urban WaterCycle Solutions

Independent research and consulting

ABN: 470 9364 5777

The Water team,

Essential Services Commission,

Level 8, 570 Bourke Street, Melbourne Victoria 3000

Email: water@esc.vic.gov.au

Attention: [redacted]

Dear Marcus and The Water Team,

Review of New Customer Contributions

Thank you for the opportunity to contribute to the review of New Customer Contributions (Developer Charges) by the Essential Services Commission (ESC). This letter provides a response to the Consultation Paper[1] and is shaped by the Author's long term contribution to the Victorian water sector.

The Author is a director of Urban Water Cycle Solutions that operates as an independent research, policy and consulting group in Victoria. He is an Honorary and Visiting Professor in the Crawford School of Public Policy at Australian National University (See Appendix A).

This review is also shaped by the Author's review of the determination of New Customer Contributions in the Coliban Water jurisdiction and research into the outcomes of economic regulation of government owned water monopolies.

Introduction

The ESC Consultation Paper describes the principles based objectives of New Customer Contributions that aim to:

- send signals to developers about the costs of developing in different locations,
- share costs and benefits of growth between new and existing customers, and
- administer new customer contributions in a transparent way.

The 2023 price review revealed a problematic implementation of New Customer Contributions (NCC) that prompted the need for a regulatory review that aims to better support the achievement of the objectives.

[1] ESC (2024), Review of New Customer Contributions, consultation paper,15 August 2024

Price submissions of some water monopolies did not sufficiently justify the costs allocated to NCCs. Many of these utilities preferred common pricing arrangements in situations where costs differed significantly across different locations.

It is proposed to seek clarity of guidance provided by an ESC assessment framework and expectations for the justification of NCCs by water monopolies. These charges are defined as a contribution towards the costs of works used directly or indirectly for the provision of the services that will benefit a property. These increased or augmented water, sewerage or recycled water services are required at the property

It is important to highlight that New Customer Contributions (NCC) were historically described as Developer Charges. There is a need to determine who pays for infrastructure across a range of timelines from short to medium to long run.

It is also essential to understand the real context of growth, shared, gifted, existing and sunk assets across these timelines. The economic drivers for different types and characterisation of assets needs to be considered in the context of the prevailing regulatory process that is dependent on a Regulatory Asset Base (RAB).

This review also considers the recent ESC determination of Coliban Water prices to provide context to the discussion.[2,3]

Equity and household welfare

The dominance of fixed tariffs in the prices for water and sewer services provide inequitable outcomes for households with diminished opportunity to change this circumstance. In 2024-25, a typical Coliban Water customer pays a total of $8.11/kL for water and sewage services that are dominated by a 69% proportion of fixed charges.

This regime of prices minimises the opportunity of citizens to use less water to improve their household welfare. It is a disincentive to better management of water to improve the resilience of water resources to the challenges of climate change and population growth.

The preference for fixed charges is justified as assistance to renters but also provides guaranteed revenue to water monopoly. It should be acknowledged that fixed charges for water and sewage services increase the costs of rental accommodation as a factor of production.

Coliban Water customers have experienced small increases in total household bills of 6.3% and have reduced their household water use by 12% since 2018-19. In contrast, New Customer Contributions have increased by $1971 (112%) and $2827 (163%) for

[2] ESC (2023), Coliban Water final decision 2023 Water Price Review 23 June 2023
[3] ESC (2018), Coliban Water Determination 1 July 2018 – 30 June 2023 19 June 2018

connection to water and sewage services. New infill development is not subject to increases in New Customer Contributions.

These large increases in New Customer Contributions are proposed to support an unprecedented doubling of infrastructure budgets to service high growth assumptions. It is proposed that urgent increases in these charges are needed to response to population growth, aging infrastructure and climate change. The assessment of New Customer Contributions is also burdened by long delays, limited legal remedies and the absence of independent arbitration.

Whilst large increases in New Customer Contributions are commonly justified as the developer should pay rather than the customer, these charges directly impact on the prices of new housing and costs of rental accommodation. The customer pays.

These changes or new interpretations of pricing policy are proposed at the time when citizens are coping with persistent unemployment and under-employment with low real wage growth.[4] The housing industry is also experiencing record low approvals and completions which increases the prices of housing and rents.[5]

An increasing number of households are experiencing rental and mortgage stress due to rental and mortgage costs growing at a higher rate than wages. The vacancy rates of rental accommodation are extremely low.

An environment of ongoing wage stagnation and price inflation is adding to the lasting negative socioeconomic and economic impacts of diminished housing affordability. Victoria is experiencing a crisis in housing supply and affordability that coincides with unusually weak growth in wages. It is important that pricing policies and infrastructure aspirations of government water monopoly do not contribute to the national economic challenge of price inflation.

It is not an ideal time to increase the costs of providing housing and the costs of living in housing whilst removing the user pays opportunity to reduce water use and associated bills.

Recommendation

Improved equity and greater economic efficiency can be achieved by careful management of New Customer Contributions from the perspective of improving household welfare and maximising the economic efficiency for whole of society. Increasing the viability of government water monopolies is not the same as improving the welfare of citizens.

---

[4] Stewart A., Stanford, J and Hardy T., (2023), The wages crisis revisited, The Australia Institute Centre for Future Work.

[5] Victorian Government (2023), The rental and housing affordability crisis in Victoria, Legislative Council Legal and Social Issues Committee, November 2023

Unprecedented increases in costs and review of regulation.

This submission to the ESC review of New Customer Contributions is supported by two key documents (see Appendix B):

1. Coombes P.J., (2024), The influence of regulation on preference for utility infrastructure investment to generate income for Australian water corporations, Australasian Journal of Water Resources, 28(2), 151-172. This peer reviewed publication refers directly to the ESC task.

2. Coombes P.J., (2022), Discussion paper on the application of the Real Business Cycle model to urban water, June 2022. This discussion paper provides information about the important trends and cycles that impact on Australia's urban water sector. These challenges and opportunities include economic shocks, pandemics, drought, fire and flood that can produce permanent or temporary economic impacts.

Price regulation of services is based on the building block or rate of return methodology that is linked to regulated asset values and costs. As outlined in the Coombes (2024) paper, the regulatory process is driving preference for utility supply side infrastructure to generate increased revenue and is crowding out alternative policy and resource options.

The historical record of the Regulatory Asset Base (RAB) and Nominal Revenue Requirement (NRR) for Coliban Water from 2018-19 to 2027-28 was sourced from utility Annual Reports and ESC Price Determinations. The NRR is the revenue that the utility is permitted to earn via price determinations.

The historical (CPI adjusted) 2024 dollar values for Coliban Water's RAB and NRR with the key explanatory variables of depreciation, net capital and operation expenses, and return on assets are presented in Figure 1 and Table 1.

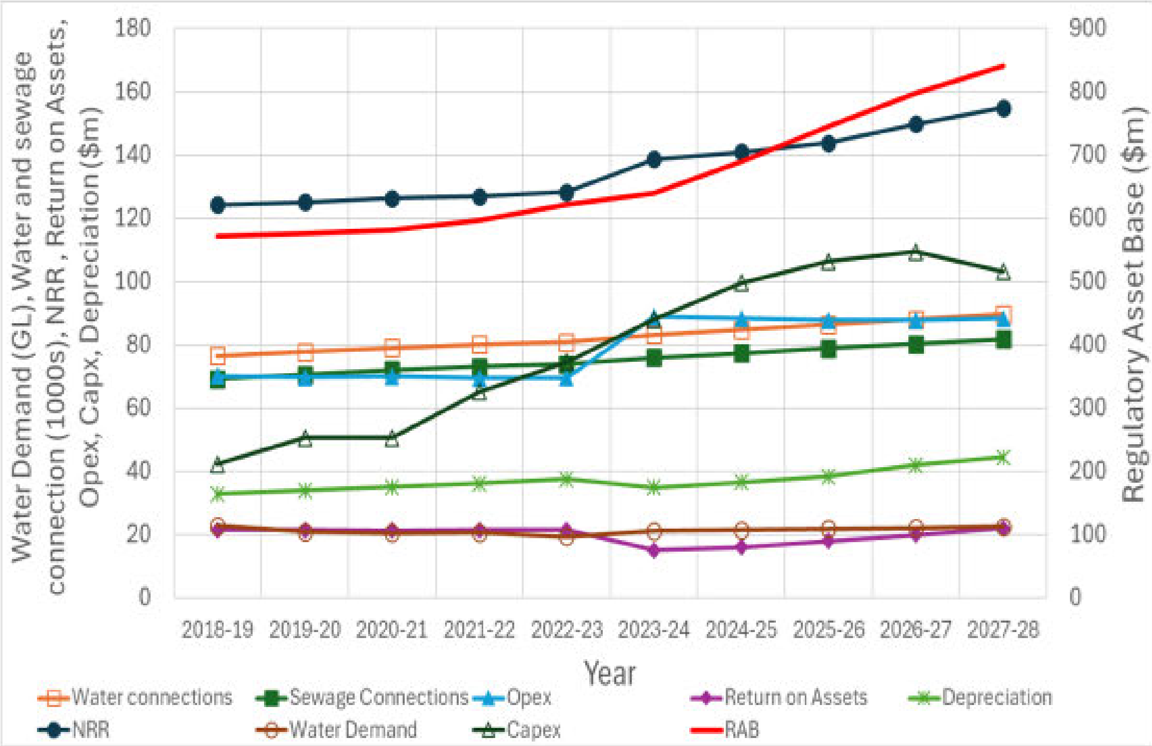


Figure 1: The CPI adjusted values (2024 dollars) for the regulatory asset base (RAB) and nominal revenue (NRR) for Coliban Water with capital, operation and depreciation expenses, and return on assets for the period 2018-19 to 2027-28.

Figure 1 and Table 1 reveal substantial real (CPI adjusted) increases in capital expenses (144.5%), Regulatory Asset Base (47%), depreciation (35.7%) and operating costs (26%) over two regulatory periods.

Table 1: Rate of change from 2018-19 to 2027-28 for selected regulatory variables that describe the Coliban Water jurisdiction.

Item	Change (%)	Change (%/year)
RAB	47	5.2
Water connections	17.2	1.9
Sewage Connections	18.3	2
Capital Costs	144.5	16
Operating Costs	26	2.9
Return on Assets	3.1	0.34
Depreciation	35.7	4
NRR	24.7	2.7
Water Demand	-1.53	-0.17

These increases in costs associated with providing services and managing assets have occurred during a period of reduced water demands (-1.53%) and are significantly greater than the growth in new water (17.2%) and sewage (18.3%) connections.

The 24.7% growth in Nominal Revenue Requirement (NRR) is also higher than the growth in new connections but less severe than the increase in capital expenses and the RAB.

Importantly, the Coombes (2024) publication explains that excessive capital expenses drive large increases in the RAB within the building block regulatory model and lock in persistent higher income streams in the long run. This results in long term and escalating price impacts on customers into the future.

It is necessary to recognise that assessments of the need and characterisation of growth infrastructure result in payments of New Customer Contributions, growth in the RAB and a continuum of payments by customers into the future.

It is also necessary to determine the temporary and permanent drivers of costs and revenue. The Real Business Cycle economics approach considers the resilience of urban water services that are revealed by responses to climate and economic shocks.

Understanding of relationships between urban water utility costs and prices, household welfare and economic activity is needed to develop sustainable policies. Cycles of drought, floods, economic shocks and water saving impact on the performance of urban water services. Different regulatory responses may be required to account for the costs of temporary or permanent impacts on Utility operations.

The unprecedented growth in expenses and New Customer Contributions is justified as a response to population growth, climate change and aging assets. These are valid concerns that have been addressed as a continuum across multiple regulatory periods by Water Utilities, the ESC and the community.

Recommendation

The proposed sudden and large increase in expenses and NCCs does need careful, independent and transparent scrutiny.

A change of preferred water security strategy cannot be a reason for a different expenses and pricing strategy without proper process. Such a process should include a comprehensive independent assessment of multiple options across whole of society and include an agreed decision with the community on the preferred path to resilience.

Growth assumptions

The determination of large increases in the expenses and New Customer Contributions by government water monopoly is underpinned by assumptions about increasing population growth. For example, the forecast growth rates (2.2% - 3.4%) was embedded in the assessment of the requirement for new and upgraded infrastructure by Coliban Water.

The growth in water connections across the Coliban Water jurisdiction was sourced from the Bureau of Meteorology National Performance Report (BOM NPR) and is provided in Figure 2.

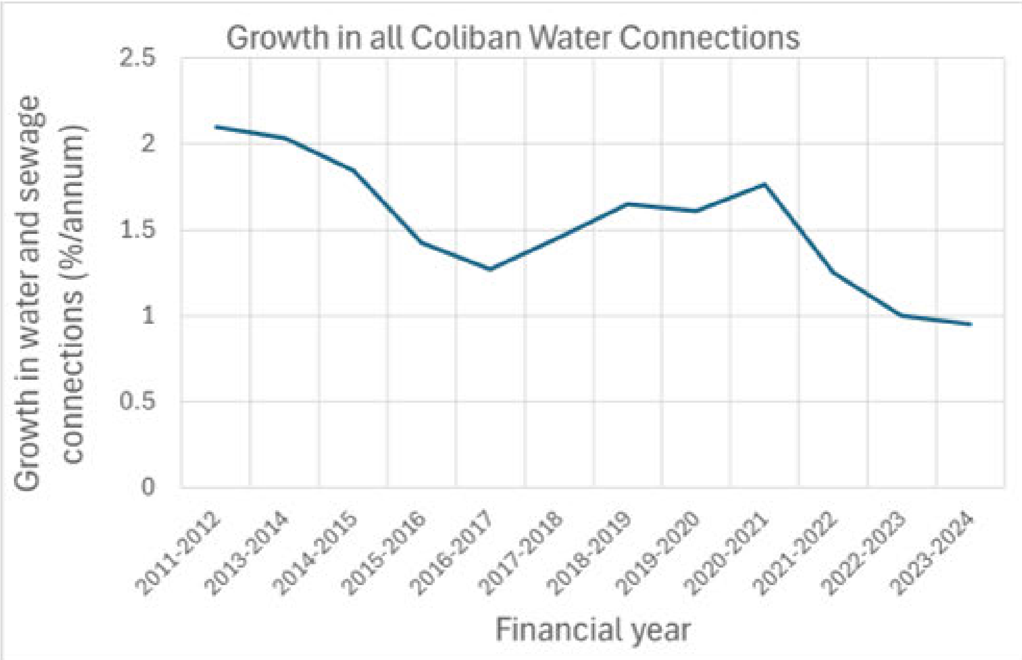


Figure 2: Growth in water connections from 2011-12 to 2023-24 for Coliban Water

Figure 2 shows that the growth in water connections has declined from 2.1% to less than 1% in the Coliban Water jurisdiction. The assumed average growth rate of 2.3% is more than double the actual growth rate of 1%.

It is important to recognise that the temporary effects of COVID-19 pandemic and work from home arrangements that created higher growth rates during the 2019-2021 period. There was substantial decline in the growth in new connections following the removal of pandemic restrictions and implementation of return to work policies.

The population growth in the Bendigo, Campaspe and Gannawarra local government areas associated with Coliban Water were sourced from the Australian Bureau of Statistics (ABS) and are presented in Figure 3.

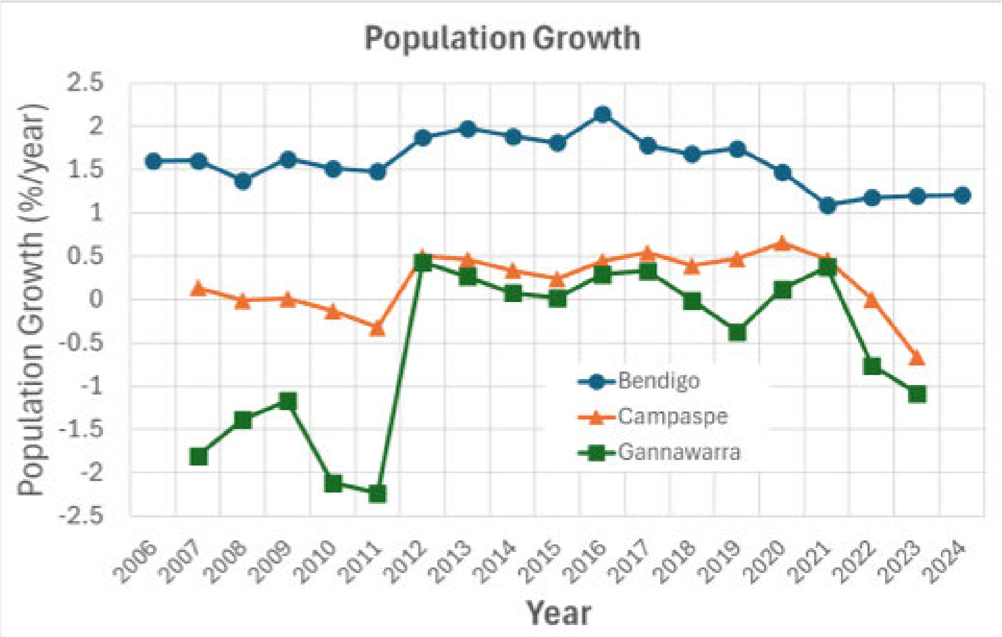


Figure 3: Population growth in Bendigo, Campaspe and Gannawarra regions from 2006 to 2024

Figure 3 shows that the population growth in the Greater Bendigo region has declined and was 1% - 1.2% since 2021. The population growth at Bendigo which is the major population centre in the Coliban Water jurisdiction is important for determining the requirement for infrastructure.

Population growth in the Campaspe (including Echuca) and Gannawarra regions has diminished substantially from a maximum rate of 0.6%. The long term population projections are about 1.4% for the Bendigo region and 0.67% for the Campaspe region. These results indicate strong spatial differences in growth rates and the costs of providing services.

The population estimates underpinning the determination of prices and NCCs in the Coliban Water jurisdiction are more than double the actual growth.

The growth in requirement for new water connections can be assessed using the ABS building approvals records as shown in Figure 4.

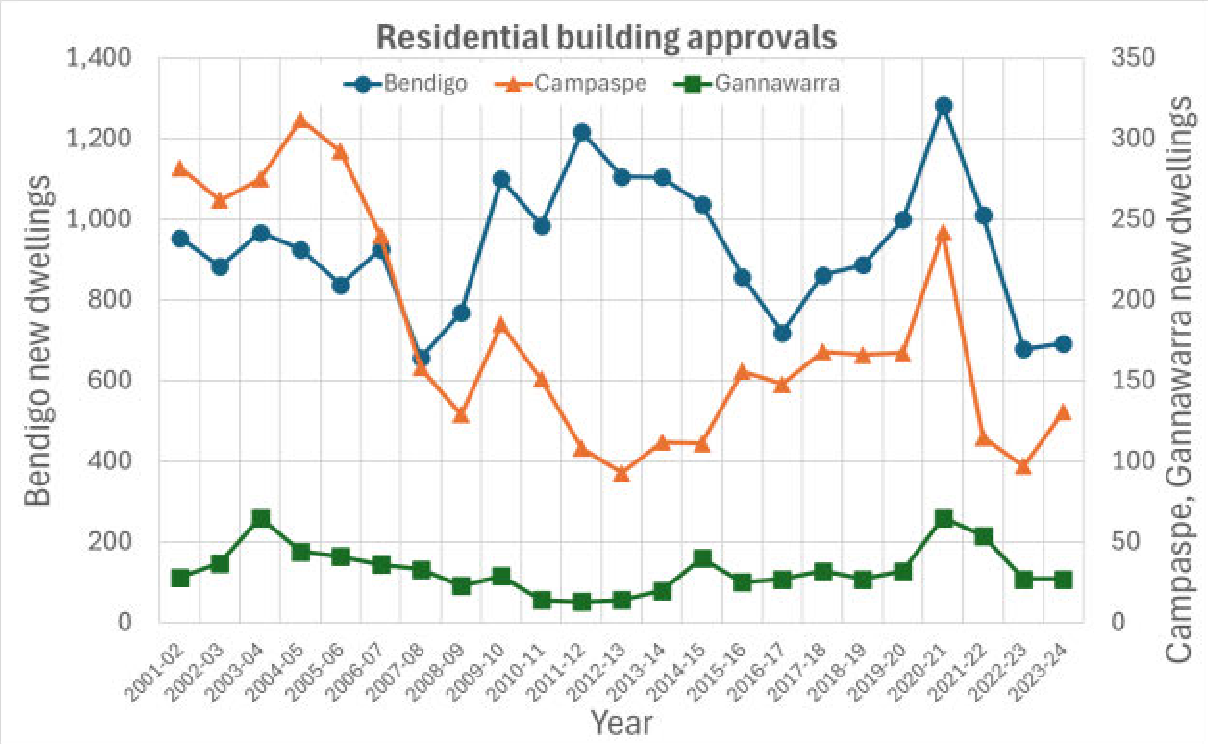


Figure 4: Building approvals in Bendigo, Campaspe and Gannawarra regions from 2006 to 2024

Figure 4 shows that the residential building approvals at all locations have halved from a peak in 2020-21 that was associated with the COVID19 lock downs and work from home arrangements.

It is important to separate the temporary impacts from long term trends in the assessment of water utility expenses. Assumptions of ongoing higher growth rates than experienced in a temporary economic shock results in proposals for excessive infrastructure requirements. This leads to higher NCCs and RAB which increases short and long run costs to whole of society.

Recommendation

It is recommended that the growth assumptions underpinning proposed water utility infrastructure are subject to careful and independent audit. The impact of temporary economic and physical shocks should be separated from real trends in determining growth rates used in regulation.

Climate Change

The proposals by water utilities for large increases in expenses and NCCs is also based on assumptions about increasing rates of climate change. For example, Coliban Water proposed an unprecedented doubling of infrastructure expenses and NCCs. The impacts of climate change were assumed to contribute to the growth categories of expenses underpinning the increased NCC charges.

