. 2y rate	-7.174	17.162	0.676			
	slope	-13.827	69.500	0.842			
1AG	(Intercept)	1.000	0.000	0.000	***	0.000	0.415
	market index	0.000	0.000	0.332			
	energy index	0.000	0.000	0.327			
	food index	0.000	0.000	0.322			
	gvt. 2y rate	-0.104	0.105	0.318			
	slope	0.184	0.185	0.319			
1AGBER	(Intercept)	1.000	0.000	0.000	***	0.499	0.000
	market index	0.000	0.000	0.328			
	energy index	0.000	0.000	0.320			
	food index	0.000	0.000	0.335			
	gvt. 2y rate	0.000	0.000	0.318			
	slope	0.000	0.000	0.318			
PO3	(Intercept)	0.916	0.013	0.000	***	0.034	0.000
	market index	-0.004	0.005	0.470			
	energy index	0.000	0.003	0.995			
	food index	0.001	0.002	0.721			
	gvt. 2y rate	9.834	1.148	0.000	***		
	slope	1.152	4.298	0.789			
D20	(Intercept)	0.690	0.041	0.000	***	0.003	0.089
	market index	-0.037	0.021	0.079			
	energy index	0.017	0.010	0.104			
	food index	0.011	0.013	0.423			
	gvt. 2y rate	2.906	5.594	0.603			
	slope	-27.635	13.762	0.045	**		
DEM	(Intercept)	0.998	0.003	0.000	***	0.008	0.008
	market index	0.003	0.003	0.317			
	energy index	-0.003	0.002	0.164			
	food index	0.000	0.002	0.812			
	gvt. 2y rate	1.447	0.677	0.033	**		
	slope	-2.946	1.770	0.096	*		

(continues)

TABLE 12 (continues)

CNQ	(Intercept)	1.287	0.201	0.000	***	0.016	0.081
	market index	0.058	0.036	0.109			
	energy index	-0.010	0.013	0.448			
	food index	-0.023	0.021	0.264			
	gvt. 2y rate	-26.690	15.297	0.082	*		
	slope	-128.393	55.279	0.021	**		
RWL	(Intercept)	0.656	0.228	0.004	***	0.020	0.074
	market index	-0.038	0.026	0.155			
	energy index	0.004	0.012	0.726			
	food index	-0.022	0.023	0.334			
	gvt. 2y rate	24.948	17.664	0.159			
	slope	34.877	57.226	0.543			

Significance level: * 10% ** 5% *** 1%

TABLE 13 Regression 3 results with daily data for 2012 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.054	0.104	0.603		0.089	0.000
	market index	0.665	0.067	0.000	***		
	energy index	-0.098	0.031	0.002	***		
	food index	-0.045	0.038	0.230			
	gvt. 2y rate	-10.052	12.479	0.421			
	slope	15.103	34.347	0.660			
WAT	(Intercept)	0.136	0.103	0.188		0.002	0.045
	market index	0.055	0.067	0.406			
	energy index	0.033	0.027	0.227			
	food index	-0.001	0.040	0.972			
	gvt. 2y rate	-14.901	12.164	0.221			
	slope	-11.379	36.138	0.753			
GWA	(Intercept)	-0.010	0.126	0.934		0.194	0.000
	market index	1.073	0.089	0.000	***		
	energy index	-0.095	0.037	0.009	***		
	food index	0.080	0.046	0.079	*		
	gvt. 2y rate	4.314	15.148	0.776			
	slope	-15.881	37.639	0.673			

(continues)

TABLE 13 (continues)

