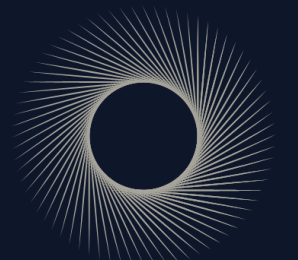




Superannuation and climate change:
Better returns for a better climate



MANDALA

This document is intended for general informational purposes only and is not intended to be used in place of consultation with professional advisors.

The analysis in this report was commissioned by the Future Group and prepared by Mandala.

All information in this report is derived or estimated by Mandala analysis using both proprietary datasets and tools, and publicly available information which is referenced and attributed throughout this document.

Views and opinions expressed in this document are prepared in good faith and based on Mandala's knowledge and understanding of its area of business. Opinions expressed herein are subject to change without notice. No part of this document may be reproduced in any manner without the written permission of Mandala.

Executive summary

- **Climate change will reallocate capital across the economy.** Australia's \$3.4 trillion of superannuation savings will be impacted by this transition.
- **Whether that impact is positive or negative will be determined by Australia's policy settings.**
 - If policy settings allow our superannuation savings to invest in this transition, the returns to savers will be higher, the benefits to the environment will be larger and the benefits to the economy will be greater. The outcomes for savers, the environment and the economy will be pulling in the same direction.
 - But if regulatory barriers prevent superannuation savings from supporting this transition, retirement savings will be lower, the transition will be slower, and the adjustment costs to the community will be greater. As always, the most disadvantaged Australians will suffer the most.
- **Current policy settings were well-intentioned but have led to unintended consequences and perverse outcomes that hurt people saving for their retirement, our climate transition and economy**
 - The previous government's *Your Future, Your Super* (YSYF) reforms were aimed at increasing member engagement, reducing fees, increasing performance, and holding trustees to account for the decisions they make. But, as the government has acknowledged, the issues raised by the reforms have necessitated a review.
 - The *Your Future, Your Super* performance tests benchmarks each asset class against a standard backward-looking benchmark. Failing this test will close the investment option to new members and put in the fund's future in jeopardy. This poses a challenge for ethical funds.
 - If a fund refuses to invest in big tobacco, arms dealers, environmentally polluting firms or the banks that fund them, they will deviate from the benchmark – particularly when the war in Ukraine is pushing up profits for fossil fuel companies – and be penalized for doing so.
 - The consequence is significant: the *Your Future, Your Super* reforms incentivize more investment in businesses and industries that delay Australia's climate transition and hurt the social good.

Benefits for savers

- Savers in green funds receive returns 15% higher over 10 years and 28% over 20 years as markets begin to price in climate risk
- Increased investment means higher wages over the next 10 years

Benefits for the environment

- Increased investment in green sectors will reduce funding costs for businesses supporting the transition and incentivize green investment
- Mandala's modelling found this will result in a 36 million tonne reduction in CO₂ emissions

Benefits for the economy

- Our modelling found this increased investment will increase real GDP by \$170 billion over 10 years, create 620,000 new green jobs and reduce inflation 7% over the same time period

1 **Your Future, Your Super Performance Tests are limiting funds from fully participating in the green transition**

2 Climate risks will structurally change the Australian economy, but superannuation funds that are forward-looking have the opportunity to benefit members

3 If funds aren't prevented from investing in green assets, the economy will gain \$170billion and 620,000 jobs will be supported



Your Future Your Super introduced Performance Tests to ensure members did not stay in underperforming funds

The Productivity Commission's (PC) Inquiry into the efficiency and competitiveness of Superannuation found that structural flaws like unintentionally having multiple accounts and having entrenched underperforming funds were harming members.

The PC found 42 funds performed below a benchmark of their own portfolio with 29 underperforming by more than 0.25%. These funds have more than 5 million members. These members tended to be younger and have lower incomes. Underperforming funds are costly for members. The difference between top quartile returns and bottom quartile returns is \$502,000 for the average member over their lifetime.