There are a range of different impacts of climate change on the operation of a water utility that should be carefully examined. Lower rainfall depths and the potential for more frequent droughts and floods impact on the availability of bulk water resources. Increases in temperature can lead to higher water demands, lower catchment runoff and increases evaporation from regional water storages.

These impacts are partially mitigated by reductions in regional and household water demands in the Coliban Water jurisdiction.

The Author's work in the Ballarat region (Central Highlands Water) indicated that increases in temperature may increase urban water demands. The increases in temperature may also associated with higher rainfall intensity that could increase sewerage flows.

These potential increases in water demands and wet weather sewer flows are expected to be small but may impact on the design and performance of water and sewage infrastructure. These impacts will mostly attribute to existing infrastructure (99% for Coliban Water) and is dependent on the rate of change in temperature and rainfall intensity.

The annual average daily maximum temperature, and annual maximum rainfall intensity from 1 and 24 hour rainfall at Bendigo is provided in Figure 5.

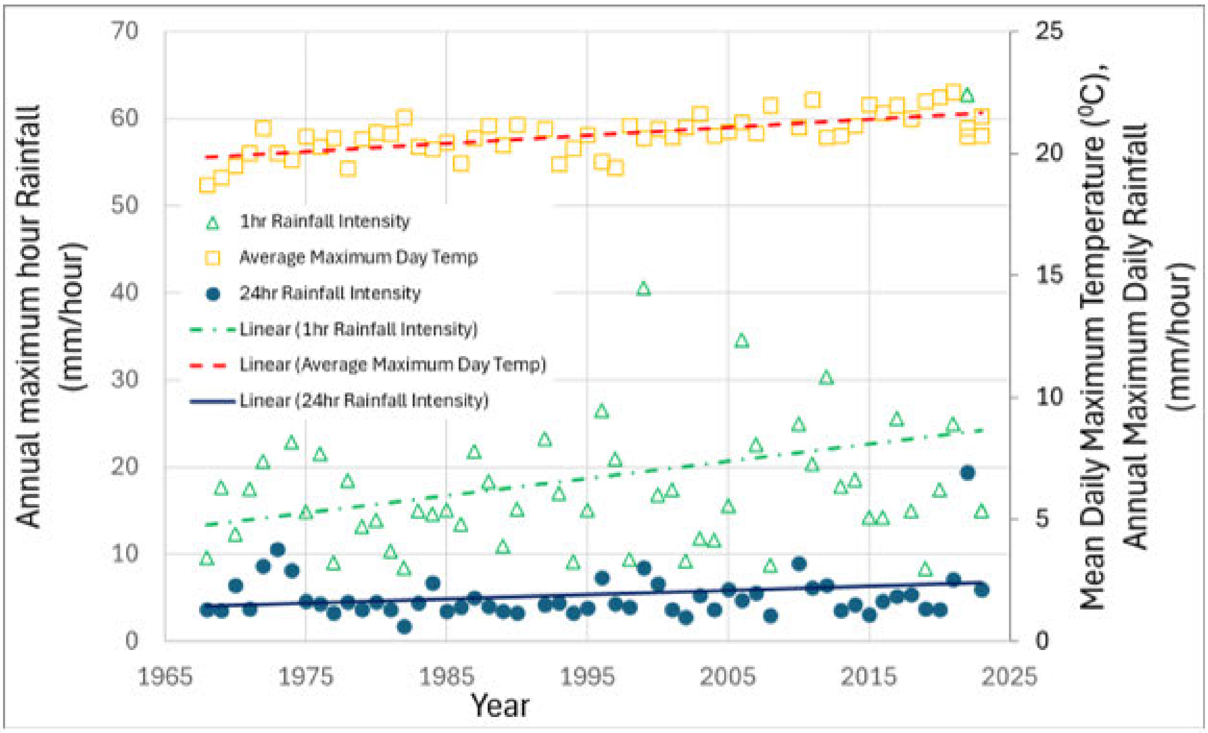


Figure 5: Annual average daily maximum temperature and annual maximum rainfall intensity (1 and 24 hour) in Bendigo region from 1965 to 2024

Figure 5 shows the trends of increasing daily maximum temperature (0.033°C/year) and rainfall intensity (one hour: 0.14 mm/year and 24 hour: 0.01 mm/year) for

Bendigo. Note that the timeline also shows consistent variation about the trend lines with recent flood event.

The gradual increase in rainfall intensity from short duration (1 hour) events may increase wet weather flows in sewage infrastructure. However, these impacts will be mitigated by improved design, construction, maintenance, renewals and operational process during the same period.

The trend of daily maximum temperatures also displays gradual increases over time that may increase urban water demands. These impacts of water demands are diminished by increasing water efficiency as demonstrated by the 12% reduction in household water demand since 2018.

These results do not show a step change in maximum daily temperature or rainfall intensity that would support a doubling of utility expenses. It is expected that these changes across multiple regulatory periods were accommodated by ongoing improvements by the utility and community.

The results also show rare high intensity rainfall events that created flooding and annual average decline in rainfall volumes with increases in temperature. The annual average daily maximum temperature, and annual maximum rainfall intensity from 1 and 24 hour rainfall at Echuca is presented in Figure 6.

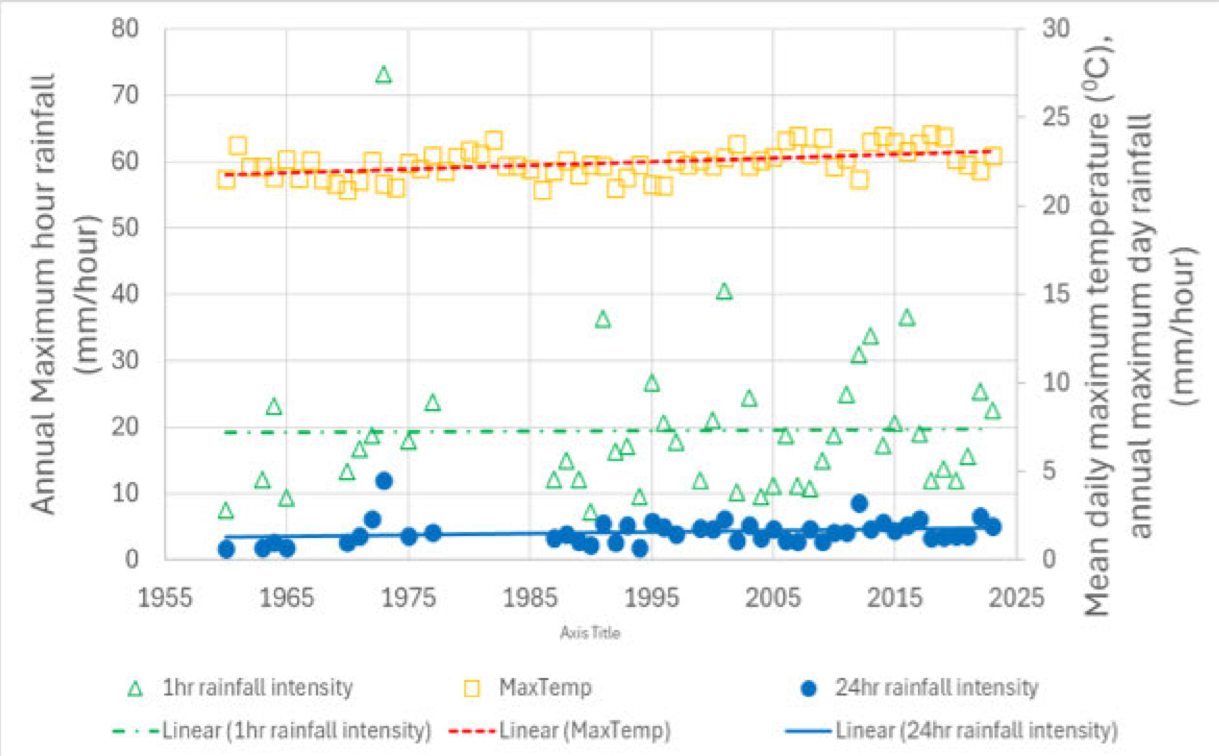


Figure 6: Annual average daily maximum temperature and annual maximum rainfall intensity (1 and 24 hour) in Echuca region from 1960 to 2024

Figure 6 shows the trends of increasing daily maximum temperature (0.026°C/year) and 24 hour rainfall intensity (0.008 mm/year). These was no trend to increased short duration (1 hour) rainfall intensity.

Both locations experience gradual increases in average daily maximum temperatures that represents a changing climate. These changes in temperature are associated with a trend to increased intensity of short duration rainfall events in Bendigo and no significant change at Echuca. There is a similar trend to small increases in daily rainfall intensities at both locations.

These results indicate that the utility has experienced gradual increases in temperatures and rainfall intensities across multiple regulatory periods. There is no sudden and dramatic increase in these trends that justify large permanent increases in operating and capital costs.

Recommendation

The discussion in this investigation indicates that most of climate change driven increases in utility costs are attributed to existing infrastructure and customers. New growth is not responsible for climate change but can increase the demand for a diminishing water resource. The proportion of new growth to existing serviced properties should be applied to the calculation of climate change impacts.

Aging infrastructure

Another stated reason for increasing capital expenditure and New Customer Contributions is the need to replace or upgrade aging infrastructure. However, it is expected that the challenges of aging infrastructure are accommodated across multiple regulatory periods by the water utility and the ESC.

In particular, the regulated allowances for depreciation, renewal, upgrades and operation expenses across a continuum of regulatory periods should provide for the management or replacement of aging assets. The aging process of water and sewage assets is gradual and large increases in costs are unusual. The costs of aging infrastructure mostly accrue to existing customers unless the infrastructure capacity is increased to cope with new growth.

Recommendation

The attribution of a proportion of the costs of replacing aging infrastructure should only apply to New Customer Contributions in situations where the aging infrastructure coincides with new growth. For a given location, the additional incremental costs to increase the capacity of the renewed infrastructure could be applied to NCCs. This cost to NCCs is likely to be less than the ratio of new growth to existing serviced properties for a given location.

What is growth infrastructure or expenses?

The Author's review of the water utility calculation of New Customer Contributions revealed that multiple categories of expenses that are not associated with growth were counted, including:

- Compliance
- Renewal
- Service improvements, and
- Upgrades.

In addition, the utility calculation of negotiated NCCs also included a wide range of additional projects that were not accepted by the ESC. These proposals include high growth rates (addressed above) and higher numbers of connections due to assumptions that the infrastructure would also service surrounding infill development.

The water utility augmentation plans for some locations assume that developers would provide all water and sewage trunk infrastructure. This infrastructure also provides additional capacity that ultimately allows infill and future connections within or external to the growing network.

Nevertheless, the developer (and new customers) is required to pay for the regional trunk augmentation that is considered to be 'developer infrastructure' and pay substantial increases in NCCs. These infrastructure augmentations are only attributed to growth and the ultimate shared component with infill and nearby upgrades was not discounted from the developer's costs.

Further key issues arise from this discussion, (1) are these developer funded augmentations included in the calculation of NCCs and the RAB, and (2) is new development at one location subsidising infill development at other locations.

Even in a situation where the developer provided trunk infrastructure is counted as gifted assets, it does include costs that accrue to all customers via operation and maintenance at a future date. Hence the gifted assets also contribute the RAB in the long run. It is essential that excessive assumptions about requirement for infrastructure and costs are avoided as these costs accrue to customers.

Recommendation

The characterisation of projects to growth and the magnitude of the proposed projects and associated expenses are also assumptions that require transparent and independent audit. It is envisaged that independent audit is undertaken by the ESC or professionals that are not linked to water utilities.

There is a need to accurately and transparently account for assets that are associated with growth in the development of New Customer Contributions.

Engagement, negotiation and asymmetry of information

The engagement process for New Customer Contributions in the Coliban Water jurisdiction involved a small customer reference group and a smaller developer panel. Both small groups and a limited number of one to one interviews responded to information provided by the water utility. The engagement process was managed by the utility or their consultant and reported by the utility.

We should be cognisant that a small number of selected people responded to information provided by the water utility. The questions were framed by the utility and summary of the results were provided by the utility.

As acknowledged by the engagement consultant, participants in the engagement were subject to "authority bias" that creates a propensity to agree with the authority. However, there is also a need to understand the context of engagement with a government monopoly that holds a significant imbalance power over approvals, assessment and employment. This process occurs in an environment of limited opportunity for legal remedy or arbitration.

A developer or consultant who disagrees with the government monopoly encounters the perceived or real risk of refusal of approval or employment on future projects. Nevertheless, some of the participants indicated that there was insufficient time or information to form a view on the questions asked by the utility in the engagement process.

It is the Author's view that the scope of questions and limited information did not enable participants to fully explore the relevant challenges and opportunities during the engagement process.

The high costs of assessment ($400,000 per network option) by utility panel consultants were also presented by the utility. These consultants are business partners of the utility, make assumptions that are consistent with utility expectations and test options provided by the utility. Information about these assumptions, explanation of the impact of assumptions and broader perspectives on options are not usually available for meaningful consideration by stakeholders.

The legislated negotiation process for contested New Customer Contributions involved limited response from the utility. This process was ultimately dominated by the utility information, assessment and refusal. As discussed above, the Author found multiple questionable assumptions in the utility assessment that could not be negotiated.

Recommendation

The engagement and negotiation processes around New Customer Contribution is inadequate. There is a need for an independent process of engagement and negotiation that is based on complete and transparent information, shared knowledge of assumptions, opportunities and challenges.

The resolution of negotiation should be transparent and independent of the participants. A provision for ordinary review by the ESC of any negotiation should be available upon request. A negotiation and any subsequent ordinary review by the ESC should follow a proscribed process that will need to be developed. This process, when needed, should occur prior to escalation to a VCAT hearing.

Concluding insights and recommendations

Our water utilities provide an essential service in an increasingly difficult environment. However, they are government monopolies operating in a broader economy, society and environment that is also coping with substantial challenges. The drive to earn more revenue is strong and the need for independent regulation is paramount.

There is a need for stronger oversight and regulation from the Essential Services Commission (ESC) of the resolutions of New Customer Contributions (NCC). It is proposed that the ESC develop a standard process for deriving, negotiating and auditing NCCs. The ESC should provide ordinary review of NCCs upon request and based on a proscribed process.

The application of average assumptions or methods to determination of NCCs should be avoided in favour of incremental local information and processes. These assessments should publish the drivers and components of all net expenses included in the NCCs.

The interdependency between the Regulatory Asset Base (RAB) and NCCs should be resolved to clarify the short to long run costs that accrue to the community. The desired impact on all customers, new customers and existing customers should be resolved from the perspective of a timeline of economic outcomes (short to long run).

The impact of the price regulation of water utilities on the broader economy and household welfare must be considered. Increasing the economic viability of water monopolies is unlikely to be a surrogate for improving the welfare of households.

The ESC should facilitate open access to all information to support informed decisions by customers, consultants, developers and water utilities in their responses to NCCs. Ideally this would include the publication of ESC audits and all assessments that underpin the development of NCCs.

Yours sincerely

[redacted]

Prof Peter Coombes FIEAust CPEng EngExec NER APEC Engineer IntPE(Aus)

[redacted]

[redacted]

Appendix A: About the Author

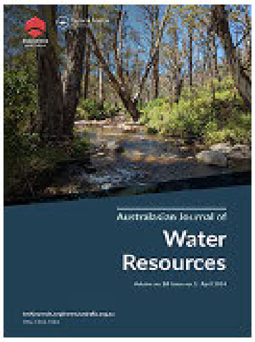
Professor Peter Coombes

Peter Coombes is a director of Urban Water Cycle Solutions, an honorary and visiting Professor in Crawford School of Public Policy at the Australian National University, a Fellow of Engineers Australia and Certified Practicing Engineer in Civil and Environmental Engineering, Leadership and Management at the Engineering Executive (EngExec) level. He was awarded the 2018 GN Alexander Medal for scientific contributions to Hydrology and Water Resources by Engineers Australia and the 2019 Presidents Medal for his role as a lead editor of the Urban Book of Australian Rainfall and Runoff. Peter holds a PhD in Civil and Environmental Engineering, degrees in Civil Engineering (Hons), Surveying (Hons) and Economics, and a Diploma of Legal Studies. He is a Registered Professional Engineer in Victoria (PE0007360) and has over 30 years experience in hydrology (surface and groundwater) and water resources.

Peter was recently the Associate Dean (Education) and Professor of Water Resources Engineering at Southern Cross University. He is a Member of Systems Research Steering Committee at Imperial College London and is an editor the Urban Book of Australian Rainfall and Runoff published by Engineers Australia. He has held senior academic positions at University of Newcastle, University of Melbourne and Swinburne University. Peter was a Chief Scientist in the Victorian Government and contributed to inquiries into stormwater management and flooding by the Senate of the Australian Parliament and into water resources by the Productivity Commission.

Peter was a managing director of Bonacci Water, a member of the water advisory group to the Prime Ministers Science, Engineering and Innovation Council, the advisory council on alternative water sources for the Victoria Government's Our Water Our Future policy, a member of the advisory panel on urban water resources to the National Water Commission, an advisor on alternative water policy to the United Nations and a national research leader of innovative WSUD strategies in the eWater CRC. He has generated over 250 scientific publications and designed more than 120 sustainable projects including settlements that generate all their water resources and manage flooding. Professor Coombes was also a co-author of Australian Runoff Quality and a former chair of the Stormwater Industry Association. More information can be found at http://urbanwatercyclesolutions.com.

Appendix B: Accompanying documents



Australasian Journal of Water Resources

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/twar20

The influence of regulation on preference for utility infrastructure investment to generate income for Australian water corporations

Peter J. Coombes

To cite this article: Peter J. Coombes (26 Aug 2024): The influence of regulation on preference for utility infrastructure investment to generate income for Australian water corporations, Australasian Journal of Water Resources, DOI: 10.1080/13241583.2024.2393933

To link to this article: https://doi.org/10.1080/13241583.2024.2393933

Published online: 26 Aug 2024.

AUSTRALASIAN JOURNAL OF WATER RESOURCES
https://doi.org/10.1080/13241583.2024.2393933

The influence of regulation on preference for utility infrastructure investment to generate income for Australian water corporations

Peter J. Coombes [a,b]

[a]Crawford School of Public Policy, Australian National University; [b]Urban Water Cycle Solutions

ABSTRACT

Effects of price regulation and preference for utility supply infrastructure on Australian urban water utilities and urban water markets are examined using historical data, models of the future and a case study of Greater Sydney. Australian regulators utilise the building block method based on operating and capital costs, and a Regulatory Asset Base to set nominal revenue requirements and ultimately prices for water utility services. Regulation of water utilities that is dependent on a Regulatory Asset Base drives preference for utility infrastructure and is remote from market mechanisms of consumer demands for water and sewage services. These regulatory processes are not linked to the operation of the urban water market of government owned utility and distributed solutions, and act to crowd out viable complementary solutions including water efficiency, distributed water sources and alternative pricing models. Government regulation, ownership and operation of utilities may produce strong performance from the perspective of urban water corporations but decrease economic efficiency, resilience and social welfare in urban water markets. The role of major water corporations needs to be redefined in a market recognising multiple complementary water sources and services. Regulation of utility services should have regard to the entire market, market demand, environmental health and consumer welfare.

ARTICLE HISTORY
Received 1 October 2023
Accepted 14 August 2024

KEYWORDS
Urban water; policy; regulation; infrastructure; prices

1. Introduction

The sustainable delivery of secure urban water services to meet broad socioeconomic and ecosystem objectives is a critical challenge for cities in Australia, and the world (IPCC 2021). Australian urban water utilities manage water, sewage and some stormwater infrastructure that has a current aggregate written down value of AUD $170 billion with annual capital investments of AUD $5.2 billion and annual revenue of AUD $20 billion (BOM 2014–2022). Most Australian urban regions are supplied with water, sewerage and partial stormwater services provided by utilities owned by state or local governments that operate at a centralised scale (BOM 2014–2022; Byrnes et al. 2010). These government owned utilities provide an essential service. Reporting and regulatory processes for urban water management are almost solely focused on utility services (Productivity Commission 2020; IPART 2020; Infrastructure Australia 2017). The urban water market also includes other sources of water supply, conservation and sanitation that occur at distributed scales from household and business to the region (Aisbett and Steinhauser 2011; P. J. Coombes, Barry, and Smit 2018).

Australian urban water management has transformed since the 1990s to include greater efficiency, transparency and stakeholder engagement (Productivity Commission 2020). The urgent challenge of the Millennium Drought motivated the integration of multiple solutions, conservation and innovation into the urban water strategy (Infrastructure Australia 2017). The Millennium Drought included severe rainfall, streamflow, soil moisture and groundwater deficits with hotter conditions across most of Australia during the period 1997 to 2009. These persistent dry conditions almost exhausted urban water supplies to cities, towns and rural communities. These initiatives combined water solutions from diverse actors with utility services to improve the resilience of water management in Australian cities. During the 2000s, Australian regulators adopted the Rate of Return or Building Block pricing strategies that are based the regulated value of infrastructure (Regulatory Asset Base) paid for by water utilities (IPART 2020). This regulatory process responds to proposals from water monopolies who are also the approval authority for infrastructure solutions.

Good progress with more efficient urban water management was followed by stalled urban water reforms and a current need to respond to the challenges of population growth, climate change, environmental and economic shocks (Infrastructure Australia 2017; Productivity Commission 2020). The learnings from the Millennium Drought and subsequent challenges have not been reflected in regulatory and

CONTACT Peter J. Coombes peter@uwcs.com.au

governance frameworks, and there is a need for greater independence and accountability (Commonwealth of Australia 2015b; P. J. Coombes, Barry, and Smit 2018; Infrastructure Australia 2017).