PET	(Intercept)	0.018	0.322	0.955		0.013	0.000
	market index	0.162	0.175	0.356			
	energy index	0.236	0.077	0.002	***		
	food index	0.072	0.111	0.516			
	gvt. 2y rate	22.801	30.772	0.459			
	slope	-37.294	89.481	0.677			
1AG	(Intercept)	-0.127	0.343	0.711		-0.001	0.855
	market index	0.227	0.226	0.315			
	energy index	-0.075	0.108	0.486			
	food index	-0.093	0.125	0.456			
	gvt. 2y rate	-21.268	41.722	0.610			
	slope	64.796	111.842	0.562			
1AGBER	(Intercept)	-0.107	0.725	0.883		-0.001	0.960
	market index	0.175	0.470	0.710			
	energy index	-0.069	0.246	0.780			
	food index	0.145	0.272	0.593			
	gvt. 2y rate	-20.255	92.831	0.827			
	slope	52.112	257.035	0.839			
PO3	(Intercept)	0.058	0.565	0.919		0.001	0.140
	market index	0.683	0.399	0.087	*		
	energy index	0.058	0.236	0.805			
	food index	-0.515	0.258	0.046	**		
	gvt. 2y rate	8.463	67.446	0.900			
	slope	-89.536	183.756	0.626			
D2O	(Intercept)	0.690	0.041	0.000	***	0.003	0.089
	market index	-0.037	0.021	0.079	*		
	energy index	0.017	0.010	0.104			
	food index	0.011	0.013	0.423			
	gvt. 2y rate	2.906	5.594	0.603			
	slope	-27.635	13.762	0.045	**		
DEM	(Intercept)	0.998	0.003	0.000	***	0.008	0.008
	market index	0.003	0.003	0.317			
	energy index	-0.003	0.002	0.164			
	food index	0.000	0.002	0.812			
	gvt. 2y rate	1.447	0.677	0.033	**		
	slope	-2.946	1.770	0.096	*		
CNQ	(Intercept)	1.287	0.201	0.000	***	0.016	0.081
	market index	0.058	0.036	0.109			
	energy index	-0.010	0.013	0.448			
	food index	-0.023	0.021	0.264			
	gvt. 2y rate	-26.690	15.297	0.082	*		
	slope	-128.393	55.279	0.021	**		

(continues)

TABLE 13 (continues)

RWL	(Intercept)	0.656	0.228	0.004	***	0.020	0.074
	market index	-0.038	0.026	0.155			
	energy index	0.004	0.012	0.726			
	food index	-0.022	0.023	0.334			
	gvt. 2y rate	24.948	17.664	0.159			
	slope	34.877	57.226	0.543			

Significance level: * 10% ** 5% *** 1%

TABLE 14 Regression 3 results with monthly data for 2000 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.134	1.468	0.927		0.121	0.000
	market index	0.698	0.172	0.000	***		
	energy index	-0.110	0.101	0.278			
	food index	-0.019	0.086	0.825			
	gvt. 2y rate	1.166	3.369	0.730			
	slope	8.575	11.312	0.449			
WAT	(Intercept)	0.589	1.531	0.701		0.043	0.005
	market index	0.313	0.200	0.120			
	energy index	0.042	0.104	0.687			
	food index	0.055	0.128	0.665			
	gvt. 2y rate	-4.797	3.322	0.150			
	slope	16.923	17.242	0.327			
GWA	(Intercept)	-0.889	1.795	0.621		0.143	0.000
	market index	0.818	0.170	0.000	***		
	energy index	-0.081	0.088	0.360			
	food index	0.135	0.097	0.165			
	gvt. 2y rate	0.880	3.843	0.819			
	slope	5.859	14.200	0.680			
PET	(Intercept)	2.778	4.567	0.544		0.017	0.105
	market index	0.853	0.384	0.027	**		
	energy index	0.037	0.206	0.857			
	food index	-0.276	0.260	0.288			
	gvt. 2y rate	-6.515	9.737	0.504			
	slope	-21.414	38.573	0.579			

(continues)

TABLE 14 (continues)