To minimise the impact of multiple funds and underperformance, the PC had two recommendations: stapling; and outcomes testing for all funds. The recommended structure of the test was similar to the test introduced in YSYF reforms.

Exhibit 1: Your Future Your Super Reforms

- Your Future, Your Super (YSYF) was a package of reforms introduced in the 2020-21 Budget that came into effect on 1 July 2021. The key elements of the package were stapling, performance tests and the best financial interest duty.
- The package was aimed at reducing fees, increasing performance, improving accountability and ensuring members didn't remain in underperforming funds.
- In July of 2022, the Minister for Financial Services announced a review into the operation of YSYF, noting that it may be discouraging certain investments.

Stapling

- Members are now 'stapled', meaning they will remain with their existing super fund when they move employers, unless they actively select a new fund.

Performance Tests

- The performance test measures fund returns over ten years comparing asset returns to benchmarks.
- Funds that fail must first alert members to their failure and following a second failure are then banned from taking on new members

Best Financial Interest Duty

- This is a refinement to trustee requirements to act in members best financial interest that reverses the onus of proof on trustees to demonstrate compliance.

But the performance test has significant consequences: it is short term and ignores member preferences

Failing performance tests forces funds to notify their members of underperformance and inhibits them taking on new members. These are dire penalties; and mean that CIOs must pass at all costs.

The current tests also impede the deployment of capital into assets with longer term investment profiles. The ten-year time frame requires upfront returns and punishes temporary blips below benchmarks, regardless of the long term pay-offs. This means that products like renewables, with long term return profiles and high upfront costs, are heavily discouraged.

The test is also blind to member preferences. Funds are restricted from investing in line with member values. If a member opts into a fund with an ethical approach, e.g. a green fund, the fund is tested against benchmarks that are not green. This means that after one off events the fund may fail the test, even if the investment strategy is strong over the long term and endorsed by members.

Exhibit 2: Identified issues from stakeholder interviews

Pass/Fail

YSYF is like the qualifying event for the main tournament – you have to qualify

Failure must be avoided at all costs, it is the death of a fund

The vast majority of funds who failed in the past two years are gone, they have already merged

Short term

Longer horizon investing was a real advantage, but YFYS takes that away

Are we genuine long-term investors? No more

Changing the time frame is the most obvious way to improve the test

Blind to member preferences

We are trapped between meeting the stated demands of our members or risk being on the front page of the mainstream news papers

Some CIOs have even questioned the ongoing ability to exclude tobacco: ‘it just chews up a chunk of our limited tracking error budget’