Ownership, regulation, operation and administration by government may be driving a narrow focus on the monopoly perspective of state owned water utilities (Commonwealth of Australia 2015b). A barrier to entry for water solutions from multiple actors may be linked to perceived threats to revenue streams of government utilities which manifests as a preference for utility owned infrastructure (NSW Audit Office 2020; Commonwealth of Australia 2015a, Troy 2008). These shortcomings in governance and project selection processes are seen by the Productivity Commission (2020) to indicate a need for community driven objectives and a greater commitment to independent economic regulation.

The NSW Audit Office (2020) found that the narrow focus on utility infrastructure has resulted in limited investigation, implementation and support for including utility demand management, complementary water sources from multiple actors and conservation in urban water strategies. Inclusion of these complementary water solutions was hampered by inadequate price signals, limited action to remove barriers to entry and assessment methods that favour utility owned supply infrastructure. This preference for utility supply infrastructure and crowding out of complementary solutions is described by the NSW Audit Office (2020) as decreasing the economic efficiency, resilience and social welfare of cities in response to population growth and climate change.

Commonwealth of Australia (2015a) and Finkel et al. (2017) reported similar challenges in the regulation of energy utilities that included over investment in utility infrastructure to seek higher revenue allocations. These outcomes were created by application of excessive reliability and security standards, and information asymmetry resulting in higher capital and operating costs.

A key principle of systems thinking is to observe the drivers of complex systems to understand and replicate the actual purpose of the system (P. Coombes, Smit, and Macdonald 2016; Meadows 2008). These processes can reveal the real-world processes, values and models that are imposed on decisions about government management of urban water resources. Previous systems analysis of Greater Sydney region and the BASIX water efficiency policy revealed greater economic efficiencies and household welfare than other regions (P. J. Coombes, Barry, and Smit 2018, 2019).

This study examines sources of water corporation income to understand if prices are determined by market responses to supply and demand for services delivered to water corporation customers. A key objective of this investigation is to explore the impact of regulatory processes on preference for utility infrastructure and other solutions.

The characteristics of the regulatory process used to set revenue and maximum prices for water corporations are explored in the Background Section to understand the preference for utility infrastructure. This includes presentation of the building block regulation, the urban water market and examination of the insights from government inquiries and auditors, researchers and regulators.

The Section on Analysis of the Past and Future provides an overview of the historical performance of the Australian urban water sector. A case study of building block price regulation for the Greater Sydney and Melbourne regions was used to incorporate real world complexity into the investigation and subsequent insights. The historical results from the Greater Sydney region were then utilised to examine the future impacts of price regulation that focuses on the value of utility infrastructure.

These processes were utilised in the Discussion Section to identify a series of key insights about the impact of price regulation of government owned water utilities and the urban water market.

2. Background

Meadows (2008) highlights the importance of understanding the real purpose or impact of a regulatory system which is not necessarily expressed and can only be deduced by observing the operation of a system.

2.1. Monopoly pricing and markets, setting the context for analysis

Water is essential to life and is subject to broad legislative objectives. The overarching NSW Water Management Act 2000 includes ecological, environmental, social and best practice management objectives. The National Water Initiative (NWI) COAG (2014) and IPART (2012) pricing principles require a real return on the written down value of assets to ensure sufficient revenue for efficient delivery of utility services. These principles include full cost recovery to promote efficient investment, operation and use of regulated services (Chu and Grafton 2021).

The National Water Initiative also encourages improved water efficiency and innovation in urban water servicing. A narrow focus on real returns from utility assets in economic regulation that inhibits innovative urban water servicing options can directly conflict with NWI policy commitments.

Australia has experienced a significant movement towards a market-based economy over the last 50 years (Health 2017) that has also influenced approaches to provision of utility water and sewage services to our cities (Infrastructure Australia 2017). Most of the major urban water monopolies in Australia are managed as water corporations and the government regulatory process attempts to replicate competitive markets (IPART 2020). The assumptions of Australian National Competition Policy that competitive markets can provide the best service to consumers and society are applied to these activities.

The free market philosophy is based on the concepts that 'the market' is the best allocator of resources, government should only play a minor role, industry should practice self-regulation and growth is the dominant objective (Jones 2020). Like all big ideas, there are advantages and disadvantages to this approach. A private business might have a stronger and simpler focus than a government, and there is arguably better measurement and reporting (Helm 2020; Stigler 1971). From the corporate perspective there may also be more efficient allocation of resources and this approach can work very well within an adequate regulatory framework or competitive market with many buyers and sellers of a similar product. The disadvantages are particularly relevant for government monopoly services. Jones (2020) describes the emphasis on individualism in the market based approach that rejects the concept of the public good. Thinking about water in this context reveals the complexity of the role of water as a private and public good that is dependent on location, time and context. Water is mobile, is a critical component of the biosphere and can have multiple different uses and ownership. The status of water varies from public good to private commodity that is altered by engineering, market and regulatory structures (Clarke and Stevie 1981; Coase 1947). The costs, ownership and classification of water also depend on the location of water within the system from river to dam storage to distribution network to consumers to disposal networks to waterways. There is a need to take a systemic viewpoint of the cumulative value and status of water. Urban water utilities are a special case where governments are required to balance their competing roles of owner, regulator and policy maker (Infrastructure Australia 2017).

Stigler (1971) recognises an idealistic perspective of the government regulation of public monopolies in economic thinking. It is an argument that the private operator must respond to shareholders and achieve growth in profits which is a stark contrast to the government monopoly that is beholden to citizens to realise public good. However, the State has the power to supply regulation that benefits particular industry and economic groups (Helm 2020; Stigler 1971). This can provide subsidy by regulation and grants the power to prefer solutions to the government entity.

Helm (2020) found that the behaviours of water monopolies are shaped by regulation rather than ownership. A narrow framing of regulation and governance objectives acts to reduce wholistic ideals of public good to narrow discussions about centralised infrastructure that increase the viability of the monopoly. Dollery and Wallis (1997) describe this process as government failure where the government business acts in its own interests which is different to the public good. Government regulation of its water corporations also requires a real return on investment in an increasing asset base (Chu and Grafton 2021; Helm 2020) which has similarity to the private sector situation.

Tan (2012) explains that government monopolies are dependent on private partnerships to deliver infrastructure solutions. These processes can result in selective infrastructure investments that are associated with rent seeking behaviours in an environment where state subsidies dilute risks and incentives.

It is also commonly assumed that urban water corporations are natural monopolies. A natural monopoly is expected to provide goods and services to an entire market at lesser economic costs than multiple businesses supplying parts of the market, and experiences economies of scale with average cost (AC) and marginal cost (MC) declining as the quantity of outputs increase as shown in Figure 1.

Figure 1 highlights that a natural monopoly maximises profits when marginal revenue (MR) is equal to marginal cost at lower output (Q_m) and higher prices (P_m). Regulators aim to manage monopoly behaviour and market power by setting prices at P_r where AC equals average revenue AR to foster larger output Q_r at zero excess profit. Note that average revenue AR is also demand.

The theory of natural monopolies is also characterised by high fixed costs that are not dependent on outputs and low marginal costs. Many authors, such as Saddler (2016), Hilmer (2014), Friedman (2002), Dollery and Wallis (1997), Di Lorenzo (1996) and

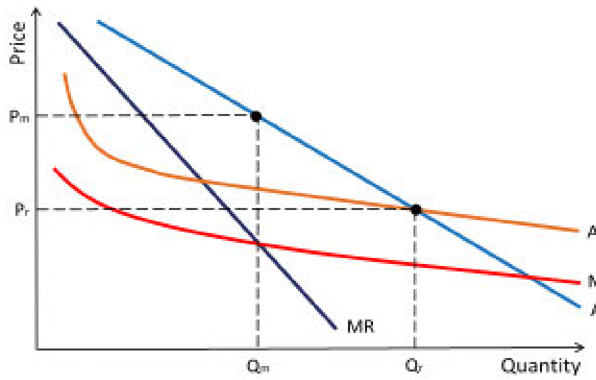


Figure 1. A natural monopoly with price regulation (after Hubbard et al. 2013).

Coase (1947), highlight that natural monopolies are created by government intervention to grant franchises to public utilities. This involves barriers to entry and regulation that protects 'sunk' infrastructure investments from competition. Large-scale and capital-intensive enterprises do not lead to natural monopolies (Di Lorenzo 1996). The provision of urban water and sewage services is not a natural monopoly process due to diseconomies of scale and the contribution of other solutions permitted by technological advances (Clarke and Stevie 1981; Guldmann 1985; Hilmer 2014; Saddler 2016). Stern (2013) explains that the regulation based on the RAB protects utilities from competition and favours capital-intensive infrastructure. The RAB approach can also be problematic for state owned industries as it can protect inefficient investments.

Pricing for utility services also utilises two part pricing methods where fixed and marginal costs are used to derive fixed and variable prices paid by consumers to maintain utility revenue in a regulated environment. Marginal costs are also used in the assessment of alternative water sources and conservation for inclusion in urban water strategy. The water industry assumption that many costs are fixed which are 'sunk' costs that are not counted in derivation of marginal costs produces artificially low values that are used in assessment of alternative strategies and favours selection of utility infrastructure (NSW Audit Office 2020). These processes also apply more broadly to the government utilities in the water and energy sectors (Commonwealth of Australia 2015a, 2015b; Finkel et al. 2017; Hilmer 2014).

Pricing decisions can favour demand for utility services and infrastructure by setting low comparative values for water conservation and complementary services. Regulation of monopolies seeks to promote and protect sunk investments (Biggar 2009) and can lead to an overwhelming resistance to any risk of stranded assets that might result from innovative solutions or policies (Simshauser 2017). For example, the economic level of water conservation (ELWC) is emerging in the water sector and employed in the Greater Sydney region to currently assume that water saving measures that cost more than \$0.31/kL are not viable and utility supply infrastructure should be preferred (SWC 2022b). In contrast, the variable tariff for water services is greater than \$2.35/kL, the total water and sewage bill for a household with a water use of 200 kL/annum is greater than \$5/kL, and spatial costs of providing water and sewage services range from \$2/kL to greater than \$20/kL (IPART 2020; P. J. Coombes 2022). The prices of alternative (non-utility) water sources are also set at 80% of the regulated variable price for utility water supply (IPART 2020; NSW Audit Office 2020).

Friedman (2002) and Hubbard et al. (2013) explain that government regulatory and pricing methodologies can act to block entry of competing solutions to the market by crowding out innovation and technical progress. The derivation of marginal cost should count all costs and in the long run all costs are variable as better solutions may be available. These issues associated with selection of prices and cost comparisons that crowd out conservation and competitors, and favour utility infrastructure also apply to electricity markets (Commonwealth of Australia 2015a; Finkel et al. 2017).

This investigation explores the regulation of water utilities using the pricing method and the assumptions of natural monopoly in Figure 1 on preference of utility infrastructure.

2.2. Government owned water monopolies and corporations

Most Australian water and sewerage utilities are owned by state and local governments. The ownership structure of urban utilities has evolved from public water and sewerage boards in the late 1880s to statutory corporations in the 1990s. Since 1994, many of the utilities servicing capital cities and significant regions have been transferred to state owned water corporations in accordance with National Competition Policy and the National Water Initiative (COAG 1994; Tisdell, Ward, and Grudzinski 2002).

An example of the changing landscape of the ownership, governance and regulation of urban water utilities is the origin of Sydney Water as the Board of Water and Sewerage in 1888 enabled by New South Wales state legislation (Government of NSW 1888). The Water Board was replaced with the Sydney Water Corporation Limited as an unlisted public company owned by the NSW government and represented by ministers of parliament in 1995 (Government of NSW 1994). Sydney Water Corporation replaced Sydney Water Corporation Limited as a state-owned statutory corporation in 1999 and is currently providing utility water, sewerage and drainage services to the Greater Sydney region.

The evolution of government owned water utilities is characterised by the transformation of urban water and sewage services from a public good to a private commodity, and change from public to corporate governance. During the 2021–22 year, Sydney Water Corporation supplied 508,476 ML of water and provided sewerage, stormwater and recycled water services to 5.3 m people in 2.1 m properties across a 12,870 km^2 area of operations (SWC 2022a).

The shareholding in Sydney Water is vested in a Portfolio Minister and Shareholder Ministers with portfolio interests in water, environment, finance and treasury. The operation of Sydney Water is regulated by the Independent Pricing and Regulatory Tribunal (IPART) which was established in 1992 (Government of NSW, 1992).

Similar to most Australian water corporations, Sydney Water Corporation is required by its enabling legislation (for example The Sydney Water Act), an operating licene and the Corporations Act (2001) to operate as a successful business and in the best interests of the corporation. These legislated business objectives include maximising the value of the state's investment in the corporation and directors are also required to act in good faith and in the interests of the corporation (Australian Institute of Company Directors 2020; Corporations Act 2001). The interests of the corporation are its own commercial benefit which is regulated by IPART.

2.3. Building block model for water pricing

The setting of tariffs for utility water, sewerage and drainage services is ultimately the responsibility of state and local governments that own and regulate urban utilities (Connell, Dovers, and Grafton 2005). These decisions about price regulation are justified to the independent regulators such as the Essential Services Commission in Victoria and the Independent Regulatory and Pricing Tribunal in New South Wales. There is substantial recent history of Commonwealth government decisions about allocation of scarce water resources, mainly focused on the Murray Darling Basin, using objectives for environmental, social and economic outcomes (Kelly 2011). These processes mostly originated from the Council of Australian Governments (COAG) 1994 agreement to implement a framework for an efficient and sustainable water industry (COAG 2014; Connell, Dovers, and Grafton 2005). This reform of water policy and regulation aimed to transform water governance to include environmental sustainability and economic efficiency (Godden and Foerster 2011).

In 2004, COAG agreed to a National Water Initiative (NWI) as a national plan for water reform which included urban water management and influenced the setting of tariffs for urban water utilities (COAG 2014). The NWI incorporates the key principles of the 1994 COAG water reform framework which includes objectives for efficient and sustainable use of water resources and infrastructure assets which include:

- Implement consumption-based tariffs which also provide important demand management (conservation) outcomes;
- Achieve full cost recovery for water and sewerage services for viability of businesses and avoid monopoly rents by implementing upper bound pricing;
- Public reporting of community service obligations and strategies to remove the need for these requirements; and
- Use independent bodies to review and set prices, and oversee the process of setting prices.

The NWI base standard for urban water pricing also includes building block pricing methods that include a Regulatory Asset Base (RAB) and a derivative Nominal Revenue Requirement (NRR) which are preferred by Australian economic regulators (ESC 2005 – 2018; IPART 2020). An example of the components of a building block model utilised by IPART (2020) in the determination of prices for water corporations (Sydney Water example) is presented in Figure 2.

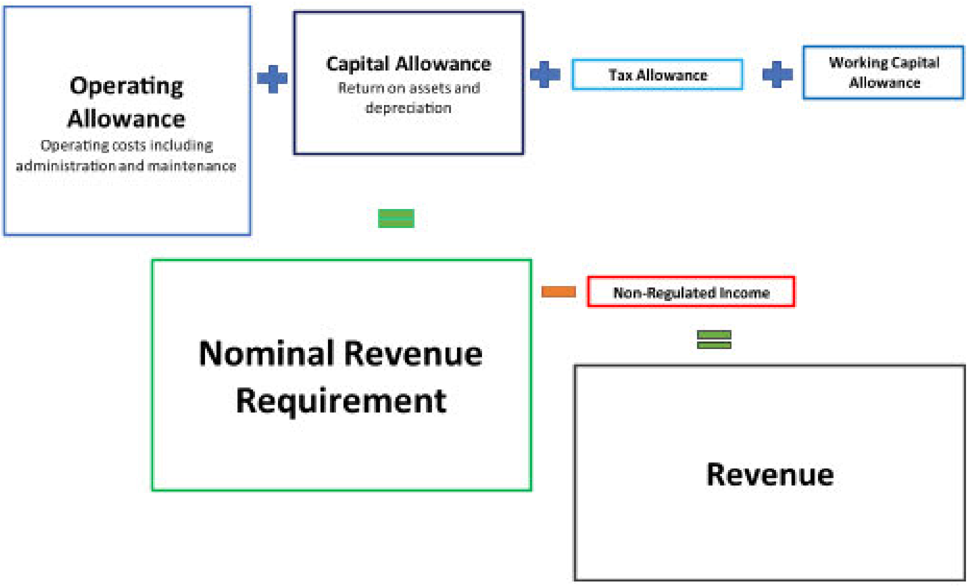


Figure 2. Components of the building block model used to determine revenue requirements for water utilities (scale of boxes based on the Sydney water 2020 price determination).

Figure 2 reveals that regulated allowances for operating and capital expenses, taxes and working capital are the key components of the nominal revenue requirement (NRR). Operating and capital allowances are dominant proportions of the determination of revenue needed to ensure a utility is viable. A capital allowance is derived from returns on and depreciation of the regulatory asset base (RAB) and the determination also includes a range of smaller components such as non-regulated income. The stated aim of the regulatory process using the building block method is to set maximum prices based on the Nominal Revenue Requirement (NRR) to efficiently provide water, sewage and stormwater services, and earn a return on the utility asset base (IPART 2008).

The regulatory asset base (RAB) is an assumed market value of the sale of a utility that represents potential to earn revenue in accordance with current pricing policies and has no relationship with the actual value of the physical assets (IPART 2003). The RAB is a key component of the building block method and is utilised to determine the returns and depreciation on capital in deriving the nominal revenue requirement (NRR).

An initial value of the RAB (for example in 2000 for Sydney Water Corporation) was derived as the net present value of revenue earned by the utility over a particular time horizon. The RAB is then determined in subsequent years by adding net capital expenditure (NetCap), depreciation (Depr), disposal of assets (Disp) and inflation (Inf) to the previous value of the RAB as follows:

$$RAB_t = RAB_{t-1} + NetCap_t - Disp_t - Depr_t + Inf_t \quad (1)$$

where t is the year.

The NRR is derived as the sum of the operation expenses (Opex), maintenance expenses (ManEx), administration expenses (AdmEx), allowance for working capital (WEx), return of capital (Depr), return on capital (CapR), taxation allowance (Tax), working capital (Wcap) and unregulated income (NoRIn) as:

$$NRR_t = Opex_t + ManEx_t + AdmEx_t + WEx_t + Depr_t + CapR_t + Tax_t + Wcap_t - NoRIn_t \quad (2)$$

Where $CapR_t = RAB_t.WACC_t$ and WACC is value for the weighted average cost of capital set by the regulator.

Equations 1 and 2 underpin the building block model used to determine the revenue requirement and to set prices for utility services, and are utilised in this investigation. The WACC is the weighted average of debt and equity costs of infrastructure investment that are compared to efficient businesses. The NRR is combined with long-run marginal costs of services to set the fixed and variable tariffs for utility services.

Regulators are also expected to apply regulatory judgement to modify the building block model determination to include consideration of social and environmental impacts in pricing decisions (IPART 2008). However, governing legislation for regulation of utilities and performance of company officers prioritise corporate performance and viability over consideration of whole of society objectives (for example; Corporations Act 2001; Essential Services Act 1994). Khosroshahi et al. (2021) discuss the emerging initiatives in Victorian regulation where the setting of the WACC is dependent on the level of engagement and trust derived from utility selected customer groups.

The processes of developing the building block pricing determinations are based on a draft report by the regulator, proposals from a water utility about infrastructure and revenue requirements, public submissions and review by the regulator assisted by water industry consultants (IPART 2020; ESC 2005 – 2018). This process is typically dominated by water utility information that is increasingly unavailable for public scrutiny due to commercial in confidence restrictions which creates strong asymmetry of information limitations to the regulatory process (NSW Audit Office 2020; Infrastructure Australia 2017; Commonwealth of Australia 2015b).

The derivation of the Regulatory Asset Base (RAB) is also partially decoupled from expanding water, sewage and stormwater networks associated with growth in connections (IPART 2022; ESC 2022). The mechanism for providing infrastructure for new growth which might expand the network (and utility infrastructure costs) is that developers or land owners (not utilities) pay for infrastructure in new developments, and this infrastructure value is not attributed to the utility until there is a need to replace or repair the asset at some future date. These 'gifted assets' or 'Asset Free of Charge (AFOC)' to the utility as defined by the regulator are recorded in the utility's asset register for statutory and tax purposes but are not included in the RAB. Only assets purchased by the utility are included. Importantly, the utility is the approval authority that determines the type of infrastructure provided by developers.

2.4. The urban water market is more than government utility infrastructure

Figure 1 assumes that the monopoly is, by definition, only one firm which provides all the goods and services. This approach is consistent with Chadwick paradigm (Troy 2008) for urban water management that is based on piped supply of fresh water from dams into the city and piping sewage out of the city to avoid contamination. This linear model is exclusively focussed on water supply to the city and sewage outputs at the utility or city scale.

The linear Chadwick model may be well suited to monopoly pricing principles based on the building block method for specifying utility infrastructure but does not account for an urban water market operating at multiple scales with feedback loops created by human interventions and environmental processes. There has been a profound transformation in scope of water solutions in response to increasing populations and variable climate since development of the Chadwick paradigm in 1843. Systems thinking and observation in the modern era have motivated conceptual models of reality that account for greater complexity (Delgado et al. 2021)

The components of the urban water market may not be adequately considered in the centralised Chadwick model or the current building block pricing approach which only considers utility scale infrastructure. Barry and Coombes (2018) also found that linear average analysis at a single centralised scale produced inconsistent insights that heavily influence infrastructure decisions that were biased against complementary solutions at different scales.

The urban water market is also narrowly defined around utility services in regulation and measurement as demonstrated in National Performance Reporting (NPR) by the Bureau of Meteorology (BOM) and information sources utilised in Water Reform Reports by the Productivity Commission that mostly focus on the utility market segment (for example; BOM 2014–2022; Productivity Commission 2020). This sole focus on utility services leads to perceptions of natural monopoly and associated regulatory assumptions.