1AG	(Intercept)	-4.866	5.246	0.355		0.014	0.200
	market index	0.781	0.739	0.292			
	energy index	-0.163	0.314	0.605			
	food index	0.539	0.367	0.145			
	gvt. 2y rate	2.189	14.424	0.880			
	slope	38.551	56.238	0.494			
1AGBER	(Intercept)	-4.051	7.791	0.604		0.022	0.126
	market index	1.856	0.934	0.049	**		
	energy index	-0.142	0.516	0.783			
	food index	-0.285	0.525	0.588			
	gvt. 2y rate	9.044	19.858	0.649			
	slope	11.785	70.671	0.868			
PO3	(Intercept)	-1.321	9.611	0.891		0.011	0.268
	market index	1.872	1.245	0.135			
	energy index	-0.208	0.741	0.780			
	food index	0.640	0.785	0.417			
	gvt. 2y rate	-11.759	27.508	0.670			
	slope	-6.741	106.264	0.950			
D20	(Intercept)	-0.754	2.158	0.728		-0.052	0.906
	market index	0.109	0.262	0.679			
	energy index	-0.016	0.094	0.867			
	food index	0.034	0.141	0.812			
	gvt. 2y rate	8.745	7.550	0.251			
	slope	6.108	22.336	0.785			
DEM	(Intercept)	11.821	9.215	0.205		0.085	0.070
	market index	0.310	0.742	0.678			
	energy index	0.392	0.317	0.221			
	food index	-0.584	0.570	0.310			
	gvt. 2y rate	-66.994	32.213	0.042	**		
	slope	-106.984	82.457	0.200			
CNQ	(Intercept)	-32.339	128.428	0.808		-0.229	0.734
	market index	1.990	3.012	0.530			
	energy index	-0.337	1.314	0.805			
	food index	0.285	1.617	0.865			
	gvt. 2y rate	91.886	332.510	0.790			
	slope	234.031	1026.360	0.826			
RWL	(Intercept)	-57.572	136.772	0.691		0.258	0.288
	market index	2.165	2.586	0.441			
	energy index	0.556	1.915	0.783			
	food index	-0.042	1.023	0.969			
	gvt. 2y rate	155.702	370.306	0.692			
	slope	415.174	1058.313	0.711			

Significance level: * 10% ** 5% *** 1%

TABLE 15 Regression 3 results with monthly data for 2012 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.790	2.105	0.708		0.178	0.000
	market index	1.146	0.318	0.000	***		
	energy index	-0.270	0.166	0.105			
	food index	-0.364	0.149	0.016	**		
	gvt. 2y rate	-8.797	8.853	0.322			
	slope	18.063	20.064	0.370			
WAT	(Intercept)	3.243	1.760	0.068	*	0.033	0.104
	market index	-0.009	0.159	0.955			
	energy index	0.130	0.084	0.125			
	food index	0.133	0.118	0.262			
	gvt. 2y rate	-11.654	6.414	0.072	*		
	slope	-10.907	17.928	0.544			
GWA	(Intercept)	0.280	2.527	0.912		0.099	0.003
	market index	0.850	0.325	0.010	***		
	energy index	-0.074	0.139	0.596			
	food index	0.085	0.186	0.649			
	gvt. 2y rate	0.853	9.506	0.929			
	slope	-13.051	23.515	0.580			
PET	(Intercept)	2.287	7.034	0.746		0.000	0.418
	market index	0.652	0.555	0.242			
	energy index	0.182	0.260	0.484			
	food index	-0.531	0.394	0.180			
	gvt. 2y rate	12.672	22.311	0.571			
	slope	-48.078	63.633	0.451			
1AG	(Intercept)	-4.050	5.688	0.478		0.002	0.387
	market index	-0.018	0.839	0.983			
	energy index	-0.090	0.343	0.794			
	food index	0.822	0.462	0.077	*		
	gvt. 2y rate	-11.353	21.864	0.605			
	slope	54.978	59.337	0.356			
1AGBER	(Intercept)	-2.824	9.231	0.760		-0.013	0.637
	market index	1.359	1.136	0.234			
	energy index	-0.068	0.593	0.909			
	food index	-0.302	0.633	0.634			
	gvt. 2y rate	-8.169	33.683	0.809			
	slope	26.380	70.647	0.710			

(continues)

TABLE 15 (continues)