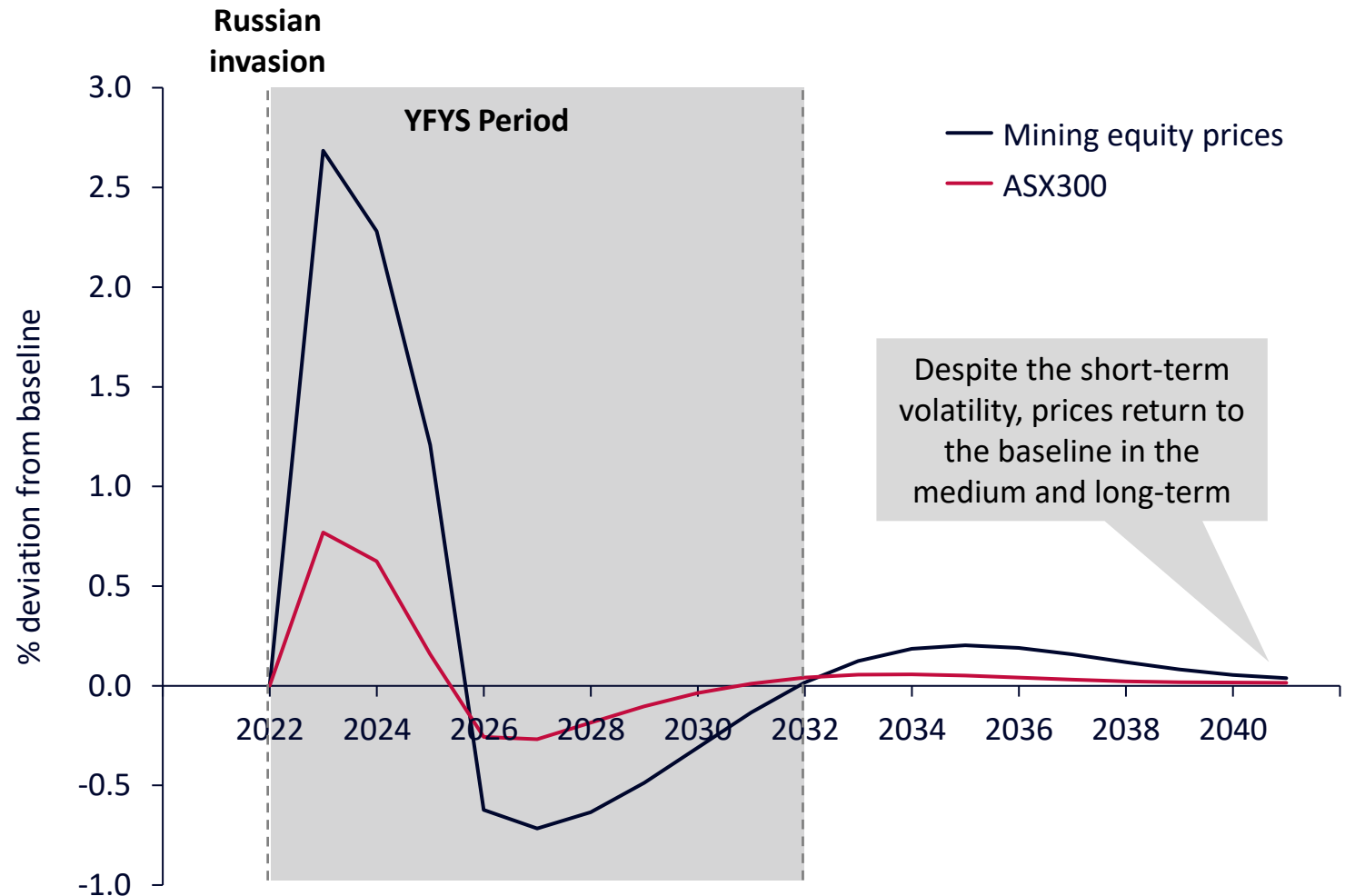
The 10-year time horizon in YFYS means funds are forced to react to short-term volatility

Russia's invasion of Ukraine has significantly increased equity prices of Australian fossil fuel firms. However, this increase is temporary and will result in no long-term impact.

If Russia's invasion of Ukraine prompted global investors to demand a 50 per cent risk premium for investing in Russia – a conservative assumption given the sanctions that are in place – Australian equity prices in mining would return to the baseline scenario.

The 10-year time horizon built into the *Your Future, Your Super* regulations is unrealistic given what we know about economic and financial shocks. Over the long term, these significant shocks will have limited impact. The 10-year time horizon means that funds are forced to react to these shocks.

Exhibit 3: The impact on mining equities from increased investment risk in Russia
Total market capitalisation of the Australian stock market, % deviation from the baseline



Performance testing is already warping the decisions of CIOs on gambling and pollution

The consequences of failing the test, their relative short termism and blindness to member preferences mean CIOs are incentivised to hug indexes by reducing tracking error to ensure they pass.

Tracking error is a measure of the variability between returns of a portfolio and returns of a benchmark. Tracking error indicates how closely a portfolio tracks the index it is benchmarked against. The higher the tracking error of a portfolio, the higher the likelihood a portfolio will perform below the index. This is true even if the portfolio outperforms the index on average or in the long run.