P. J. Coombes, Barry, and Smit (2018) and P. J. Coombes (2022) highlight that urban water utilities only supply part of the market for urban water services, and distributed solutions and water conservation are significant complementary contributors to urban water markets. Data from BOM 2014–2022, P. J. Coombes, Barry, and Smit (2018) and published reports on private recycled water schemes by local governments (for example by City of Sydney) were utilised to estimate the urban water market for the Greater Sydney and Melbourne regions as shown in Figures 3 and 4.

Where WEA are water efficient appliances, RWH is rainwater harvesting and SWH is stormwater harvesting.

Figures 3 and 4 demonstrate that a considerable proportion of the urban water market consists of complementary solutions to the utility water supply and losses. It is noteworthy that the proportions of the different urban water market solutions presented in Figures 3 and 4 are likely under-estimated because there is limited collated reporting on non-utility water solutions and utility demand management, and

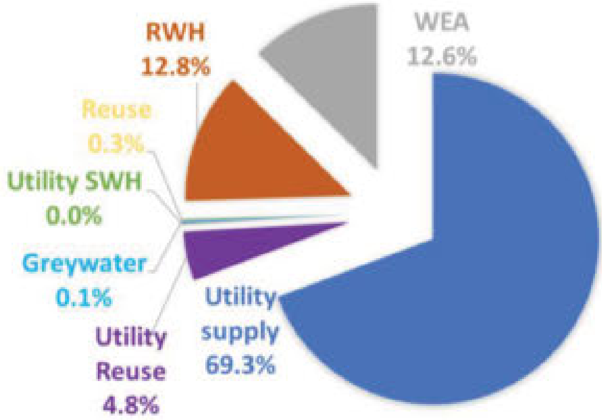


Figure 3. Components of the urban water market based on volumes of water supplied and saved for Greater Sydney.

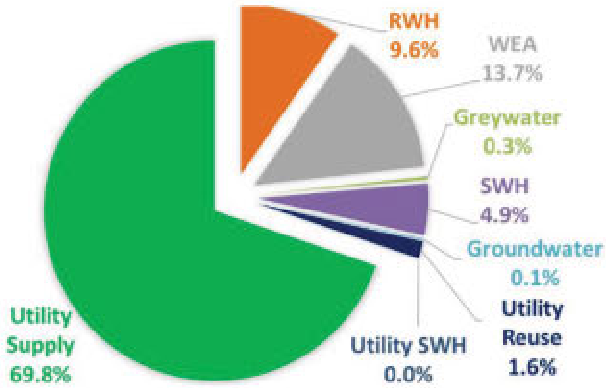


Figure 4. Components of the urban water market based on volumes of water supplied and saved for Greater Melbourne.

these results will vary across years and are dependent on government policy settings and market processes.

Urban water markets often include a single dominant corporation with many distributed participants (classified as a dominant firm oligopoly) where pricing and planning decisions for or by the corporation dominate all other contributions and solutions. The urban water market includes multiple solutions and contributors. Different and more inclusive regulatory processes are needed to maximise the opportunity for all participants and solutions in the market, the environment and for society.

2.5. Challenges for monopoly price regulation

Dollery and Wallis (1997) highlight that there can be substantial social costs of monopoly power. These processes include rent seeking, institutional capture and construction of unnecessary infrastructure (or failure to construct infrastructure) to maintain, increase and exercise monopoly power (Commonwealth of Australia 2015; Helm 2020; Pindyck and Rubinfeld 2015).

These challenges apply to the scenario where governments have competing roles as owner, regulator, operator and policy maker for urban water utilities (Infrastructure Australia 2017). Market failure is created when policymakers do not have sufficient information about market processes that are necessary to design rational government regulation and leads to government failure as the inability to achieve its announced intentions in an efficient manner, and allocative inefficiency such as excessive provision of public goods and services (Dollery and Wallis 1997). The ultimate outcome can be legislative failure where the bureaucracy fails to implement policy efficiently and leads to rent seeking involving wealth transfers to groups that support a particular paradigm or solution (Spinesi 2009; Di Lorenzo 1996; Dollery and Wallis 1997).

It is the Australian experience from the energy and telecommunications industries that shows government regulation creates natural monopolies and increases in monopoly power by limiting complementary solutions to meeting market demands (Commonwealth of Australia 2015a; Finkel et al. 2017; Hilmer 2014). The markets for most urban services, including water and sewerage services, incorporate a range of complementary solutions from other sources and advances in technology at distributed scales that alters the economies of scale with respect to the entire market (Commonwealth of Australia 2015b; P. J. Coombes, Barry, and Smit 2018; Finkel et al. 2017).

Helm (2020) highlights that the framing of regulation can change the objectives and governance of utilities from public benefit to narrow preference for centralised technology. This can limit the ability of the utility to respond to emerging challenges and opportunities in the interest of society (customers).

A key objective of price regulation is to achieve efficient provision and use of regulated services whilst encouraging investment in government owned utilities (Chu and Grafton 2021; IPART 2020; COAG 2014). Pricing strategies can also achieve multiple social and political objectives, management of water demand and incentivise complementary solutions. Regulators interpret full cost recovery underpinning efficient pricing as fixed tariffs derived from utility fixed costs and connections, and volumetric charges determined from marginal cost of water supply and distribution (Chu and Grafton 2021; IPART 2020; ESC, 2015). In contrast to these considerations, maximum prices for monopoly water services are commonly based on rate of return regulation that is focused on a utility's cost of capital based on the building block method that is underpinned by a fair rate of return on a regulatory asset base (Zetland 2021).

Chu and Grafton (2021) explain that this approach to pricing utility services may not be economically efficient as it does not maximise social surplus, and can be unaffordable for poor households. Mack, Wrase, and Meliker (2017) reported diminished household welfare associated with declining efficiency of water utilities in North America. The regulated price for utility water services is not the market price because it only represents the private costs of the utility and does not include external social and environmental costs (Grafton, Chu, and Wyrwoll 2020).

The determination of monopoly prices dominated by operation and provision of utility infrastructure can serve to embed increasing amounts of infrastructure and perceived fixed costs for utilities which in turn drives higher requirements for revenue (Commonwealth of Australia 2015a).

2.6. Recognising that urban water markets include complementary solutions

Urban water markets include services provided by government utilities and complementary solutions from many other providers including households. This integration of solutions across providers and consumers is understood in the electricity industry (Finkel et al. 2017). Distributed water sources and conservation ensured that many Australian urban areas did not exhaust water supplies during the millennium drought from 2000 to 2010 (AWA Water Efficiency Specialist Network 2012; Turner et al. 2016). Australian governments mandated limited water conservation measures in the wake of the Millennium Drought including Water Wise Guidelines in New South Wales, Permanent Water Savings Rules in Victoria and a national Water Efficiency Labelling and Standards scheme, but additional water conservation policies subsequently failed to appear.

The performance of utility water supplies and the water security of cities was improved by actions that increased local supply and water conservation (P. J. Coombes, Barry, and Smit 2018, 2016).

This historical experience highlighted the importance of solutions that both increase local supply and reduce demand for utility water supply, and the effectiveness of strong demand management programs in uniting the community in meeting water saving targets (Aisbett and Steinhauser 2011).

More recently the benefits of demand side strategies were contested or not well understood and utility supply side infrastructure solutions were preferred. Specifically, water restrictions, distributed water sources and conservation were considered to be economically inefficient when compared to utility water supplies and resulted in reduced revenue earned by utilities (Productivity Commission 2011, 2017, 2020). It was argued that it is also difficult to measure and value non-utility contributions (Productivity Commission, 2017). The loss of utility revenue due to water restrictions during drought and as a result of demand management have led to calls for scarcity pricing where water prices increase during droughts (IPART 2020).

National reporting processes (for example BOM 2014–2022) are focused on utility services and do not report on demand management, alternative water sources, conservation and health outcomes. Reporting on alternative water sources and conservation by the Australian Bureau of Statistics (for example ABS 2013 Environmental Issues) ceased in 2013. Daniell, Coombes, and White (2014) highlights that innovation occurring at distributed scales encounters barriers associated with the actions of multi-layer governance systems. The dominance of the paradigm of supply side utility infrastructure in central government and asymmetry of information can lead to regulation that does not consider complementary solutions and conservation provided at distributed scales. For example, evaluation of the NSW Government's State Environmental Planning Policy BASIX that mandates household water and energy savings by NERA (2010) only considered estimated reductions in expenditure on utility water usage tariffs and excluded all other potential benefits as externalities.

The NSW Audit Office (2020) found that water conservation and distributed water sources have not been effectively investigated, implemented or supported. A focus on utility supply side solutions provided by utilities has prioritised investment in utility infrastructure over demand management and distributed solutions. As a consequence, the utility water supply to Greater Sydney may have diminished resilience to population growth, climate variability and drought. This outcome is expected by the NSW Audit Office (2020) to increase the costs of providing water and sewage services with greater impacts on household welfare and environments. Increased utility water use resulting from diminished household water efficiency and rainwater harvesting was found by P. Coombes, Smit, and Macdonald (2016) to drive higher utility debt and diminished household welfare from increased utility bills in South East Queensland. Feinglas, Gray, and Mayer (2014) found that water conservation diminished growth in the costs of water and sewage services, and associated household bills. Increased reliance on utility scale supply side solutions were found by the Queensland Audit Office (2013) to correspond with diminished economic efficiency of utility urban water supply and the need to levy higher tariffs. These impacts on household welfare, preference for utility infrastructure and decline in economic efficiency of utility services are also experienced in the energy sector (Commonwealth of Australia 2015a; Finkel et al. 2017; Saddler 2016).

3. Analysis of the past and future

This investigation examines the incentives that are reported to drive preferences for utility owned infrastructure in an urban water market that actually includes multiple opportunities for additional water sources and savings. The preference for utility infrastructure is outlined in previous sections as a function of natural monopoly assumptions that includes the building block pricing methodology that is based on utility asset values.

This section explores the impact of growth or decline in utility capital and operating expenses in defining the RAB and the growth in revenue NRR for a Water Corporation, and therefore the regulatory success of the business. These issues are considered by examination of historical data from the Australian urban water services, the application of building block pricing approaches for Greater Sydney and Melbourne, and analysis using a simple model of future scenarios.

The Australian urban water sector has responded to population growth, ageing infrastrastructure, increasingly variable climate and economic shocks during the last two decades. The growth in utility expenses and tariffs are compared to growth in serviced population and urban water demands to examine the preference for utility infrastructure in decision making.

3.1. Australian urban water services

The performance of the Australian urban water sector was estimated using data from multiple sources such as regulators (for example: IPART 2020; ESC 2005 – 2018), annual reports (for example: SWC 2022b), National Performance Reports (NPR) (NWC 2004; BOM 2014–2022) and National Accounts (ABS 2022a). The aggregate urban water use, water and sewage tariffs (Utility Tariffs), utility capital and operating costs, serviced population and non-farm gross domestic product (GDP) is presented in Figure 5.

Figure 5 reveals strong growth in utility costs and tariffs corresponds with inceases in serviced population and the economy with variable and decreasing demand for utility water supply. Note that non farm GDP was chosen to represent urban economic growth as it excludes variable agricultural effects. This investigation focuses on the NPR that provides annual data from 2002 to 2022 about urban utilities and on economic data from the ABS National Accounts. Whilst it is acknowledged that these data sources do not represent all urban water services in Australia, the available data for 81 utilities and councils was sufficient to indicate the aggregate relationships between the key variables.

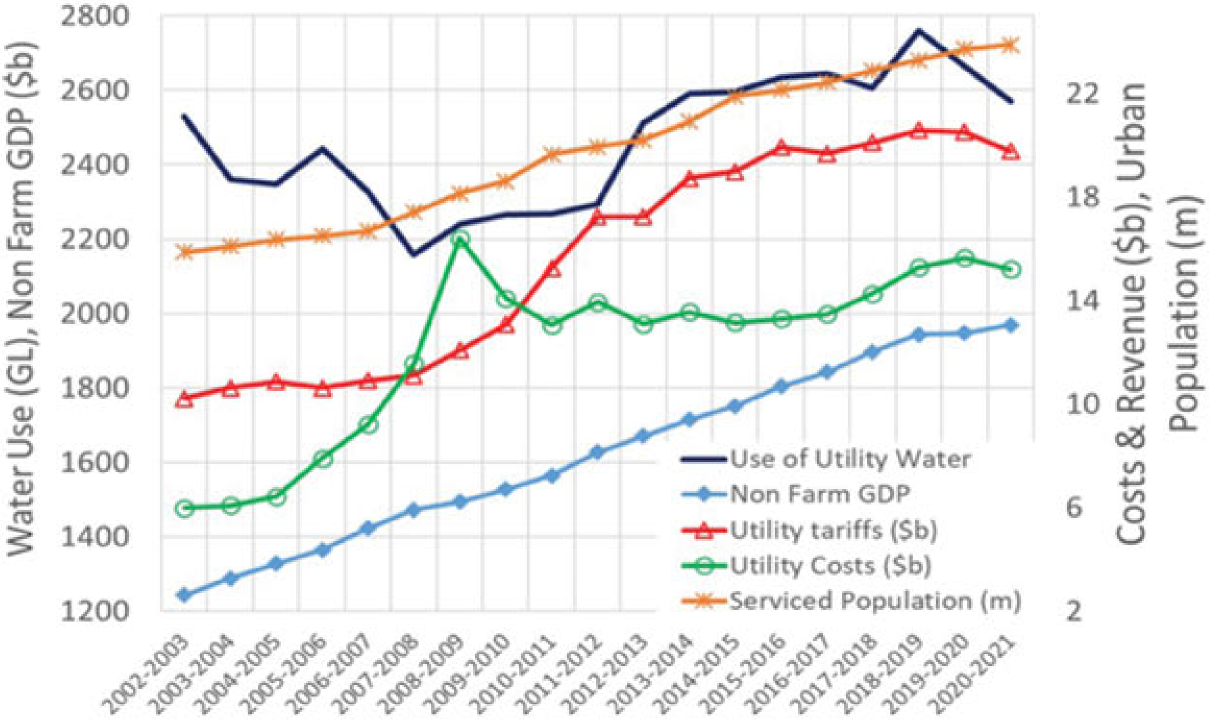


Figure 5. Aggregate values of demand for utility water, serviced population, utility revenue, utility costs and non-farm GDP (economic values in 2022 dollars).

The Australian urban water sector experienced droughts during the periods 1997 to 2009, and 2017 to 2019. The responses from urban areas are characterised by restrictions on use of utility water supplies to conserve capacity, purchases of water efficient appliances and complementary water sources to reduced demand for utility water, and subsequent investment in additional supply sources by utilities. Urban areas also experienced a range of economic shocks including the 2008 Global Financial Crisis (GFC) with subsequent stimulus payments and 2020 COVID-19 Pandemic.

The relative behaviour of the key variables was separated from the changes in the value of money by using 2022 monetary values (CPI adjusted) and from population growth by using per-capita values as shown in Table 1.

Table 1 demonstrates that the real (2022 dollar values) national aggregate of water and sewage tariffs has increased by 93% which is significantly greater than changes in population growth (+50%), total water use (+2%) and non-farm GDP (+58%). The increase in water and sewage tariffs is not solely attributed to population and economic growth or demand for utility services. Increases in utility capital and operating costs (+154%), associated with provision of utility infrastructure, are substantially higher than all the selected key parameters. Utility operating costs also include maintenance, replacement and renewal of existing infrastructure, and payments for purchase of water supply and treatment infrastructure services (IPART 2020).

Table 1. Real aggregate and per-capita changes in urban water services since 2002/03 financial year.

Criteria	Aggregate change (%)	Per capita change (%)
Tariffs ($)	+93	+29%
Water Use (GL)	+2%	−32%
Capital and Operating Costs ($)	+154	+69
Serviced Population (people)	+50	-
Non-Farm GDP ($)	+58	+21%

Removing the population effects by examining the real per capita values of the parameters confirm the growth in tariffs (29%), non-farm GDP (21%), and capital and operating costs (69%) for significant decline in per capita water use (−32%). These results indicate increases in tariffs and investment in utility assets that are greater than economic and population growth, and per-capita demand for utility services.

Figure 5 shows that the peak of increased utility costs to provide water security infrastructure in 2008–09, rapid growth in utility tariffs from 2007–08 to 2015–16 and substantial reductions in demand for utility water supply during the period 2004–5 to 2011–12. The response to the drought involved substantial reductions in demand for utility water due to water restrictions, water conservation and complementary water sources. This situation led to findings (for example: Productivity Commission 2011) that utility infrastructure and supply of services are preferred to water restrictions, water conservation and alternative water sources. The utility costs of increasing water supply capacity occurred following a period of diminished revenue from demands for utility services (Infrastructure Australia 2017). Increased tariffs were leveed to recover lost revenue and pay for infrastructure.

The aggregate data for Australian urban water services shows that growth in expenditure on utility infrastructure and tariffs is greater than changes in water use, population and economy. These effects are most likely smoothed due to spatial and temporal variability of weather and implementation of the building block price regulation.

3.2. Application of building block regulation for Greater Sydney

This section presents the historical record of the Regulatory Asset Base (RAB) and Nominal Revenue Requirement (NRR) for Sydney Water from 2000–01 to 2019–20 that was sourced from Sydney Water Annual Reports and IPART Price Determinations. The historical (CPI adjusted) 2022 dollar values for Sydney Water's RAB and NRR with the key explanatory variables of depreciation, net capital and operation expenses, and return on assets are presented in Figure 6.

Figure 6 reveals 121% real (CPI adjusted) growth in the Regulatory Asset Base for Greater Sydney. The growth in the Regulatory Asset Base is consistent over the 20-year period which includes investment in the Kurnell desalination plant from 2006 to 2011 and after divestment of the desalination plant in 2012. Growth in the Regulatory Asset Base was driven by 83% increase in capital expenses and 245% growth in depreciation costs, and a smaller 16.9% growth on operating costs.

Figure 6 reveals 40% growth in the nominal revenue requirement (NRR) that translates into utility prices and therefore represents a real increase in cumulative charges to customers over that period. The growth in the NRR was driven by increases in operation and depreciation expenses, and return on the regulatory asset base (RAB). The proportion of the NRR driven by variables associated with the RAB (return on assets and depreciation) has increased (in real terms) from 34% to 46% in the period 2000–01 to 2020–21.

The context of these historical regulatory outcomes for Greater Sydney is provided by annual growth in customer connections, urban water use, average household water bill (CPI adjustment to 2022 dollar values) sourced from SWC (2022b) and IPART (2016, 2022), and annual rainfall from Parramatta provided by BOM, (2014–2022) as shown in Figure 7.

Figure 7 demonstrates a decrease in total urban water demands (6.8%) during the 2003 to 2021 period and real increases in total household utility bills (8.3%) in the context of a 25.3% increase in connections to utility water services. An increase in wastewater discharges (26.8%) will also impact on the costs of providing utility services.

The nominal increase in total household bills was 53% during this time period and the real increase (8.3%) represents increases in household costs above

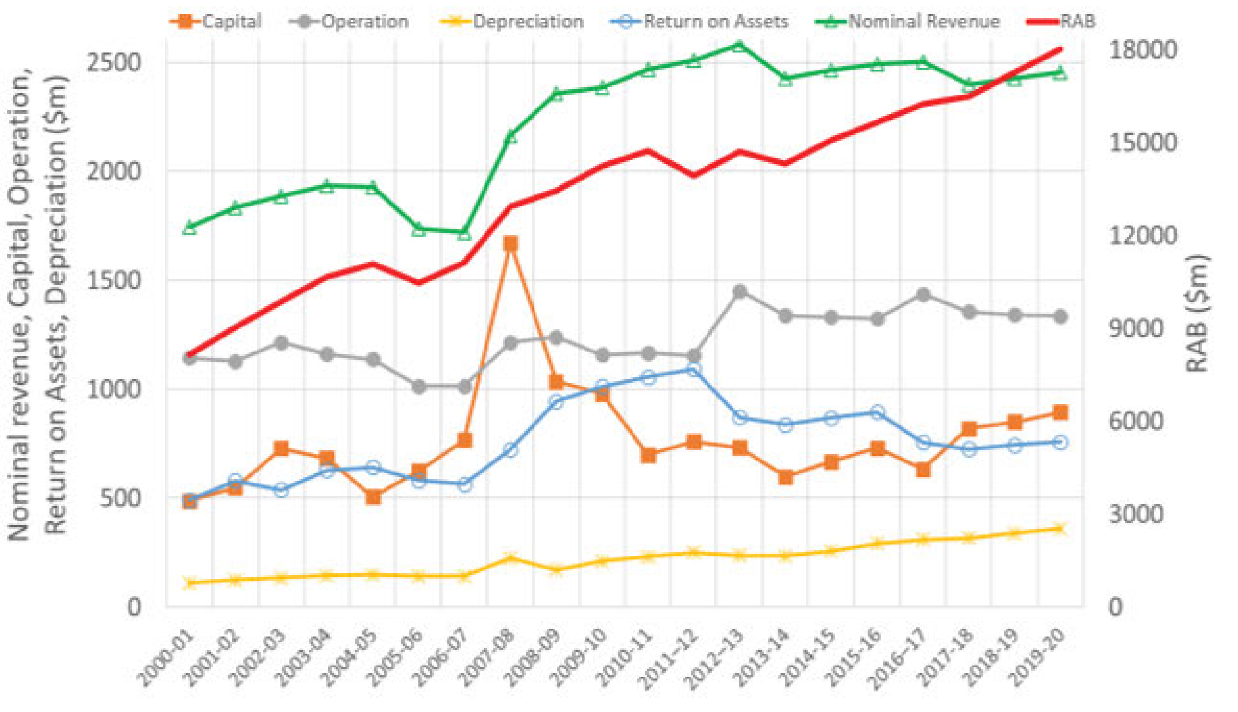


Figure 6. The CPI adjusted values (2022 dollars) for the regulatory asset base (RAB) and nominal revenue (NRR) for Greater Sydney with capital, operation and depreciation expenses, and return on assets for the period 2000–01 to 2019–20.