PO3	(Intercept)	-4.337	9.873	0.661		-0.001	0.443
	market index	1.304	1.296	0.316			
	energy index	-0.129	0.759	0.865			
	food index	0.930	0.831	0.265			
	gvt. 2y rate	12.252	42.574	0.774			
	slope	-0.333	106.798	0.998			
D20	(Intercept)	-0.754	2.158	0.728		-0.052	0.906
	market index	0.109	0.262	0.679			
	energy index	-0.016	0.094	0.867			
	food index	0.034	0.141	0.812			
	gvt. 2y rate	8.745	7.550	0.251			
	slope	6.108	22.336	0.785			
DEM	(Intercept)	11.821	9.215	0.205		0.085	0.070
	market index	0.310	0.742	0.678			
	energy index	0.392	0.317	0.221			
	food index	-0.584	0.570	0.310			
	gvt. 2y rate	-66.994	32.213	0.042	**		
	slope	-106.984	82.457	0.200			
CNQ	(Intercept)	-32.339	128.428	0.808		-0.229	0.734
	market index	1.990	3.012	0.530			
	energy index	-0.337	1.314	0.805			
	food index	0.285	1.617	0.865			
	gvt. 2y rate	91.886	332.510	0.790			
	slope	234.031	1026.360	0.826			
RWL	(Intercept)	-57.572	136.772	0.691		0.258	0.288
	market index	2.165	2.586	0.441			
	energy index	0.556	1.915	0.783			
	food index	-0.042	1.023	0.969			
	gvt. 2y rate	155.702	370.306	0.692			
	slope	415.174	1058.313	0.711			

Significance level: * 10% ** 5% *** 1%

TABLE 16 Regression 4 results with monthly data for 2000 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	-0.069	1.664	0.967		0.116	0.000
	market index	0.695	0.175	0.000	***		
	energy index	-0.114	0.103	0.266			
	food index	-0.010	0.088	0.907			
	gvt. 2y rate	1.537	3.618	0.671			
	slope	9.869	11.652	0.398			
	temperature	0.040	0.465	0.931			
	rain	-0.013	0.019	0.468			
WAT	(Intercept)	0.011	1.828	0.995		0.037	0.018
	market index	0.307	0.203	0.131			
	energy index	0.039	0.105	0.712			
	food index	0.069	0.130	0.596			
	gvt. 2y rate	-4.203	3.475	0.228			
	slope	18.055	17.788	0.311			
	temperature	0.412	0.707	0.561			
	rain	0.013	0.034	0.701			
GWA	(Intercept)	-1.174	2.027	0.563		0.137	0.000
	market index	0.808	0.171	0.000	***		
	energy index	-0.078	0.089	0.379			
	food index	0.139	0.098	0.159			
	gvt. 2y rate	1.305	4.135	0.753			
	slope	7.043	14.412	0.626			
	temperature	0.164	0.590	0.781			
	rain	-0.010	0.027	0.706			
PET	(Intercept)	2.185	4.781	0.648		0.014	0.178
	market index	0.839	0.393	0.034	***		
	energy index	0.038	0.210	0.855			
	food index	-0.275	0.267	0.304			
	gvt. 2y rate	-5.158	9.795	0.599			
	slope	-16.039	38.622	0.678			
	temperature	0.040	1.369	0.977			
	rain	-0.063	0.055	0.251			

(continues)

TABLE 16 (continues)

1AG	(Intercept)	-3.702	5.605	0.510		0.002	0.396
	market index	0.808	0.748	0.282			
	energy index	-0.159	0.320	0.619			
	food index	0.508	0.379	0.182			
	gvt. 2y rate	0.762	14.743	0.959			
	slope	37.154	56.653	0.513			
	temperature	-0.913	2.426	0.707			
	rain	-0.004	0.100	0.965			
1AGBER	(Intercept)	-7.640	7.495	0.310		0.019	0.187
	market index	1.776	0.944	0.062	**		
	energy index	-0.153	0.537	0.776			
	food index	-0.222	0.511	0.665			
	gvt. 2y rate	11.138	21.395	0.603			
	slope	11.781	69.747	0.866			
	temperature	3.490	2.934	0.236			
	rain	0.099	0.143	0.491			
PO3	(Intercept)	2.070	12.033	0.864		0.004	0.377
	market index	2.017	1.256	0.111			
	energy index	-0.279	0.748	0.710			
	food index	0.679	0.818	0.408			
	gvt. 2y rate	-21.049	31.050	0.499			
	slope	2.955	115.177	0.980			
	temperature	-3.329	3.578	0.354			
	rain	-0.048	0.141	0.736			
D20	(Intercept)	-0.377	2.910	0.898		-0.083	0.973
	market index	0.121	0.279	0.665			
	energy index	-0.013	0.099	0.892			
	food index	0.019	0.156	0.904			
	gvt. 2y rate	8.385	8.379	0.321			
	slope	1.704	24.664	0.945			
	temperature	-0.014	1.011	0.989			
	rain	0.020	0.033	0.552			
DEM	(Intercept)	13.908	12.809	0.282		0.076	0.120
	market index	0.276	0.728	0.706			
	energy index	0.449	0.308	0.151			
	food index	-0.697	0.606	0.255			
	gvt. 2y rate	-59.421	32.503	0.073	**		
	slope	-111.027	104.784	0.294			
	temperature	-2.484	3.088	0.425			
	rain	-0.136	0.157	0.389			