Green funds that exclude or reduce investment in polluting products have a higher tracking error because they are unable to recreate the index they are tracking. When these funds are in danger of failing performance tests they are forced to reduce their tracking error by increasing their investment in polluting products.

Exhibit 4: Case study of investment decisions in a green fund

Product

- A large Australian super fund runs a socially responsible Choice product that excludes and minimises investment in products that don't align with the funds values

Situation

- The fund experienced short term under-performance in 2021.
- In 2022, with the upcoming performance tests for Choice products, the fund was forced to reduce tracking errors in its product

Impact

- **Australian equities:** fund increased its stake in petroleum, gambling and heavy emitters in manufacturing
- **International equities:** fund increased its stake in oil and gas along with arms manufacturing



Takeaways

- The fund's under-performance meant that investment decisions were made to reduce tracking error
- A fund that was attempting to reduce its members exposure to pollution, gambling and arms manufacturing was forced to invest in those areas to ensure it passed the upcoming performance tests

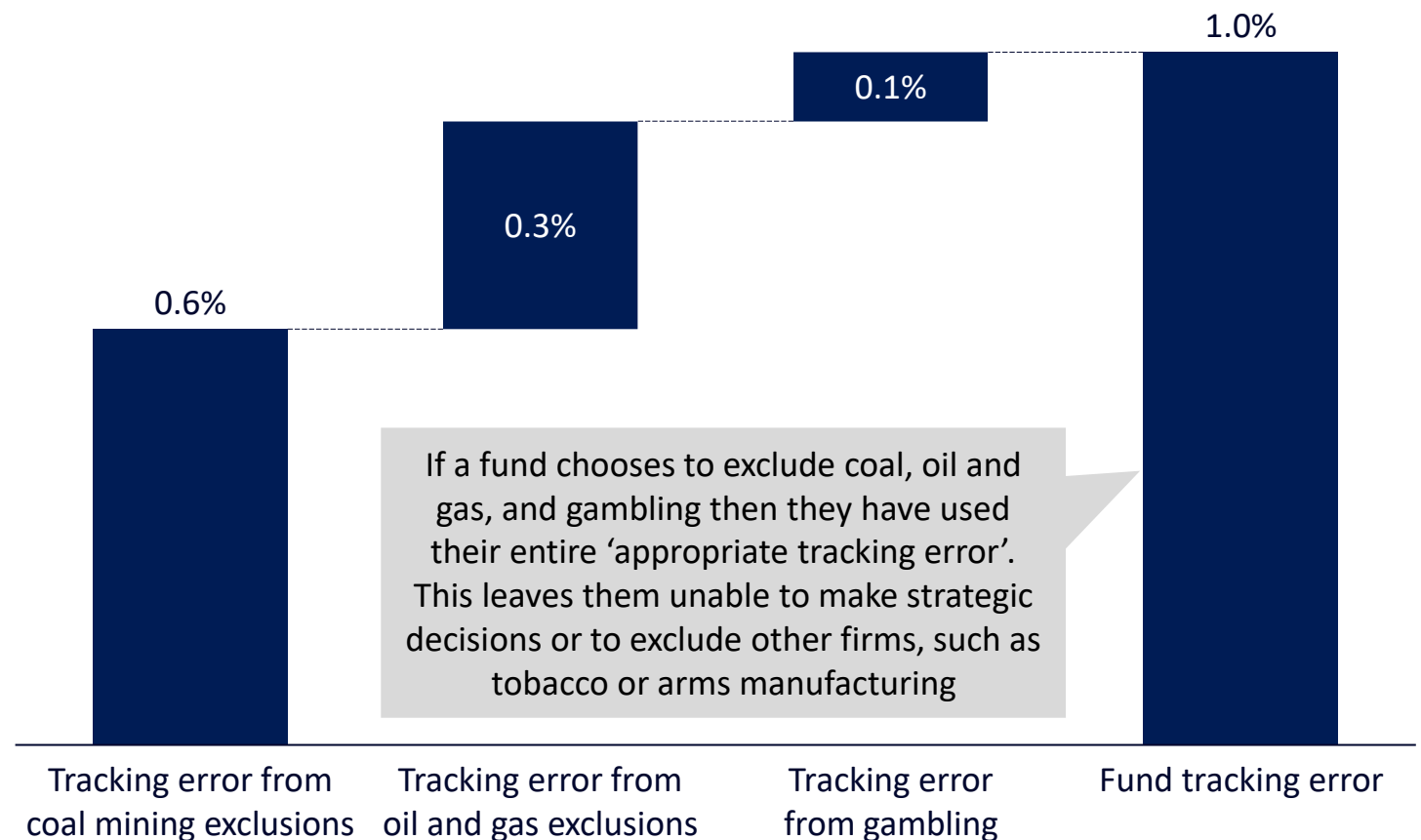
The tracking error incurred by excluding high-emission businesses puts super funds at risk of closure