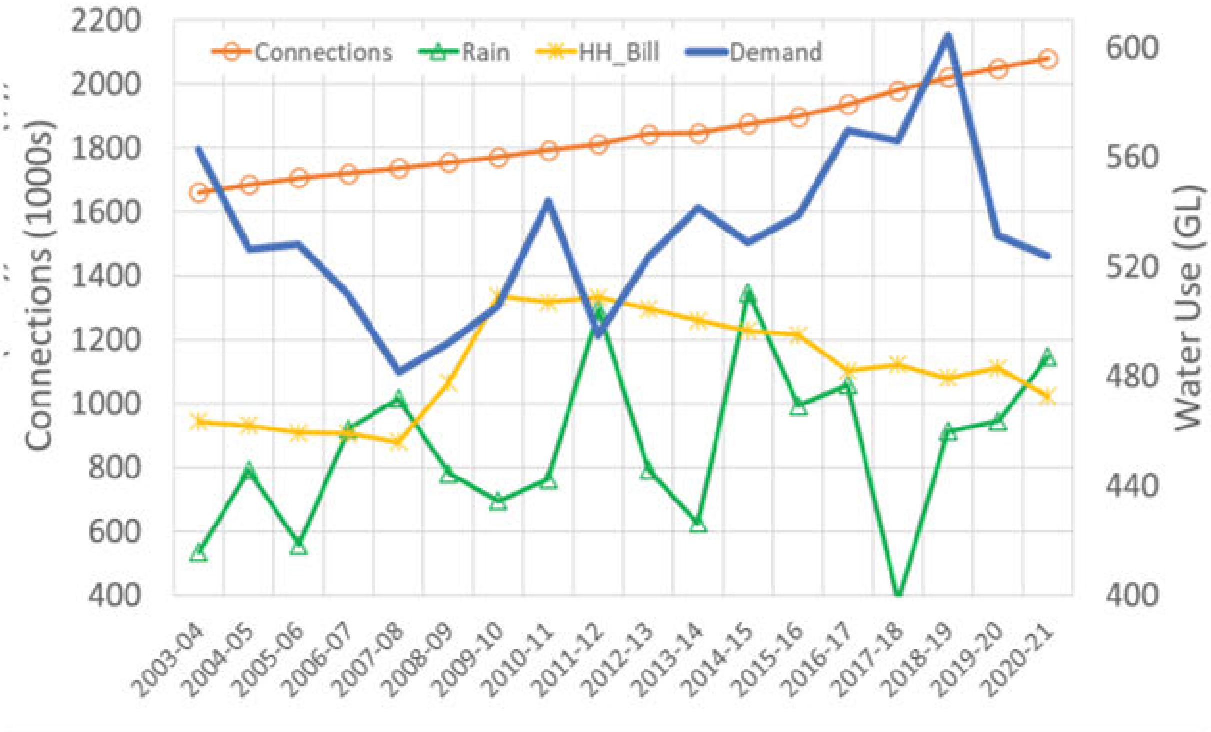


Figure 7. Growth in water connections, total household water bills (Hh_bill, 2022 dollars) and urban water use (demand) with annual rainfall from parramatta (rain).

the inflation rate during a period of limited real change in household income (Gilfillan 2019). This indicates a decline in household welfare associated with water utility tariffs. Growth in real wages has declined from 1.5% in 2008 to −1.2% in 2022 (ABS 2022b). In contrast the RAB and NRR were subject to substantially greater growth of 121% and 40% respectively.

It is noteworthy that total household bills for utility services were held low due to the very low Australian interest rate environment and a legacy of a higher level of household water efficiency in Sydney that was facilitated by the BASIX planning policy (P. J. Coombes, Barry, and Smit 2018).

The increases in the RAB and NRR are only partially associated with expanding infrastructure networks in response to increases in water and wastewater connections (25.3%, 26.1%) because infrastructure created by new developments is not paid for by the utility and not directly included in the RAB. The value (2022 dollars) of these 'gifted assets' increased from AUD $103 million in 2011/12 to AUD $236 million in 2020/21 and are a significant proportion of infrastructure investment that has increased from 13% to 27% of capital expenses. In the Greater Sydney region, gifted assets are ultimately included in operational expenses when maintenance is required and as capital or depreciation expenses when renewal or replacement of the infrastructure is needed in the future (IPART 2022).

It is also shown in Figure 6 that adding a desalination plant to the infrastructure portfolio increases the operating costs and the returns on assets during the period 2007–08 to 2011–12. The growth in the NRR can also be attributed to increases in the RAB, and provision of water security and wastewater treatment infrastructure which includes higher returns on assets and greater operation expenses. Nevertheless, the growth in regulated expenses associated with utility infrastructure is significantly higher than the growth in connections and the economy in the context of decreased water demands. These impacts have been mitigated by a low interest rate environment and strong water efficient behaviours supported by the BASIX policy.

3.3. Comparison to application of building block regulation for greater Melbourne

The application of the building block regulation for the Greater Melbourne region was examined as a comparison to the Greater Sydney region. This investigation defines Greater Melbourne as recieving water, sewage and partial stormwater services from the bulk provider Melbourne Water Corporation (MWC), and the retailers City West Water (CWW), South East Water (SEW) and Yarra Valley Water (YVW). The MWC also provide services to nearby regions and the jurisdiction of Greater Melbourne has recently expanded to incorporate Western Water.

This investigation utilised information from the Essential Services Commission (ESC 2005 – 2018), the NPR (NWC 2004 – 2013; BOM 2014–2022) and water utility annual reports to compile the historical record of the RAB and NRR for Greater Melbourne from 2004–05 to 2020–21. The historical (CPI adjusted) 2022 dollar values for the RAB and NRR for Greater Melbourne with the variables of depreciation, net capital and operation expenses, and return on assets are presented in Figure 8.

Figure 8 shows real (CPI adjusted) growth in the regulatory asset base (82%) and nominal revenue requirement (118%) during the period 2004–05 to 2020–21. The growth in capital and operating expenses also includes development of the Wonthaggi desalination plant and the Sugerloaf pipeline from 2007–08 to 2013–14. The high growth in the RAB and NRR is similar to the outcomes for Greater Sydney and was driven by increases in capital expenses (68%), depreciation expenses (117%), and operating costs (173%).

The growth in the return on assets (−4%), depreciation (117%) and capital expenses (68%) is less than Greater Sydney, and the increase in operation expenses (173%) is significantly greater. This represents the different allocation of Weighted Average Cost of Capital (WACC), and capitalisation and operation of the desalination plant. The substantial growth in the operation expenses is driven by security payments for the desalination plant which represents both operation and purchase of the plant. For example these security payments ranged from $677 million in 2015–16 to $493 million in 2021–02 which is 64% to 52% of operation expenses. During the same period the incremental capitalisation of the desalination plant represented 9%–5% of capital expenses.

Whilst there is some variation in the methods that account for the costs of utility infrastructure within the building block approach, the outcome of increasing RAB and NRR is similar. The RAB is also revalued at the commencement of each regulatory period to incorporate these contributions to utility infrastructure and the operating expense is a strong contribution to growth in the NRR.

The context of these historical regulatory outcomes for Greater Melbourne is provided by annual growth in customer connections, urban water use, average household water bill (CPI adjustment to 2022 dollar values) sourced from the ESC (2022) and NPR data, and annual rainfall for Melbourne provided by BOM (2014–2022) as shown in Figure 9.

Figure 9 shows real increases in household utility bills (60%) in response to growth in water connections (47%) and decline of total water demands (−2%) during the period 2003–04 to 2020–21. The costs of providing water utility services to the Greater Melbourne region was also influenced by the growth in connections to sewage services (46%) and increased sewage discharges (14%).

Figure 9 also reveals the substantial contribution of water restrictions, water conservation and complementary water sources to reducing demands of the utility water services during the 2003–04 to 2015–16 period in response to drought. These reductions

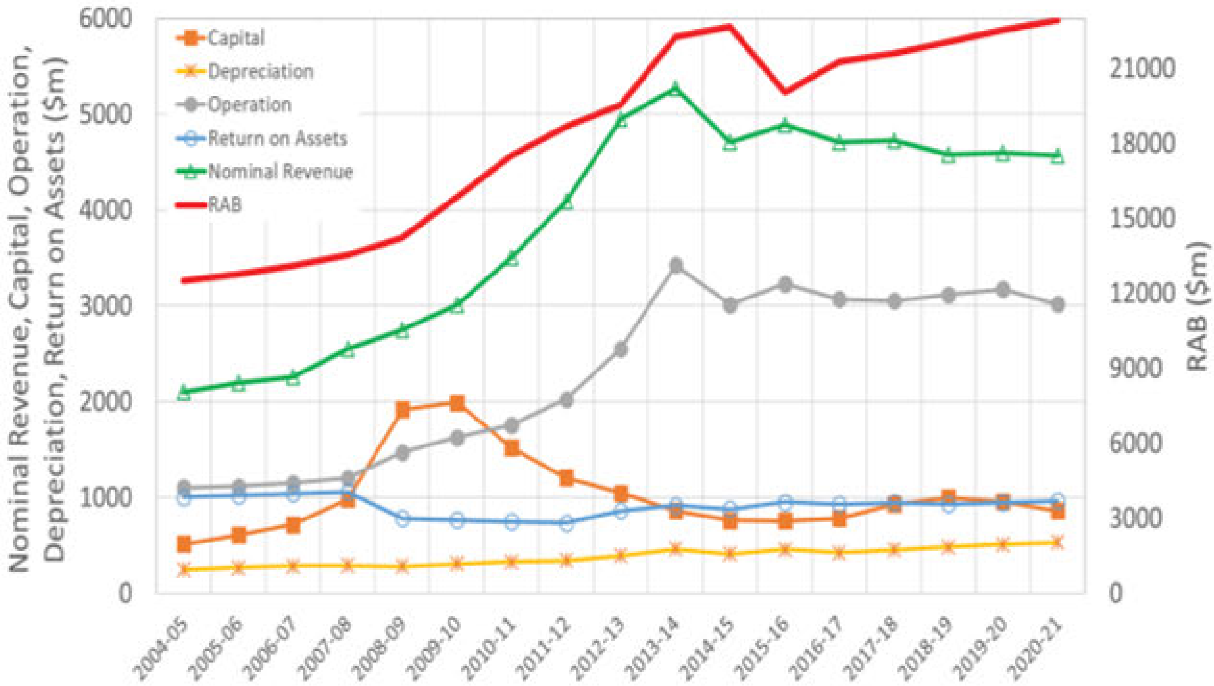


Figure 8. The CPI adjusted values (2022 dollars) for the regulatory asset base (RAB) and nominal revenue (NRR) for greater Melbourne with capital, operation, depreciation expenses, and return on assets for the period 2004–05 to 2020–21.

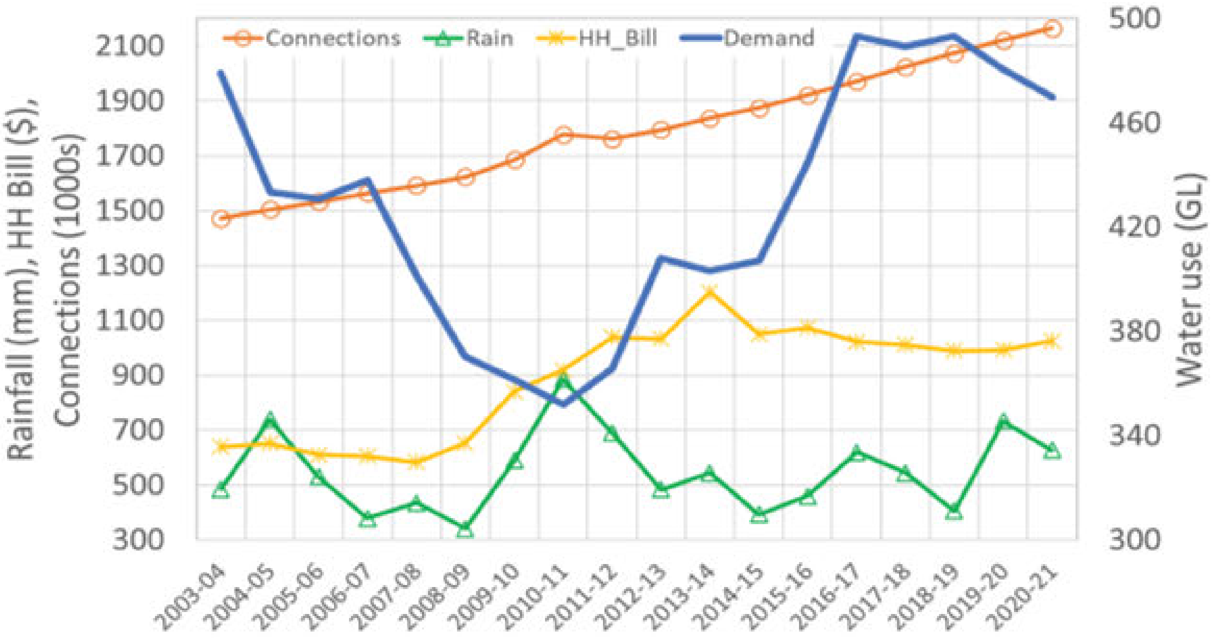


Figure 9. Growth in water connections, total household water bills (household bills in 2022 dollars) and urban water use (demand) with annual rainfall from Melbourne (rain).

in demand for utility water were expected to reduce the revenue earned from water sales. However, increases in utility tariffs have offset this potential decreased revenue.

The real growth in RAB (83%), NRR (118%) and household tariffs (60%) is significantly greater than increases in water (47%) and sewage (46%) connections, and economic growth (54%). In addition, the increases in water demands (−2%) and sewage discharges (14%) are substantially less than growth in the RAB and NRR that is based on provision of utility infrastructure. The expansion of utility infrastructure to service the Greater Melbourne region is also partially decoupled from the growth in the RAB by gifted assets provided by new developments that represent an additional 20% of capital expenses. The region has experienced a 46% growth in gifted assets that will ultimately transfer to the RAB when replacement, maintenance, renewal and depreciation is required.

The magnitude of the Return on Assets is dependent on the Weighted Average Cost of Capital (WACC) and the RAB which are, in turn, influenced by interest rates and inflation. The historical decline in national interest rates was expected to reduce the WACC and therefore diminish the Return on Assets component of the NRR. However, there was significant growth in the Return on Assets for Sydney and a small decline for Melbourne. The Reserve Bank of Australia (RBA 2022) cash rate and inflation is compared to the WACC for Sydney and Melbourne in Figure 10 to better understand this issue.

Figure 10 reveals a significant difference between the RBA cash rate and the WACC for Sydney after the 2008–09 year that are well above (greater than 2% higher than RBA rates) the margin applied to returns on assets in previous years. In contrast, the WACC for Melbourne was set substantially lower than the Sydney WACC during the period from 2008–09 to 2016–17 which may explain the diminished growth in the return on assets.

The similarity between RBA cash rate and inflation after 2008–09 suggests that the return on investments will be zero. This may explain the setting of the WACC at levels greater than 2% above the RBA cash rate to ensure a return on infrastructure value as part of setting revenue allowances. Nevertheless, the setting of the WACC and the value of the utility infrastructure in the RAB impacts on the revenue a utility is permitted to earn. The more recent increases in interest and inflation rates are expected to increase the WACC and returns to utilities.

Consider that a 2% variation in the WACC on a RAB of AUD $20b represents an additional annual income of AUD $400 m or 16% of Sydney Water's annual revenue of AUD $2.52b (SWC, 2020). The cumulative impact of the higher margin assigned to the Return on Asset component of the NRR results in higher tariffs to customers that are not related to service levels. The impact of these higher capital costs is currently distributed across a growing customer base which decreases the relative growth in prices for each customer.

3.4. Prediction of future RAB and NRR for Sydney

A model based on equations 1 and 2 was utilised to estimate future revenue (NRR) for Greater Sydney

Figure 10. The RBA cash rate and inflation versus the WACC for Sydney and Melbourne for the period 2000 to 2021.

derived from the regulatory asset base (RAB) for the period 2020 to 2050. This model commenced with inputs of historical values for the 2019–20 financial year from IPART (2020) and used annual depreciation (2%), inflation (2.3%) and weighted average cost of capital (WACC) of 3.4% to derive annual values. The model also included annual growth in capital (Capex), operational (Opex) and depreciation (deprec) expenses as a function of RAB and time t that was derived from the 2010 to 2020 historical record for Sydney (see Figure 6) as follows:

$$Capex = (0.0476 + 0.00023_{t-2020})RAB_t \quad (3)$$

$$Opex = (0.071 - 0.00072_{t-2020})RAB_t \quad (4)$$

$$Deprec = (0.019 + 0.00051_{t-2020})RAB_t \quad (5)$$

The second time dependent parameter in equations 3 - 5 accounts for the delayed effect of gifted assets impacting the utility RAB by increases in depreciation and replacement costs. This model was utilised to compare the impacts of 0% and 8% annual growth in capital expenses to the performance of historical average 4.76% growth in capital expenses for Sydney by changing the first parameter in equation 3. These scenarios were explored to understand the proportion of NRR from the different futures for Return on Assets as shown in Table 2.

Table 2 demonstrates that 8% annual growth in capital expenses would increase the value of the RAB by AUD $59,670 million (154%) in 2050 which in turn increases the annual value of revenue NRR associated with utility infrastructure by AUD $7041 million compared to average growth. In contrast, a scenario with zero growth in capital expenses will diminish the associated annual value of revenue by AUD $3464 million (76%) compared to a stable asset base and the value of the RAB would decline by AUD $29,353 million in 2050.

Table 2. Predicted future asset value (2022 dollar values) and associated revenue to 2050.

	Growth in capex (%) versus RAB and NRR ($m)		
Criteria	Low (0%)	Average (4.76%)	High (8%)
RAB in 2050	9264	38,617	98,287
Annual revenue based on RAB in 2050	635	2645	6733
NRR in 2050	1093	4557	11,598

These results indicate that the utility is dependent on growth in capital and operating expenses to increase the value of RAB which generates higher annual revenue NRR. Zero growth in capital expenses creates substantial reductions in the revenue that the utility is permitted to earn. Increasing growth in capital expenses to increase value of the Regulatory Asset Base, which is the regulated value of the infrastructure the water corporation owns, is a key determinant of regulated future income for a water corporation. Increasing the quantum of utility supply side infrastructure results in higher asset values and annual revenue which is a crucial business strategy for a regulated utility.

4. Discussion

The study examined the relationship between regulation and behaviour of water corporations with respect to investment decisions to understand the impact of the building block method.

4.1. Urban water regulatory processes and market characteristics

Monopoly pricing should account for the welfare of citizens, health of the environment and viability of the utility (Chu and Grafton 2021). A focus on narrowly defined private costs of a utility can also produce high levels of social and environmental costs as externalities. This includes the crowding out, either by artificially low usage tariffs with high fixed tariffs or by monopoly influence, of complementary distributed solutions from the market (Dollery and Wallis 1997). This creates government and market failure with hidden opportunity costs associated with a preference for utility infrastructure. These outcomes are evidenced by responses of the Productivity Commission (2011, 2017, 2020), the NSW Auditor General (2020) and Infrastructure Australia (2017) which are consistent with the insights from this investigation.

Classical theory for setting monopoly pricing (Figure 1) may be inconsistent with the actual characteristics of the urban water market and application of regulation (Figures 2, 3 and 4) described in this investigation. The linear Chadwick paradigm of utility scale water and sewage services does not reflect the complexity and components of urban water markets. The Building Block method focussed on utility operational and capital allowances (Figure 2) does not reflect the broad objectives for urban water markets and could create economic and social inefficiencies associated with market failure as outlined by Dollery and Wallis (1997) and Chu and Grafton (2021). The mix of water corporation and complementary services should be considered to optimise public benefit (P. Coombes, Smit, and Macdonald 2018, 2016). These considerations also need to integrate both demand and supply opportunities across all scales.

The Commonwealth of Australia (2015a) summarised concerns about the operation of the building block method, the RAB and the WACC as an incentive for utilities to favour excessive capital expenditures which lock in higher prices and associated revenue. This investigation has demonstrated that selection of the rate of return (WACC) can also inflate the regulatory assessment of acceptable monopoly revenues. These processes can motivate a preference for utility supply infrastructure (IPART 2020; ESC 2005 – 2018) which can also crowd out more sustainable alternatives from local communities that could deliver higher social and environmental benefits (Infrastructure Australia 2017).

The building block model for setting maximum water utility prices is shown by this investigation to be remote from the urban water market and it may not respond to the market processes of supply and demand for water and sewage services which includes changes in water use behaviours. This is evidenced by growth in the weighted average cost of capital (WACC) that is greater than the RBA cash rate since 2008–09 and regulatory price setting that is internalised around increasing the asset value of the water corporation. This seems to be an inherent flaw of the WACC and the Building Block method as it allows significant increases and decreases in customer tariffs quite independent of the demand and supply of services or the efficiency of technology or society objectives. The setting of monopoly prices does not appear to be based on the market mechanisms of supply and demand for services. The process seems to maximise monopoly power by eliminating competition to utility infrastructure which is a perverse outcome of a regulatory process that aims to mitigate monopoly power.

This circular process locks in increasing growth in regulatory capital with declining incentive for water conservation and other market opportunities which in turn annually increases asset values that are assumed to be fixed or sunk costs resulting in declining estimates of marginal costs. In contrast, P. J. Coombes, Barry, and Smit (2018, 2019) demonstrated increasing marginal costs in the urban utility market based on all costs that were variable in the long run. These investigations also demonstrated that complementary water solutions that reduce requirement for utility infrastructure provide greater cost savings than potential loss of revenues.

Despite government owned water utilities being restructured as government corporations, it is difficult to understand how market principles have been applied to the building block method of setting maximum prices and determining appropriate income. This suggests even in a market economy the state still needs to effectively apply the appropriate market principles and that independent governance remains important (Helm 2020; Stigler 1971).