(continues)

TABLE 16 (continues)

CNQ	(Intercept)	-30.085	93.143	0.763		0.475	0.205
	market index	3.005	2.097	0.225			
	energy index	0.999	1.306	0.487			
	food index	0.399	1.868	0.841			
	gvt. 2y rate	125.909	219.459	0.597			
	slope	224.069	850.630	0.805			
	temperature	-11.664	11.161	0.355			
	rain	0.683	1.003	0.534			
RWL	(Intercept)	-216.088	208.861	0.410		0.413	0.387
	market index	3.419	2.936	0.364			
	energy index	3.885	5.383	0.545			
	food index	-0.890	2.281	0.734			
	gvt. 2y rate	599.888	559.901	0.396			
	slope	1678.304	1712.591	0.430			
	temperature	-14.270	20.202	0.553			
	rain	0.745	1.246	0.610			

Significance level: * 10% ** 5% *** 1%

TABLE 17 Regression 4 results with monthly data for 2012 – 2022

Stock	**Coefficients**	**Estimate**	**Std. Error**	**Prob.**		**Adj. R2**	**Prob.**
REH	(Intercept)	1.946	2.225	0.384		0.178	0.000
	market index	1.176	0.321	0.000	***		
	energy index	-0.267	0.174	0.128			
	food index	-0.383	0.153	0.013	***		
	gvt. 2y rate	-10.129	9.012	0.263			
	slope	15.943	20.476	0.438			
	temperature	-0.883	0.648	0.176			
	rain	0.000	0.041	0.994			
WAT	(Intercept)	2.087	1.831	0.257		0.033	0.135
	market index	-0.032	0.159	0.840			
	energy index	0.110	0.084	0.190			
	food index	0.177	0.121	0.147			
	gvt. 2y rate	-11.841	6.336	0.064	**		
	slope	-6.582	18.172	0.718			
	temperature	0.868	0.635	0.174			
	rain	0.005	0.035	0.886			

(continues)

TABLE 17 (continues)

GWA	(Intercept)	-0.436	3.058	0.887		0.093	0.009
	market index	0.835	0.332	0.013	***		
	energy index	-0.085	0.144	0.557			
	food index	0.109	0.187	0.560			
	gvt. 2y rate	1.814	10.173	0.859			
	slope	-7.061	24.927	0.778			
	temperature	0.148	0.945	0.875			
	rain	-0.052	0.061	0.402			
PET	(Intercept)	1.819	7.490	0.809		-0.015	0.643
	market index	0.637	0.570	0.266			
	energy index	0.189	0.262	0.472			
	food index	-0.536	0.418	0.202			
	gvt. 2y rate	14.143	22.835	0.537			
	slope	-48.025	64.808	0.460			
	temperature	0.324	1.938	0.868			
	rain	-0.008	0.100	0.933			
1AG	(Intercept)	-5.528	6.718	0.412		-0.011	0.589
	market index	-0.052	0.854	0.951			
	energy index	-0.102	0.345	0.769			
	food index	0.860	0.484	0.078	**		
	gvt. 2y rate	-11.182	22.810	0.625			
	slope	55.716	62.648	0.376			
	temperature	1.459	2.582	0.573			
	rain	0.049	0.106	0.642			
1AGBER	(Intercept)	-9.448	8.822	0.286		0.011	0.304
	market index	1.197	1.195	0.319			
	energy index	-0.100	0.655	0.879			
	food index	-0.170	0.630	0.788			
	gvt. 2y rate	-5.658	34.188	0.869			
	slope	24.821	66.130	0.708			
	temperature	6.747	3.359	0.047	***		
	rain	0.241	0.203	0.237			
PO3	(Intercept)	0.960	12.149	0.937		-0.007	0.530
	market index	1.463	1.310	0.266			
	energy index	-0.174	0.766	0.821			
	food index	0.937	0.872	0.285			
	gvt. 2y rate	0.779	42.825	0.986			
	slope	0.875	119.584	0.994			
	temperature	-4.365	3.750	0.247			
	rain	-0.018	0.189	0.924			