4.2. Historical observations

Figure 5 shows that the Australian urban water sector has provided large real increases in tariffs (+93%) and costs (+154%) that are significantly greater than the growth in serviced population (+50%), the economy (+58%) and urban water use (+2%).

The Greater Sydney region has experienced strong 121% real increases in its regulatory asset base over the last 20 years resulting in 40% increased revenue. These increases RAB and NRR are dominated by increases in capital (83%) and depreciation expenses (245%) in comparison to 16.9% increases operation expenses. The choice of a supply side water security augmentation was also shown to increase the value of regulatory asset base with associated higher operating and capital expenses which equate to higher revenue using the Building Block method. In contrast, Figure 7 shows that urban water demand decreased by 6.8% in response to a 23.5% increase in connections and 8.3% real increases in household utility bills during the same time period. The increases in household utility bills in a low interest rate environment with little or no wage growth equate to a decline in household welfare.

In comparison, the building block regulation of the Greater Melbourne region involves substantial real increases in the RAB (+83%), NRR (118%), capital (+68%), operating (+173%) and depreciation (+117%) expenses (Figure 8), and utility household bills (+60%) (Figure 9). The associated increases in water use (+2%), sewage discharges (+14%) and connections to services (water: +46%; sewage: +47%) are also substantially less than the growth associated with utility infrastructure.

These findings are also more significant given that the fate of the Regulatory Asset Base (RAB) is partially decoupled from expanding networks in response to growth in connections driven by new development. The mechanism for providing infrastructure for new growth which might expand the network is that developers or land owners pay for that infrastructure (not the utility), and the infrastructure value is not attributed to the Utility until there is a need to replace or repair the asset at some future date. These 'gifted assets' or 'Asset Free of Charge (AFOC)' to the utility as defined by the regulator are recorded in the Utility's asset register for statutory and tax purposes but are not included in the RAB. Only assets purchased by the utility are included in the RAB. It is noteworthy that the utility is also the approval authority that determines the type of infrastructure solutions permitted to service new development.

The Building Block method is demonstrated to favour investment in utility supply side infrastructure (83% and 68%% increase in capital expenses) and the Regulatory Asset Base (121% and 83% increase) over other forms of investment, such as demand management, leak reduction, distributed solutions from others and conservation, that do not contribute to the utility asset base. This insight is consistent with the findings of the NSW Auditor General (2020) that the regulatory process motivated increased demand for utility services and associated infrastructure. The security and resilience of urban water services may be diminished by preference for utility scale supply side infrastructure over more integrated solutions. P. J. Coombes, Barry, and Smit (2018) highlight the stronger performance of Sydney Water relative to other utilities for household welfare and operating costs due to legacy demand management provided by the BASIX policy and other initiatives. The impacts of the regulated preference for utility supply infrastructure on household welfare (as indicated by real increases in utility bills) was higher in the Greater Melbourne jurisdiction.

4.3. Future impacts

This investigation shows that the current regulatory process creates utility dependence on growth in expenses associated with utility owned infrastructure to ensure future revenue. A situation that involves zero growth in capital expenses for utility infrastructure is expected to result in a 76% decline in revenue by 2050 (Table 2). In contrast, 8% growth in capital expenses for utility infrastructure drives considerable increases 154% increases in RAB and NRR. The regulatory process locks in dependence and preference for utility supply infrastructure that is counted in the RAB.

These insights imply that changing water efficiency, distributed water sources and pricing policy have a direct impact on the operating and capital costs of the corporation. Increasing water efficiency and decreasing demand for utility water services (higher efficiency scenario) is likely to reduce the operating costs and growth in the Regulatory Asset Base which decreases future regulated revenue allowance. It also follows from this that decreasing water efficiency and water saving (lower efficiency scenario) increases operating costs and the regulatory asset base which drives higher future revenue. Scenarios with greater water efficiency are expected to make the water corporation more efficient by reducing growth in operating and capital costs. These savings however represent a potential for lost income to the water corporation in the context of the current building block regulation.

It is an important consideration that future increases in the RAB are unlikely to be buffered by lower interest rates. It is noteworthy that both interest and inflation rates are now increasing. Depreciation expenses will continue to increase as new and gifted assets are included at their full value and the arbitrary write downs of the asset base associated with the start of economic regulation in 2000 will become a lower proportion of the total asset base. This situation will ultimately lead to a strong escalation of regulated utility costs which may increase debt and will require higher prices.

An important practical consideration in this discussion is time. Utility assets are considered to have long asset lives of up to 90 years (IPART 2020; ESC 2005 – 2018). This implies that the impact of a growing Regulatory Asset Base will increase nominal revenue for the water corporation for nearly a century into the future. The higher regulated value of infrastructure in a low efficiency scenario, in the context of the building block regulation and natural monopoly assumptions, also leads to higher assumed fixed or sunk costs and artificially lower variable costs. The assumptions about the assumed fixed costs associated with natural monopoly and with infrastructure decisions also seem to be at odds with economic theory that in the long run all costs are variable (Friedman 2002).

4.4. The risk to complementary solutions

The results of this investigation indicate that the regulatory income model can create society risks due to loss of demand management, distributed solutions and conservation. This finding is consistent with the observations of the NSW Audit Office (2020). These complementary solutions provide systems benefits and reduce costs but are unlikely to increase investment in the Regulatory Asset Base or provide additional water corporation income.

It is difficult to see how the government owners of regulators and water corporations could support strategies that reduce demand for utility services as a successful utility business outcome.

4.5. Separation of powers

Urban water management is an example of market failure where government owns, regulates and operates urban water corporations (Infrastructure Australia 2017). State bureaucracies hold delegated responsibility for governance of utilities whilst also providing oversight of regulators. Water utilities provide their preferred solutions and data to regulators who rely on that information to implement economic regulation. Utilities and associated government agencies are also the planning and approval authorities for strategies and infrastructure solutions in the urban water market. This investigation has revealed a dichotomy of conflicts where building more infrastructure is seen to maximise performance of the government utility and shareholder interests, but this process can negatively impact on viable alternatives from others. This process encounters the profound conflicts associated with multi-level governance systems and competing innovations as explained by Daniell, Coombes, and White (2014) and requires intervention. The Australian Constitution is based on the concept of separation of powers to avoid concentrations of excessive power in segments of society which includes scale and hierarchy constraints (Joseph and Castan 2014). It would seem that the principles of separation of powers in the regulation and policy settings for government water utilities are needed to maximise overall urban water benefits to society and the environment. There is a need to separate the ownership and operation of government utilities from the planning and approval of infrastructure solutions. In addition, independent economic regulation should be focused on maximising the opportunity and value of the entire urban water market.

5. Conclusions

Meadows (2008) advised systems thinkers to look at behaviour to deduce the purpose of a system. This investigation considered the impacts of the price regulation of government owned urban water utilities using historical information and models of likely future behaviours.

The current regulatory paradigm assumes urban water corporations are natural monopoly providers of water and sewerage services. Regulation using the building block method to set maximum prices is based on the capital and operating expenses, and an assumed market value of utility assets. It was revealed that at least part of the behaviour, and therefore purpose, of urban water corporations is to build infrastructure to increase the Regulatory Asset Base and future income. The Australian urban water sector has experienced high growth in real (CPI adjusted) utility infrastructure costs and tariffs that are significantly greater than increases in serviced population, the economy and water demand. Indeed, urban water demand has declined over the last two decades and there has been significant contributions from utility water efficiency and non-utility solutions. Historical behaviours in the Greater Sydney and Melbourne regions demonstrate that regulators and utilities have acted to increase the Regulatory Asset Base far in excess of changes in the supplied water and sewage services, and the utilities have a regulated dependence on growth in utility owned infrastructure. These processes act as a barrier to more integrated solutions that include demand management and recycling, distributed solutions and water conservation.

The operation of the building block method provides a clear incentive to fund additional utility scale infrastructure in order to increase future revenue. A more expensive, less efficient solution provides a greater revenue benefit to the utility than a less expensive, more efficient solutions under this regulatory model. The contributions from people in households, whole of society and other solutions in the urban water market are not directly relevant to this model.

The urban water market is not limited to the operation of government water utilities and the characteristics of the market does not align with the regulatory model that is dependent on utility asset values. This finding is surprising at a number of levels. A considerable volume of demands in the urban water market and many market processes are not managed by the water corporation or considered in the pricing method.

The building block method for determining monopoly revenue is well established but in the context of this analysis is surprisingly one dimensional. There is significant evidence that the method prioritises the viability of the water monopoly over market forces, social and environmental considerations. These insights are consistent with economic text book definition of market and government failure associated with monopoly with novel integration of these issues to government owned monopolies (Dollery and Wallis 1997; Friedman 2002; Hubbard et al. 2013).

There is evidence that regulation of water utilities is driving investment in supply side infrastructure owned by utilities to build Regulatory Asset bases as the overriding purpose of regulatory models. In economic terms water corporations and regulators have done exactly what we asked them to do. This investigation has revealed a situation where government, regulators and utilities are bound within overlapping interests and a narrow partial market definition which does not permit consideration of the entire urban water market and associated opportunities, and emerging integrated systems paradigms.

This is a structural problem. The solution will require a redefinition of the market and for a regulatory structure with separation of powers to have regard to the entire urban water market.This discussion provides a prima facie case for a new market and regulatory regime that builds on the contribution of P. J. Coombes, Want, and Colegate (2012) and could include the following key elements:

(1) The regulatory process recognises the environmental and social benefits provided by innovative servicing options in a whole of society framework that combines utility and non-utility services;
(2) Water utilities are rewarded for facilitating customer access to traditional and non-traditional servicing arrangements. This will involve revising the objectives for the successful governance and operation of water utilities;
(3) Provide structural separation of planning, approval and operational processes involved in delivering water cycle services from the operation of water utilties. This will involve assigning water cycle planning and approval functions to an independent authority and broadening the objectives of the regulator, and
(4) Provide open, transparent, and freely accessible information about the performance of water cycle systems throughout cities to all stakeholders and the community. This information should be managed by an independent authority in each city and be available in a common location and format.

Acknowledgements

This paper is the product of a decade of discussion and collaboration around the economics, social and environmental performance of urban water markets from a systems perspective. In particular the effect of government regulation and policy on urban systems is the genesis of this investigation. The collaboration and advice of colleagues in the water industry, the regulators IPART and ESC and the improvements motivated by the anonymous reviewers are gratefully acknowledged. This manuscript benefited from the original proposal and recommendations from Michael Smit to explore the influence of the regulatory asset base on water utility decisions about infrastructure.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Notes on contributor

Peter J. Coombes is an Honorary and Visiting Professor in the Crawford School of Public Policy at The Australian National University and is also the managing director of Urban Water Cycle Solutions that provides policy advice to government and industry. He is also a member of the steering committee for the CAMELLIA Community Water Management for a Liveable London at Imperial College London and a member of Australian Water Association Committee on Water Efficiency. Peter was an editor of the Urban Book of Australian Rainfall and Runoff, a Chief Water Scientist in the Victorian Government and

a member of the PMSIEC water working group. He was previously Chair of Engineering, Professor of Water Resources Engineering and Associate Dean (Education) at the University of Southern Cross. He holds a PhD in environmental and civil engineering systems, and has qualifications in Surveying, Engineering, Economics and Law. His research interests include systems analysis, hydrology and water resources, molecular sciences, public policy, economics, law and sustainability.

ORCID

Peter J. Coombes http://orcid.org/0000-0002-1852-8263

References

ABS. 2013. *4602.0.55.003 - Environmental Issues: Water Use and Conservation*. Canberra, Australia: Australian Bureau of Statistics. https://abs.gov.au/ausstats/.

ABS. 2022a. *Expenditure and Product*. 5206.0. Canberra Australia: Australian Bureau of Stastics.

ABS. 2022b. *6401.0, Consumer Price Index Australia*. Canberra Australia: Australian Bureau of Statistics. June.

Aisbett, E., and R. Steinhauser. 2011. "Does Anybody Give a Dam? The Importance of Public Awareness for Urban Water Conservation During Drought." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1906962.

Australian Institute of Company Directors. 2020. "General Duties of Directors. Australian Institute of Company Directors. https://aicd.companydirectors.com.au/-/media/cd2/resources/director-resources/director-tools/pdf/05446-6-2-duties-directors_general-duties-directors_a4-web.ashx .

AWA Water Efficiency Specialist Network. 2012. *The Case for Water Efficiency - AWA Position Paper October 2012*. Sydney: Australian Water Association.

Barry, M. E., and P. J. Coombes. 2018. "Planning Resilient Water Resources and Communities: The Need for a Bottom-Up Systems Approach." *Australasian Journal of Water Resources* 22 (2): 113–136. https://doi.org/10.1080/13241583.2018.1497125.

Biggar, D. 2009. "Is Protecting Sunk Investments by Consumers a Key Rationale for Natural Monopoly Regulation?" *Review of Network Economics* 8 (2). https://doi.org/10.2202/1446-9022.1173.

BOM. 2014–2022. "Urban National Performance Reports." Bureau of Meteorology. Commonwealth Government of Australia.

Byrnes, J., L. Crase, B. E. Dollery, and R. Villano. 2010. "The Relative Economic Efficiency of Urban Water Utilities in Regional New South Wales and Victoria." *Resource and Energy Economics* 32 (3): 439–455. https://doi.org/10.1016/j.reseneeco.2009.08.001.

Chu, L. R., and Q. Grafton. 2021. "Dynamic Water Pricing and Risk Adjusted User Cost." *Water Resources and Economics* 35:100181. https://doi.org/10.1016/j.wre.2021.100181.

Clarke, R. M., and R. G. Stevie. 1981. "A Water Supply Cost Model Incorporating Spatial Variables." *Land Economics* 57 (2): 18–32. https://doi.org/10.2307/3145749.

COAG. 1994. *Water Reform Framework, Council of Australian Governments*, 25 February 1994. Hobart Australia: Communiqué.

COAG. 2014. "Intergovernmental Agreement on a National Water Initiative, Coalition of Australian Governments." s24(vi). (24 June, 2014).

Coase, R. H. 1947. *The Economics of Uniform Pricing Systems*, 139–156. 2nd ed., Vol. 15. Manchester England: Manchester School of Economics and Social Studies. https://doi.org/j.1467-9957-1947.tb00558.x

Commonwealth of Australia. 2015a. "Performance and Management of Electricity Network Companies, Interim Report, Environment and Communications References Committee, the Senate." Commonwealth of Australia.

Commonwealth of Australia. 2015b. *Stormwater Management in Australia, Environment and Communications References Committee*. Canberra Australia: The Senate Commonwealth of Australia.

Connell, D., S. Dovers, and R. Q. Grafton. 2005. "A Critical Analysis of the National Water Policy Initiative." *Australasian Journal of National Resources, Law and Policy* 10 (1): 82–107.

Coombes, P. J. 2022. *A Systems Perspective on Characterising Resilience in Urban Water Markets, OzWater 2022*. Brisbane: Australian Water Association.

Coombes, P. J., M. E. Barry, and M. Smit. 2018. *Systems Analysis and Big Data Reveals Economic Efficiency of Solutions at Multiple Scales, OzWater 2018*. Brisbane, Australia: Australian Water Association.

Coombes, P. J., M. E. Barry, and M. Smit. 2019. *Bottom Up Systems Analysis of Market Mechanisms for Pricing Water and Sewage Services OzWater19*. Melbourne: Australian Water Association.

Coombes, P. J., S., Want, and M. Colegate. 2012. "Development of Policies for Water Cycle Reform in Greater Melbourne and Sydney." In *Water and Climate – Policy Implementation Challenges*, edited by K. A. Daniell. Canberra: Engineers Australia.

Coombes, P., M. Smit, and G. Macdonald. 2016. "Resolving Boundary Conditions in Economic Analysis of Distributed Solutions for Water Cycle Management." *Australian Journal of Water Resources* 20 (1): 11–29. https://doi.org/10.1080/13241583.2016.1162762.

Corporations Act. 2001. "Commonwealth of Australia."

Daniell, K. A., P. J. Coombes, and I. White. 2014. "Politics of Innovation in Multi-Level Water Governance Systems." *Journal of Hydrology* 519 (C): 2415–2435. https://doi.org/10.1016/j.jhydrol.2014.08.058.

Delgado, A., D. J. Rodriguez, C. A. Amadei, and M. Makino. 2021. *Water in Circular Economy and Resilience (WICER)*. Washington, DC: World Bank.

Di Lorenzo. 1996. "The Myth of Natural Monopoly." *The Review of Austrian Economics* 9 (2): 43–58. https://doi.org/10.1007/BF01103329.

Dollery, B. E., and J. L. Wallis. 1997. "Market Failure, Government Failure, Leadership and Public Policy." *Journal of Interdisciplinary Economics* 8 (2): 113–126. https://doi.org/10.1177/02601079X9700800202.

ESC. 2005 – 2018. *Water Price Review for City West Water, South East Water and Yarra Valley Water*. Melbourne, Victoria: Victorian Government.

ESC. 2022. "Personal Communication, May – August 2022."

Essential services act. 1994. "Victorian Government."

Feinglas, S., C. Gray, and P. Mayer. 2014. "Conservation Efforts Limit Rate Increases for Colorado Utility." *Journal AWWA* 106 (4): 64–69. https://doi.org/10.5942/jawwa.2014.106.0057.

Finkel, A., C. Munro, T. Effeney, and M. O'Kane. 2017. "Independent Review into the Future Security of the National Energy Market. Blueprint for the Future." *Report by Australian Chief Scientist*. Commonwealth of Australia.

Friedman, L. S. 2002. *The Microeconomics of Public Policy Analysis*. Princeton and Oxford: Princeton University Press.

Gilfillan, G. 2019. *The Extent and Causes of the Wage Growth Slowdown in Australia, Department of Parliament Services*. Canberra Australia: Parliament of Australia.

Godden, L., and A. Foerster. 2011. "International Transitions and Water Law Governance." *Water Law* 22 (2/3): 53–57.

Government of NSW. 1888. "Metropolitan Water and Sewerage Amendment Act 1888 NSW."

Government of NSW. 1992. "Independent Pricing and Regulatory Tribunal Act 1992 NSW."

Government of NSW. 1994. *Sydney Water Act 1994 no.88 NSW Government of NSW, 1992*. Sydney New South Wales: NSW Government.

Grafton, R. Q., L. Chu, and P. Wyrwoll. 2020. "The Paradox of Water Pricing: Dichotomies, Dilemmas, and Decisions." *Oxford Review of Economic Policy* 36 (1): 86–107. https://doi.org/10.1093/oxrep/grz030.

Guldmann, J. M. 1985. "Economies of Scale and Natural Monopoly in Urban Utilities: The Case of Natural Gas Distribution." *Geographical Analysis* 17 (4): 302–317. https://doi.org/10.1111/j.1538-4632.1985.tb00852.x.

Health, A. 2017. *Structural Change in Australian Industry: The Role of Business Services*. Canberra Australia: Reserve Bank of Australia.

Helm, D. 2020. "Thirty Years After Water Privatization—Is the English Model the Envy of the World?" *Oxford Review of Economic Policy* 36 (1): 69–85. https://doi.org/10.1093/oxrep/grz031.

Hilmer, F. 2014. "New Technologies Will Crack Flawed NBN Model." *The Australian Financial Review*, 28/04/2014.

Hubbard, R. G., A. M. Garnett, P. Lewis, and A. P. O'Brien. 2013. *Microeconomics*. 3rd ed. Essex England: Pearson Education.

Infrastructure Australia. 2017. *Reforming Urban Water – a National Pathway for Change*. Canberra Australia: Commonwealth of Australia.

IPART. 2003. "Sydney Water Corporation. Prices of Water Supply, Wastewater and Stormwater Services." *From 1 July 2003 to 30 June 2005, Independent Pricing and Regulatory Tribunal*. New South Wales.

IPART. 2008. "Prices of Sydney Water Corporation's Water, Sewerage, Stormwater and Other Services." *Final Determination No.1 2008. From 1 July 2008 to 30 June 2012*. New South Wales: Independent Pricing and Regulatory Tribunal.

IPART. 2012. "Prices of Sydney Water Corporation's Water, Sewerage, Stormwater and Other Services." *From 1 July 2012 to 30 June 2016. Water - Final Report June 2012*. New South Wales: Independent Pricing and Regulatory Tribunal.

IPART. 2016. "Review of Prices for Sydney Water Corporation from 1 July 2016 to 30 June 2020." *Water - Final Report*. New South Wales: Independent Pricing and Regulatory Tribunal.

IPART. 2020. *Review of Prices for Sydney Water from 1 July 2020 - Final Report*. New South Wales: Independent Pricing and Regulatory Tribunal.

IPART. 2022. "Personal Communication, January 2022."

IPCC. 2021. "Summary for Policy Makers". In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Jones, B. 2020. *What is to Be Done: Political Engagement and Saving the Planet*. Brunswick: Scribe Publications.

Joseph, S., and M. Castan. 2014. *Federal Constitutional Law. A Contemporary View*. 4th ed. Pyrmont NSW: Thomson Reuters.

Kelly, R. 2011. "Getting the Balance Right: Why the Murray Darling Basin Plan Can Implement the Triple Bottom Line Approach." *Canberra Law Review* 10 (178): 182–183.

Khosroshahi, S., L. Crase, B. Cooper, and M. Burton. 2021. "Matching customers' Preferences for Tariff Reform with managers' Appetite for Change: The Case of Volumetric-Only Tariffs in Australia." *The Australian Journal of Agricultural and Resource Economics* 65 (2): 449–471. https://doi.org/10.1111/1467-8489.12417.

Mack, E. A., S. Wrase, and J. Meliker. 2017. "A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States." *PLOS ONE* 12 (1): e0169488. https://doi.org/10.1371/journal.pone.0169488.

Meadows, D. 2008. *Thinking in Systems, a Primer*. England: Chelsea Green Publishing.

NERA. 2010. *BASIX Post-Implementation Cost-Benefit Analysis. An Economic Evaluation of the State Environmental Planning Policy- Building Sustainability Index (BASIX)*. Sydney Australia: Government of NSW.

NSW Audit Office. 2020. *Water Conservation in Greater Sydney, Report by the NSW Auditor General*. Sydney: Parliament of NSW.

NWC. 2004 – 2013. "National Performance Reports: Urban Water Utilities." Canberra.

Pindyck, R. S., and D. L. Rubinfeld. 2015. *Microeconomics*. 8th ed. Essex England: Pearson Education.

Productivity Commission. 2011. "Australia's Urban Water Sector." *Final Inquiry Report No. 55, Canberra Productivity Commission, 2017, National Water Reform, Draft Report*.

Productivity Commission. 2017, National Water Reform, Draft Report.

Productivity Commission. 2020. *National Water Reform, Issues Paper*. Canberra.

Queensland Audit Office. 2013. "Maintenance of Water Infrastructure Assets, Report to Parliament 14: 2012–2013." Brisbane: Queensland Audit Office.

RBA. 2022. "Interest Rate Tables." Reserve Bank of Australia. Retrieved 6 October 2022. https://rba.gov.au/statistics/tables.

Saddler, H. 2016. "Rising Power Bills Signal the End of an Era for Australia's Electricity Grid." *Article from Australian National University Published in the Conversation*.

Simshauser, P. 2017. "Monopoly Regulation, Discontinuity & Stranded Assets." *Energy Economics* 66:384–398. https://doi.org/10.1016/j.eneco.2017.06.029.

Spinesi, L. 2009. "Rent-Seeking Bureaucracies, Inequality, and Growth." *Journal of Development Economics* 90 (2): 244–257. https://doi.org/10.1016/j.jdeveco.2008.09.009

Stern, J. 2013. "The Role of the Regulatory Asset Base as an Instrument of Regulatory Commitment, CCRP Working Paper No 22, Centre for Competition and Regulatory Policy (CCRP)." City University London.

Stigler, G. J. 1971. "The Theory of Economic Regulation." *Bell Journal of Economics and Management Science* 2 (1): 3–21. https://doi.org/10.2307/3003160.

Sydney Water. 2022a. "Annual Report 2021-21."

Sydney Water. 2022b. "The Current Value of Water Under the ELWC." Accessed August 22, 2022. https://www.syd

neywater.com.au/about-us/our-organisation/what-we-do/operating-licence.html .
Tan, J. 2012. "The Pitfalls of Water Privatization: Failure and Reform in Malaysia." *World Development* 40 (12): 2552–2563. https://doi.org/10.1016/j.worlddev.2012.05.012.
Tisdell, J., J. Ward, and T. Grudzinski. 2002. *The Development of Water Reform in Australia*. Brisbane Australia: Cooperative Research Centre for Catchment Hydrology, Griffith University.
Troy, P. 2008. *Troubled Waters. Confronting the Water Crisis in Australian Cities*. Canberra Australia: ANU Press.
Turner, A., S. White, J. Chong, M. A. Dickinson, H. Cooley, and K. Donnelly. 2016. *Managing Drought: Learning from Australia, Prepared by the Alliance for Water Efficiency, the Institute for Sustainable Futures*. Sydney Australia: University of Technology Sydney and the Pacific Institute for the Metropolitan Water District of Southern California, the San Francisco Public Utilities Commission and the Water Research Foundation.
Zetland, D. 2021. "The Role of Prices in Managing Water Security." *Water Security* 12. https://doi.org/10.1016/j.wasec.2020.100081.

Discussion Paper

Application of the Real Business Cycle model to urban water

Peter Coombes

June 2022

Abstract

This investigation aimed to investigate the influence of the Australian urban water sector on the productivity of the national economy using Real Business Cycle theory. Aggregate national water and sewage income from tariffs, and costs from water utilities were described in the Real Business Cycle model as net rental income and net investment in physical capital. A prima facie argument is made that urban water services contribute to business cycles in Australia. Methods to better understand these phenomena are proposed.

1 Introduction

Water is essential for life and economic activities (World Bank, 2016). Droughts, fires and floods impact on water availability and economic productivity (RBA, 2020; Qureshi et al., 2012). A majority of macroeconomic research into water focuses on rural impacts. There is limited analysis of urban water services. Most (86%) Australians live in urban areas that are dependent on water, sewage and stormwater services provided by government utilities.

Briand et al (2021) describes urban water services as a factor of production that impacts on all other economic sectors. Macroeconomic impacts of resilience of urban water services are revealed by responses to climate and economic shocks in systems analysis (Grafton et al., 2019; Meadows, 2008). Understanding of relationships between urban water utility costs and prices, household welfare and economic activity is needed to develop sustainable policies. Cycles of drought, floods, economic shocks and water saving impact on the performance of urban water services (Coombes, 2022; Coombes et al., 2018).

Macroeconomic models are used to develop government economic policy (Bullen et al., 2021; Pecatari and Jaman, 2011). Computable general equilibrium models have been used to investigate the macroeconomic effects of water scarcity, population growth and climate change in Australia (Qureshi et al., 2012), North America (Fadali et al., 2012), South Africa (Briand et al., 2021), and internationally (World Bank, 2016). Hansen and Bhatia (2004) explored links between water supply and poverty. Impacts of low wage growth in Australia is discussed by Gilfillan (2019).

Utility urban water services in Australia are impacted by cycles of weather events and population growth that affect household welfare, utility expenditures and water conservation (Coombes, 2022). Urban water services can be assumed to be a factor of production (Briand et al., 2021).

National economic and urban utility datasets were utilised to understand if Real Business Cycle (RBC) theory (Rebelo, 2005) can be applied to national data to reveal the impacts of urban water services on household welfare and the Australian economy.

This research project aims to utilise the RBC framework to explore the systemic effects of urban water tariffs and costs on Australian business cycles that are expected to generate changes in consumption, investment, savings and economic growth.

2 Background

This section summarises the economic and environmental shocks encountered by the Australian urban water sector since the 2000s and the limited available data that can be used to understand the macroeconomic responses. A discussion is provided about the application of Real Business Cycle (RBC) theory and the available data to the Australian urban water sector. The investigation seeks to provide information about the important trends and cycles that impact on Australia's urban water sector.

2.1 Shocks and Data

The Australian urban water sector is described by partial, incomplete and sometimes derived data from multiple sources such as regulators (IPART, 2020, ESC, 2018), annual reports (SWC, 2020), National Performance Reports (NPR) (NWC, 2004 – 2013, BOM, 2014 - 2022) and National Accounts (ABS, 2022). This investigation focuses on the NPR that provides annual data from 2002 to 2022 about urban utilities and economic data from the National Accounts that also includes quarterly water and sewage tariffs from 1985 to 2022.

A key impact on the behaviour of the urban water supplies is decreases availability of water created by persistent lower rainfall that are droughts. During recent history the Australian urban water sector has experienced droughts during the periods 1982 to 1983, 1997 to 2009, and 2017 to 2019. The responses from urban areas are characterised by restrictions on use of utility water supplies to conserve capacity, purchases of water efficient appliances and water sources to reduce demand for utility water, and investment of additional supply sources by utilities. In particular, the 1997 – 2009 Millennium Drought was reported to impact on the productivity of urban Australia.

Urban areas also experienced a range of economic shocks including the 1990 – 1991 recession, 2001 dot.com crash, 2008 Global Financial Crisis (GFC) and 2020 COVID-19 Pandemic. These events also impact on the productivity of urban Australia. The reductions in productivity created by the GFC were driven, in part, by a $27b decrease in exports during 2007-08.

The regulation of urban water utility pricing also changed from 2000 to a building block method of determining a regulatory value of assets based on utility capital, operating costs, depreciation and cost of capital (IPART, 2020). The regulatory asset base is used to set nominal revenue requirements and ultimately prices of water utility services. This pricing regime is influenced by utility costs which can be considered to be investment that is impacted by real interest rates.

The government response to the GFC included a 1% reduction in interest rates in 2007 and increases in government spending during 2008 – 2010 to increase productivity. Government spending on reduced taxes and temporary transfer payments, and diminished interest rates aimed to increase consumption, investment and productivity in the Australian economy. It is noteworthy that these global impacts will also impact on the urban water sector. The aggregate urban water use, water and sewage tariffs (Utility Revenue), utility costs, urban population and non-farm gross domestic product (GDP) is presented in Figure 1. The national interest rates (Cash Rate) set by the RBA (2022) and inflation is provided in Figure 2.

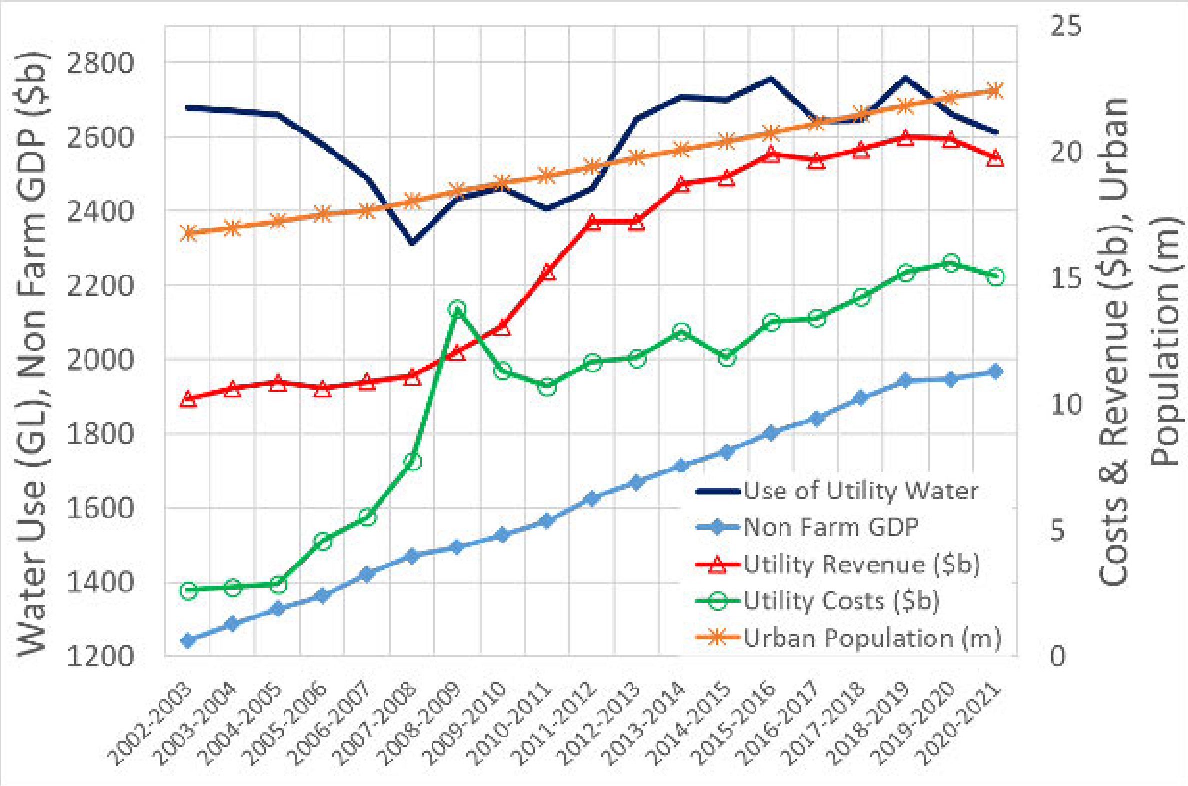


Figure 1: Selected macroeconomic parameters associated with Australian urban water supply

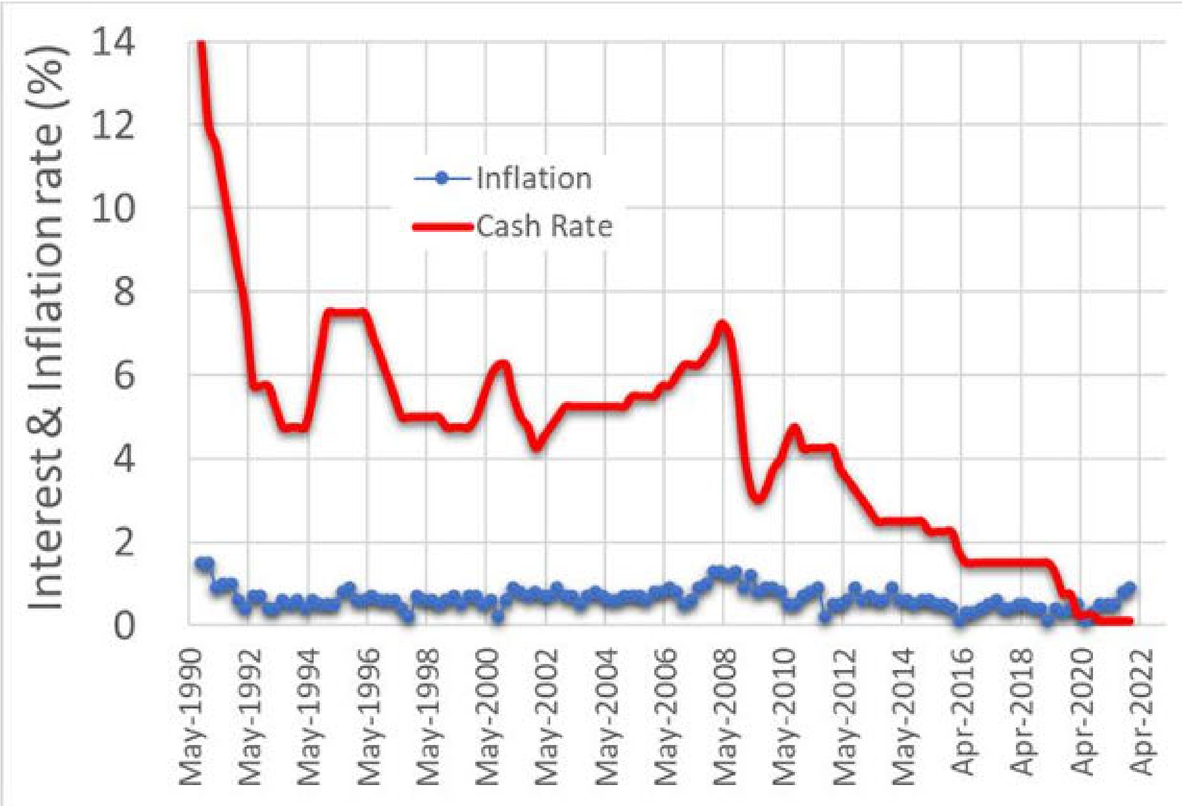


Figure 2: The Australian cash and inflation rates

2.2 Application of Real Business Cycle (RBC) theory

This investigation seeks to examine the influence of urban water services on Australian business cycles. However, it is important to also consider the impact of national events on urban water services in the context of the performance of the national income identity:

$$Y_t = C_t + I_t + G_t + NX_t \qquad (1)$$

where Y_t is real GDP, C_t is consumption, I_t is investment and NX_t is net exports at time t. For example, the decline in net exports NX_t in 2008 was associated with decreased real GDP Y_t, price level and consumption C_t with increased unemployment rates (McDonald and Morling, 2011). The subsequent fiscal response increased government spending by provision of transfer payments V and reduced taxes T, and decreased interest rates. These interventions were taken to stimulate growth in consumption, investment and ultimately GDP.

The real business cycle model (RBC) can used to describe cyclic variations in real GDP as responses to shocks described by short term changes in technology level A:

$$Y = A.f(\kappa K, L) \qquad (2)$$

Where K is physical capital, κ is capital utilisation rate and L is the labour services that is subject to the nominal wage rate ω. According to RBC theory, households perform all functions in the economy in the goods, labour, rental and bond markets. The household budget constraint in accordance with the RBC theory is:

$$C + \left(\frac{\Delta B}{P}\right) + \Delta K = \left(\frac{w}{P}\right).L^s + r.\left(\frac{B}{P} + K\right) + (V - T) \qquad (3)$$

where P is price level, B is the number of bonds at nominal rates, L^s is labour supply, r is real interest rate and Δ is change.

This investigation examines the hypothesis that there is a cyclic relationship between urban water services and productivity. Households rent water and sewage services. Government water utilities provide water and sewage services, and the necessary infrastructure capacity. During environmental shocks (such as droughts) the capacity of services and associated rental income is diminished with ultimate increases in rental price to fund additional infrastructure capacity (see Figure 1).

According to RBC theory, the national economy is centred around households that are consumers and producers in the various markets. Households ultimately pay for and earn income from rented physical capital services (water and sewage services). They also invest in additional water and sewage services (physical capital).

The household budget constraint presented in Equation 3 can be simplified by (perhaps unrealistically) disregarding the government intervention (V – T), assuming that all markets clear (B = 0) and zero economic profit in equilibrium. The real interest rate r is a function of the real rental price R/P, and capacity κ and depreciation δ of physical capital, which is equal to the marginal product of capital MPK:

$$r = \left(\frac{R}{P}\right)\kappa - \delta(\kappa) = MPK \quad (4)$$

In this situation we can assume the following in the goods and rental markets:

Change in rental income: $\Delta r.\kappa K \rightarrow \Delta C \rightarrow \Delta Y\ (permanent); \rightarrow \Delta S \rightarrow \Delta Y\ (temporary)$

Change in net investment: $\Delta K \rightarrow \Delta C \rightarrow \Delta S \rightarrow \Delta Y$

The impact of a change in rental income on consumption is influenced by the real interest rate r, inter-temporal consumption and income effects. If the expected change in rental income is temporary, current savings will increase and consumption is not changed. However, an expected permanent change in rental income will invoke consumption smoothing and an increase in consumption across all years.

The impacts on labour supply L^s and demand L^d and unemployment U were not considered in this investigation. It is noteworthy that there has been little or no growth in the real wage rate ω/P over the last two decades and there may be minimal impacts on urban water services. It is acknowledged that there were cyclic behaviours in these labour variables that may also be influential.

3 Results and Discussion

The costs of water and sewage infrastructure services as change in net investment in physical capital (ΔK) and tariffs for water and sewage services as change in rental income ($\Delta r.\kappa K$) were compared to GDP, consumption, savings and real interest rates in this section. Real per capita values were employed to remove population growth and inflation influences from the data.

The eViews software was utilised to examine the correlation of annual growth rates and cyclic changes between the parameters. The Hodrick Prescott (HP) filter was utilised to separate the trend and cyclic attributes of each parameter (see Appendix A). The analysis aimed to compare the behaviour of the urban water parameters to theoretical RBC outcomes for the economy.

Initial examination of the annual per capita data (2002 – 2022) reveals a 2% decline in annual water use and real increases of 45% for tariffs, 21% for GDP, 74% for consumption, 329% for urban water costs, 34% for population growth and 260% for savings.

The ratio of annual change in parameters (growth rates) was determined and the correlation between annual growth rates is provided in Table 1.

Table 1: Correlation of annual growth rates

Criteria	GDP	Consumption	Savings	Tariffs	Costs	r
GDP	1	0.824	-0.101	0.138	-0.025	0.679
Consumption	0.824	1	-0.133	0.215	0.128	0.745
Savings	-0.101	-0.133	1	-0.025	0.249	-0.069
Tariffs	0.138	0.215	-0.025	1	-0.081	0.476
Costs	-0.025	0.128	0.249	-0.081	1	0.244
r	0.679	0.745	-0.069	0.476	0.244	1

Table 1 shows that the annual growth rates in tariffs (rental income) is associated with growth in GDP and consumption, and decline in savings and costs. This result suggests that increases in water use or tariff rate (rental price) with decreased real interest rates require higher consumption which reduces capacity to save. It is noteworthy that the components of rental income are rental price and utilisation of physical capital.

Growth in costs (investment) is associated with growth in consumption and savings, and decline in GDP and tariffs (rental income). The increased investment in utility infrastructure and household water saving products can be seen as increased savings. The associated increased tariff rates (rental price) motivate lower rental income which influences water savings behaviours and purchases of products that reduce rental income. Water use restrictions also reduce rental income. The data shows a lag effect between changes in water use and infrastructure investment.

The cycles of annual differences to the trend of parameter values were determined using the HP filter and the correlation between cycles is presented in Table 2.

Table 2: Cycle of annual differences to trends for key parameters

Criteria	GDP	Consumption	Savings	Costs	Tariffs	r
GDP	1	0.769	0.045	-0.244	0.103	0.074
Consumption	0.769	1	-0.09	-0.213	0.046	-0.048
Savings	0.045	-0.09	1	0.204	0.232	0.035
Costs	-0.245	-0.213	0.204	1	-0.228	0.178
Tariffs	0.103	0.046	0.232	-0.228	1	0.421
r	0.074	-0.048	0.036	0.178	0.421	1

Table 2 shows that the cycles of increases in tariffs (water rental income) is associated with increases in GDP, consumption and savings. These cyclic increases in rental income are also correlated with increases in real interest rates.

Cyclic increases in costs (water investment) are associated with decreased GDP, consumption and rental income with increased savings and real interest rates. These cyclic effects are influenced by a lag in investment, increased rental prices and reduced real interest rates. Nevertheless, the cyclic increases in investment and savings with associated reductions in productivity (GDP) and consumption is consistent with RBC theory with respect to temporary impacts on income and investment.

The cyclic behaviour of the parameters is provided in Figure 3.