(continues)

TABLE 17 (continues)

D20	(Intercept)	-0.377	2.910	0.898		-0.083	0.973
	market index	0.121	0.279	0.665			
	energy index	-0.013	0.099	0.892			
	food index	0.019	0.156	0.904			
	gvt. 2y rate	8.385	8.379	0.321			
	slope	1.704	24.664	0.945			
	temperature	-0.014	1.011	0.989			
	rain	0.020	0.033	0.552			
DEM	(Intercept)	13.908	12.809	0.282		0.076	0.120
	market index	0.276	0.728	0.706			
	energy index	0.449	0.308	0.151			
	food index	-0.697	0.606	0.255			
	gvt. 2y rate	-59.421	32.503	0.073	**		
	slope	-111.027	104.784	0.294			
	temperature	-2.484	3.088	0.425			
	rain	-0.136	0.157	0.389			
CNQ	(Intercept)	-30.085	93.143	0.763		0.475	0.205
	market index	3.005	2.097	0.225			
	energy index	0.999	1.306	0.487			
	food index	0.399	1.868	0.841			
	gvt. 2y rate	125.909	219.459	0.597			
	slope	224.069	850.630	0.805			
	temperature	-11.664	11.161	0.355			
	rain	0.683	1.003	0.534			
RWL	(Intercept)	-216.088	208.861	0.410		0.413	0.387
	market index	3.419	2.936	0.364			
	energy index	3.885	5.383	0.545			
	food index	-0.890	2.281	0.734			
	gvt. 2y rate	599.888	559.901	0.396			
	slope	1678.304	1712.591	0.430			
	temperature	-14.270	20.202	0.553			
	rain	0.745	1.246	0.610			

Significance level: * 10% ** 5% *** 1%

TABLE 18 Regression 5 results with monthly data for 2004 – 2022

Stock	Coefficients	Estimate	Std. Error	Prob.		Adj. R2	Prob.
REH	(Intercept)	0.523	1.518	0.731		0.182	0.000
	market index	1.010	0.204	0.000	***		
	energy index	-0.215	0.112	0.055	**		
	food index	-0.202	0.103	0.053	**		
	gvt. 2y rate	0.251	3.617	0.945			
	slope	3.775	12.015	0.754			
	ASVIClimate	-0.417	1.565	0.790			
	ASVIDrought	-1.304	1.374	0.344			
	ASVIWarming	1.115	1.479	0.452			
	ASVIWater	9.098	6.368	0.155			
WAT	(Intercept)	0.237	1.611	0.883		0.055	0.012
	market index	0.169	0.230	0.463			
	energy index	0.060	0.119	0.618			
	food index	0.142	0.157	0.369			
	gvt. 2y rate	-5.868	4.219	0.166			
	slope	22.575	17.699	0.204			
	ASVIClimate	0.812	1.536	0.598			
	ASVIDrought	1.138	1.638	0.488			
	ASVIWarming	-3.119	2.795	0.266			
	ASVIWater	12.655	6.801	0.064	**		
GWA	(Intercept)	-0.465	1.993	0.816		0.136	0.000
	market index	0.883	0.226	0.000	***		
	energy index	-0.090	0.106	0.397			
	food index	0.105	0.130	0.423			
	gvt. 2y rate	-0.315	4.526	0.945			
	slope	0.368	16.330	0.982			
	ASVIClimate	-0.202	1.739	0.908			
	ASVIDrought	-1.626	1.831	0.375			
	ASVIWarming	0.777	1.952	0.691			
	ASVIWater	1.441	7.458	0.847			
PET	(Intercept)	3.658	4.824	0.449		0.003	0.376
	market index	0.896	0.412	0.031	***		
	energy index	0.030	0.220	0.892			
	food index	-0.350	0.288	0.225			
	gvt. 2y rate	-9.461	10.576	0.372			
	slope	-28.401	40.523	0.484			
	ASVIClimate	2.160	2.898	0.457			
	ASVIDrought	-0.299	4.228	0.944			
	ASVIWarming	-1.311	3.634	0.719			
	ASVIWater	1.643	15.540	0.916			