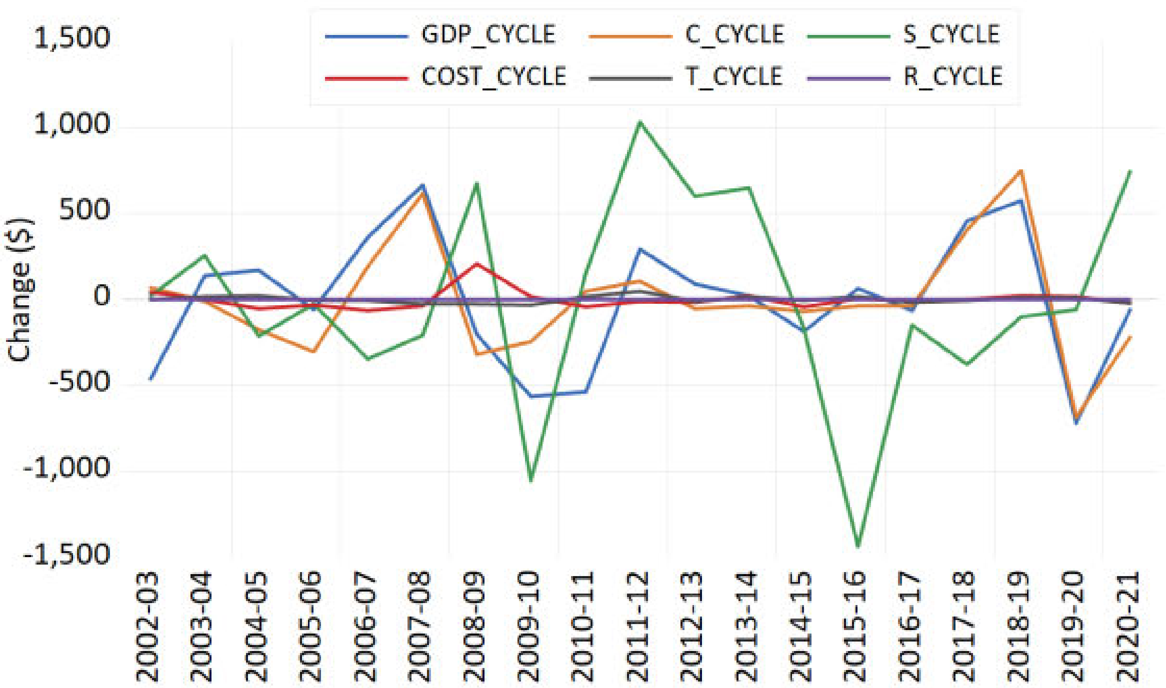


Figure 3: Cyclic behaviour of the parameters

Figure 3 shows that water and sewage tariffs (T_CYCLE: net real rental income) is procyclic, and water and sewage costs (COST_CYCLE: net investment in physical capital) are counter cyclic. The cycles of costs demonstrate some lags in net investment during the peak drought period from 2005 to 2009. Similarly, the procyclic behaviour of tariffs as rental income varies during the peak drought period due to reduced water demand and increased tariff rates (rental price).

These results suggest some consistency with RBC theory where income and investment are procyclic but investment is subject to lagged responses. This outcome suggests that RBC technical shocks in the urban water sector could be described as climate or weather shocks using the parameter A in Equation 2. However, the influence of the other key parameters in the economy will need to be resolved in this relationship.

The impact of urban water tariffs and costs were investigated as national aggregates which can mask the strong spatial variations in weather, socioeconomics, urban water configurations and agricultural influences on GDP. These issues can be addressed by inclusion of non-farm GDP in the analysis and inclusion of regional responses to weather, socioeconomics and configurations of water utility services. This systems analysis approach can be combined with econometric methods such as two stage least squares that utilise weather as an instrument variable in evaluation of Klien's model of the national economy (Hill et al. 2017). These resolved responses to key national aggregates can then be used as inputs to the RBC model to determine the relationship between urban water services and business cycles in the Australian economy

4 Conclusions

This investigation utilised aggregate data on utility water and sewage tariffs, and costs to explore the influence of urban water services on Australian business cycles. The performance of the national economy from 2002 to 2022 was also impacted by fiscal responses to financial crisis and pandemic. However, characterisation of water utility tariffs and costs as net income and net investment in physical capital in the real business cycle were correlated with changes in GDP, consumption, investment and savings.

Variations in aggregate urban water tariffs are associated changes in consumption and higher proportional impacts on savings. Changes in urban water investment are equally proportional to changes in GDP, consumption, savings and aggregate tariffs. This investigation has shown a prima facie relationship between urban water services and business cycles in Australia and has proposed spatial systems methods to better understand these impacts.

References

ABS, (2022), Australian National Accounts: National Income, Expenditure and Productivity, Australian Bureau of Statistics.

BOM, (2014 - 2022), Urban National Performance Reports, Bureau of Meteorology. Commonwealth Government of Australia.

Briand A., Viroleau F., Markantonis V., and Branciforti G., (2021), Assessing The Macroeconomic Effects Of Water Scarcity In South Africa Using A Water-CGE Model, Environmental Modelling and Assessment, Springer Nature.

Bullen, J., Conigrave, B., Elderfield, A., Karmel, C., Lucas L., Murphy, C., Ruberl, H., Stoney, N., and Yao, H., (2021), The Treasury Macroeconometric Model of Australia: Modelling Approach, The Treasury, Government of Australia, Canberra.

Coombes P.J., (2022), A systems perspective on characterising resilience in urban water markets, OzWater 2022, Australian Water Association, Brisbane, Australia (in Press).

Coombes P.J., Barry, M.E., & Smit, M., (2018), Systems analysis and big data reveals economic efficiency of solutions at multiple scales, OzWater 2018, Australian Water Association, Brisbane, Australia.

Fadali, E., Rollins, K., and Stoddard, S., (2012), Determining Water Values with Computable General Equilibrium Models, The Importance of Water to the U.S. Economy: Technical Workshop, National Academy of Public Administration, Washington

Gilfillan, G., (2019), The extent and causes of the wage growth slowdown in Australia, Department of Parliament Services, Parliament of Australia.

Grafton, Q.R., Doyen, L., Bene, C., Borgomeo, E., et al., (2019), Realising resilience for decision making, Nature Sustainability, October, 907-913

Hansen S., and Bhatia, R., (2004), Water and poverty in macroeconomic context, Norwegian Ministry of Environment

Hill, C. R., Griffiths W. E., and Lim C. G., (2017), Principles of Econometrics, 5th edition, Wiley, USA

IPART, 2020, Review of Prices for Sydney Water from 1 July 2020 - Final Report. Independent Pricing and Regulatory Tribunal New South Wales.

Meadows, D. H., (2008), Thinking in systems: a primer, Chelsea Green Publishing.

McDonald, T., and Morling S., (2011), The Australian Economy and the Global Downturn Part 1: reasons for resilience, Economic Roundup (2), The Treasury, Australian Government.

NWC, (2004 – 2013), National performance reports: urban water utilities, Canberra.

Pecatori A., and Zaman S., (2011), Macroeconomic models, forecasting and policy making, Economic Commentary, Federal Reserve Bank of Cleveland, USA.

Qureshi, M E., Proctor, W., Young, M. D., and Wittwer, G., (2012), The Economic Impact of Increased Water Demand in Australia: A Computable General Equilibrium

Analysis. Economic Papers, 31(1), pp. 87-102.

RBA, (2020), Macroeconomic effect of droughts and bushfires, Statement of Monetary Policy – February 2020, Reserve Bank of Australia.

RBA, (2022), Cash Target Rate: Statement of Monetary Policy, Reserve Bank of Australia.

Rebelo, S., (2005), Real business cycle models: past, present and future, Working Paper 11401, National Bureau of Economic Research, Cambridge, MA, USA.

World Bank, (2016), High and Dry: Climate Change, Water, and the Economy. World Bank, Washington, DC.

Appendix A: Application of the HP filter to the data

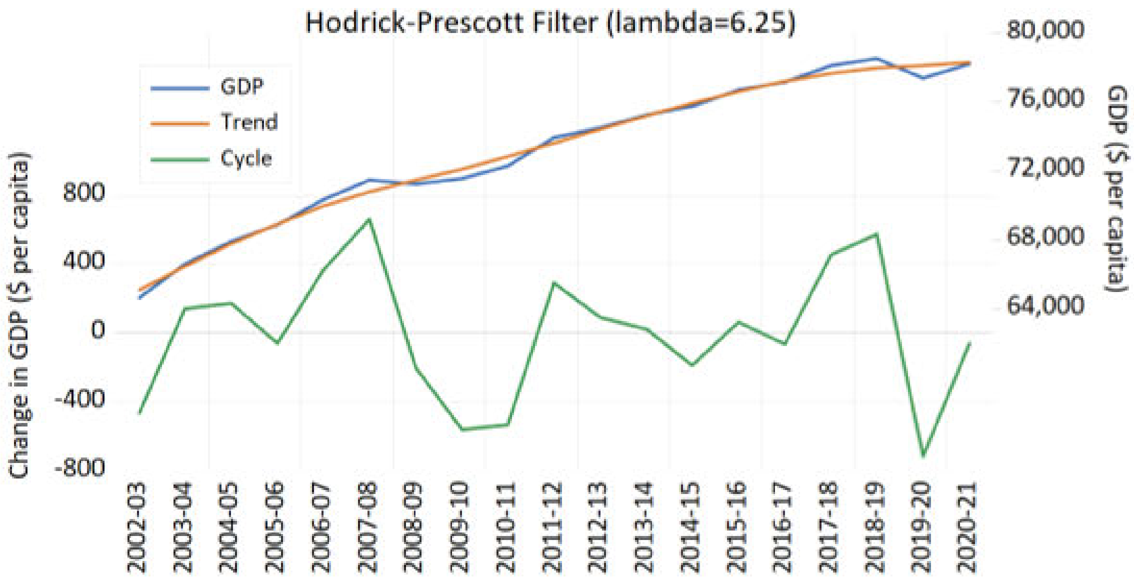


Figure A1: The annual trend and variation from the trend for real per capita GDP showing growth in GDP and cyclic behaviour

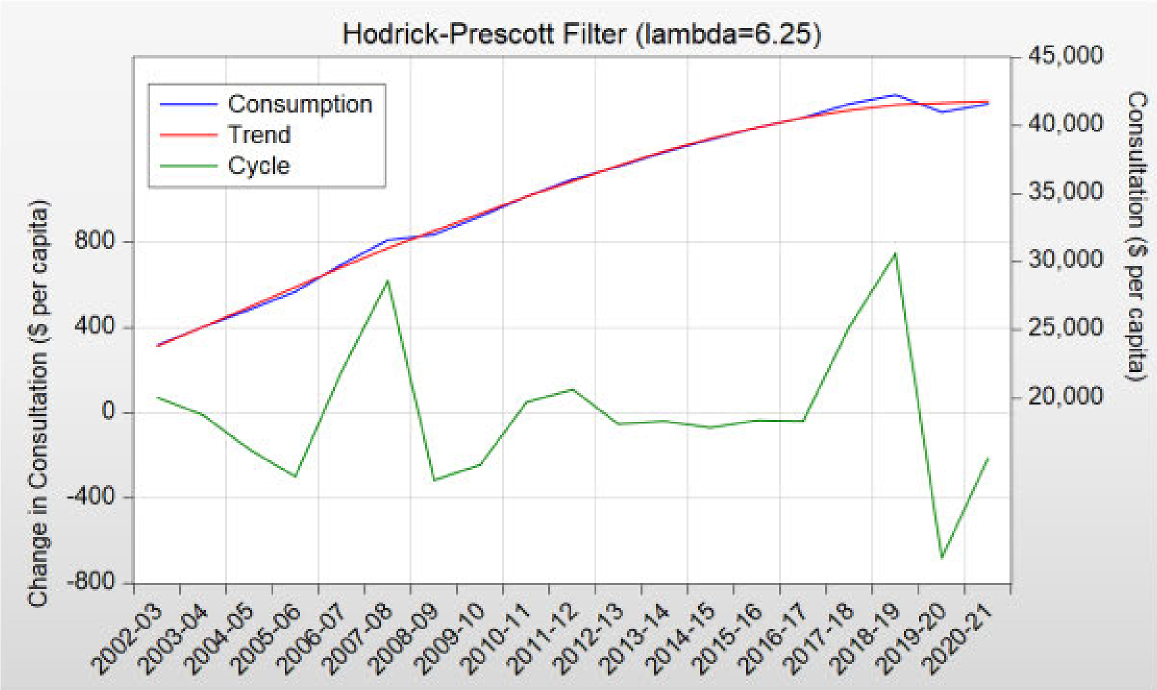


Figure A2: The annual trend and variation from the trend for real per capita consumption showing growth in consumption and cyclic behaviour

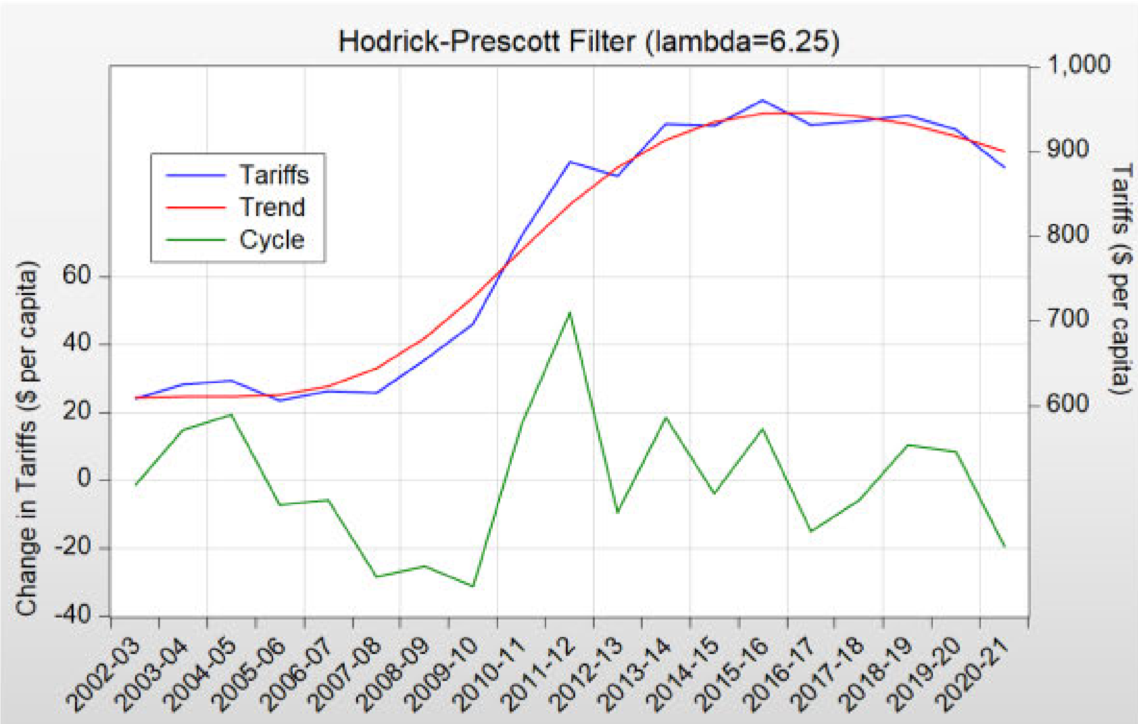


Figure A3: The annual trend and variation from the trend for real per capita water utility tariffs (total bills) showing growth in tariffs and cyclic behaviour

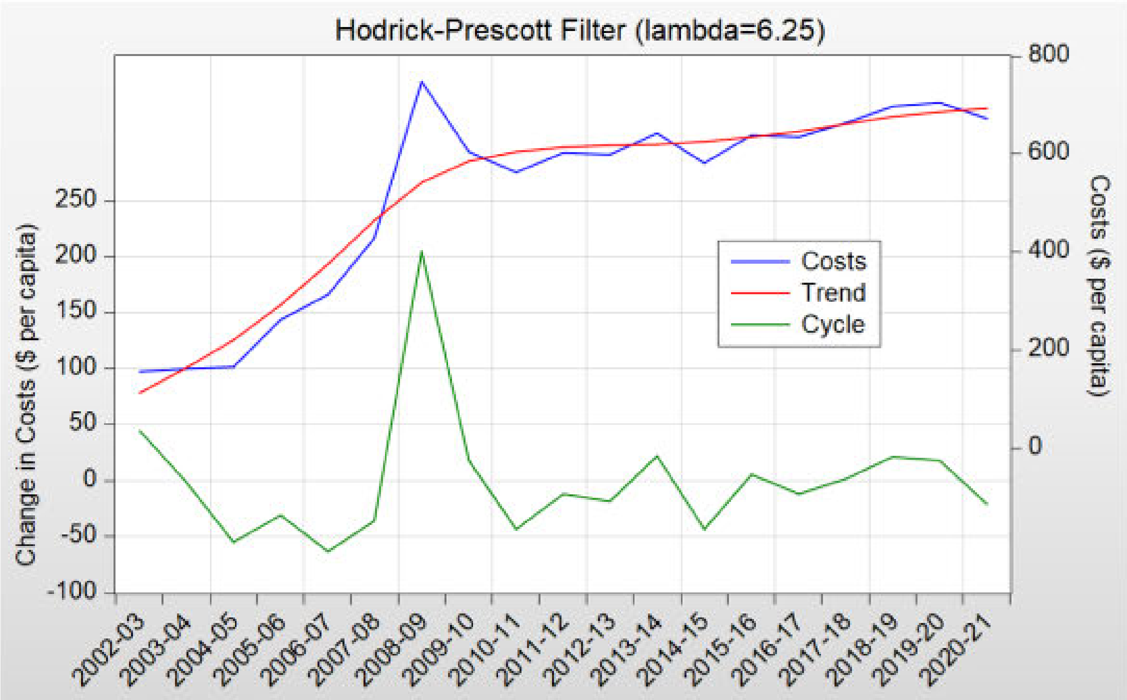


Figure A4: The annual trend and variation from the trend for real per capita water utility costs showing growth in utility costs (investment) and cyclic behaviour

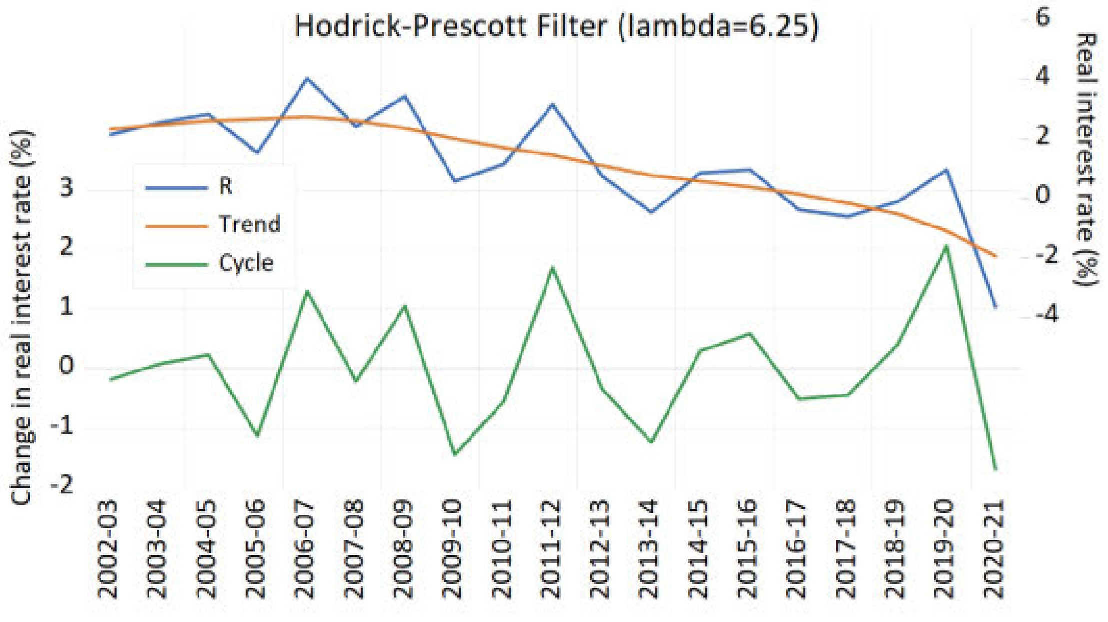


Figure A5: The annual trend and variation from the trend for real interest rate showing decline in real interest rate and cyclic behaviour

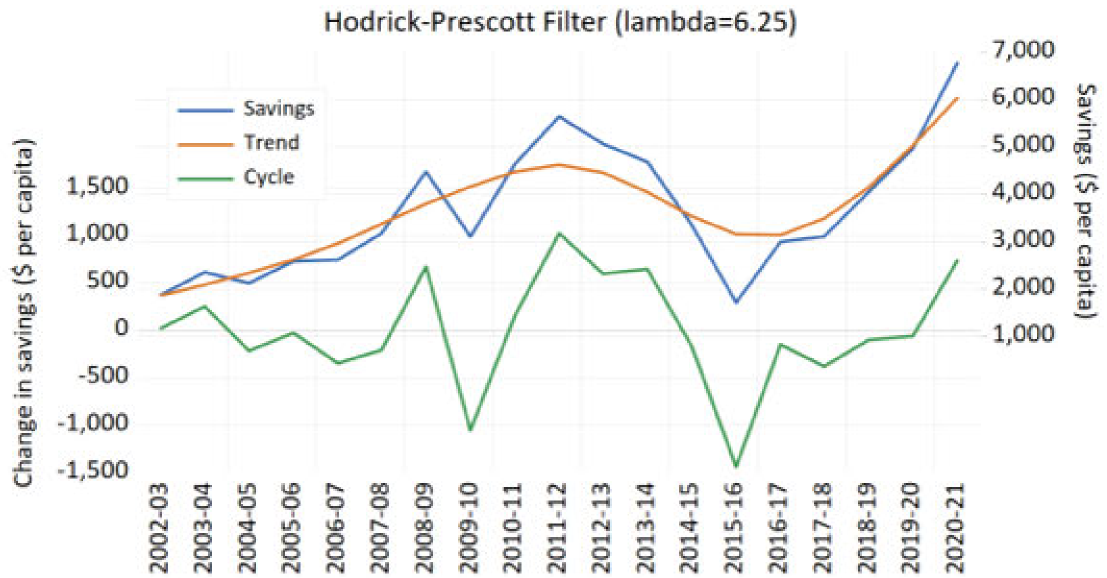


Figure A6: The annual trend and variation from the trend for real per capita savings showing growth in savings and cyclic behaviour