(continues)

TABLE 18 (continues)

1AG	(Intercept)	-4.440	5.200	0.394		0.001	0.421
	market index	0.725	0.773	0.349			
	energy index	-0.079	0.326	0.809			
	food index	0.467	0.394	0.237			
	gvt. 2y rate	1.598	14.144	0.910			
	slope	34.142	56.243	0.545			
	ASVIClimate	2.803	7.812	0.720			
	ASVIDrought	-8.271	6.177	0.182			
	ASVIWarming	3.540	10.101	0.727			
	ASVIWater	-1.478	27.087	0.957			
1AGBER	(Intercept)	-3.733	8.034	0.643		0.018	0.223
	market index	1.750	0.975	0.075	**		
	energy index	-0.076	0.538	0.889			
	food index	-0.361	0.558	0.518			
	gvt. 2y rate	7.849	20.175	0.698			
	slope	7.480	73.791	0.919			
	ASVIClimate	12.513	9.517	0.190			
	ASVIDrought	-5.681	5.700	0.320			
	ASVIWarming	-13.730	11.498	0.234			
	ASVIWater	13.105	36.946	0.723			
PO3	(Intercept)	-1.610	9.009	0.858		0.021	0.225
	market index	1.821	1.309	0.167			
	energy index	-0.147	0.749	0.845			
	food index	0.439	0.748	0.558			
	gvt. 2y rate	-10.357	29.490	0.726			
	slope	-10.032	98.514	0.919			
	ASVIClimate	-0.607	13.176	0.963			
	ASVIDrought	-6.523	17.967	0.717			
	ASVIWarming	-17.018	17.771	0.340			
	ASVIWater	-16.053	62.761	0.799			
D20	(Intercept)	-0.621	2.455	0.801		-0.107	0.985
	market index	0.077	0.297	0.797			
	energy index	-0.011	0.103	0.919			
	food index	0.061	0.144	0.672			
	gvt. 2y rate	7.519	9.139	0.414			
	slope	6.048	24.332	0.805			
	ASVIClimate	-0.242	1.817	0.895			
	ASVIDrought	1.427	2.432	0.560			
	ASVIWarming	0.165	3.373	0.961			
	ASVIWater	-1.641	10.702	0.879			

(continues)

TABLE 18 (continues)

DEM	(Intercept)	10.237	9.504	0.286		0.105	0.085
	market index	0.217	0.874	0.805			
	energy index	0.246	0.304	0.421			
	food index	-0.285	0.622	0.649			
	gvt. 2y rate	-67.990	34.879	0.056	**		
	slope	-83.914	84.761	0.327			
	ASVIClimate	0.043	4.084	0.992			
	ASVIDrought	8.726	5.577	0.123			
	ASVIWarming	-4.183	8.693	0.632			
	ASVIWater	27.668	29.819	0.358			
CNQ	(Intercept)	-12.695	446.879	0.979		-1.298	0.955
	market index	2.032	12.175	0.878			
	energy index	0.914	5.081	0.869			
	food index	0.263	14.666	0.987			
	gvt. 2y rate	41.458	1243.054	0.976			
	slope	46.669	3435.790	0.990			
	ASVIClimate	0.432	83.687	0.996			
	ASVIDrought	-38.992	166.671	0.830			
	ASVIWarming	38.070	264.433	0.895			
	ASVIWater	45.923	919.396	0.963			
RWL	(Intercept)	-179.692	1.26E+04	0.991		-2.050	0.922
	market index	4.500	218.080	0.987			
	energy index	1.975	117.579	0.989			
	food index	0.730	42.189	0.989			
	gvt. 2y rate	567.420	4.12E+04	0.991			
	slope	1181.794	8.33E+04	0.991			
	ASVIClimate	-0.320	445.293	1.000			
	ASVIDrought	-78.557	7591.548	0.993			
	ASVIWarming	40.814	4055.493	0.994			
	ASVIWater	311.240	2.94E+04	0.993			

Significance level: * 10% ** 5% *** 1%