Stakeholder engagement found that CIOs consider tracking error as a budget. Each deviation they make from investing in the index adds to their tracking error and 'uses up' the budget. Green or ethical funds that wish to exclude polluting, gambling or tobacco industries find that their tracking error budget is quickly used up. This means that their remaining portfolio must mimic the index as closely as possible, reducing the ability of these funds to make strategic decisions and align with members.

Stakeholders indicated that funds run a tracking error of around 1-1.5% in Australian equities. Conexus estimates that the maximum tracking error is around 1% for the asset class.

Mandala has found that the tracking error associated with excluding coal mining was the costliest at 0.6% while the error associated with excluding oil and gas was 0.3% and excluding gambling was 0.1%. This means that green funds with exclusions must take on unsustainable risk

Exhibit 5: Tracking error in Australian equities associated with sector exclusions¹
% Tracking error between ASX300 and the ASX300 with specified exclusions



Notes: 1 Average of the yearly tracking error between market capitalisation weighted monthly returns of the ASX200 and the ASX200 with specified exclusions
Sources: Morningstar; Mandala analysis

1

Your Future, Your Super Performance Tests are limiting funds from fully participating in the green transition

2

Climate risks will structurally change the Australian economy, but superannuation funds that are forward-looking have the opportunity to benefit members

3

If funds aren't prevented from investing in green assets, the economy will gain \$170billion and 620,000 jobs will be supported



Climate change drives risk that will reallocate capital in the Australian economy




Climate change drives three main risks for businesses: **physical risks** from extreme weather events, **transition risks** from changes in government policy and community attitudes, and **liability risks** from potential environmental clean up.

These risks will reallocate capital away from riskier industries and businesses towards those with a lower risk profile.

If this reallocation is delayed or inhibited by government policy, the costs to the economy, investors and the community will be larger and the opportunities to benefit from this transition will be squandered.

Ensuring government policy supports this capital reallocation will deliver a lower cost transition for the Australian community and better returns for investors and those saving for their retirement.

Exhibit 6: Climate risks to businesses

Risk	Transmission	Impact
 <p>Physical risk</p>	<p>Direct damage to assets or property from extreme weather events</p>	<p>Lower asset values</p> <p>Increased insurance claims</p> <p>Supply chain disruptions</p>
 <p>Transition risk</p>	<p>Disruption from changes to policy and community attitudes</p>	<p>Impacts on pricing and demand</p> <p>Increased number of stranded assets</p> <p>Rising defaults on loans</p>
 <p>Liability risk</p>	<p>Being held liable for costly environmental clean-ups</p>	<p>Reduced profits from higher penalties</p> <p>Defaults on loans</p> <p>Business disruption</p>

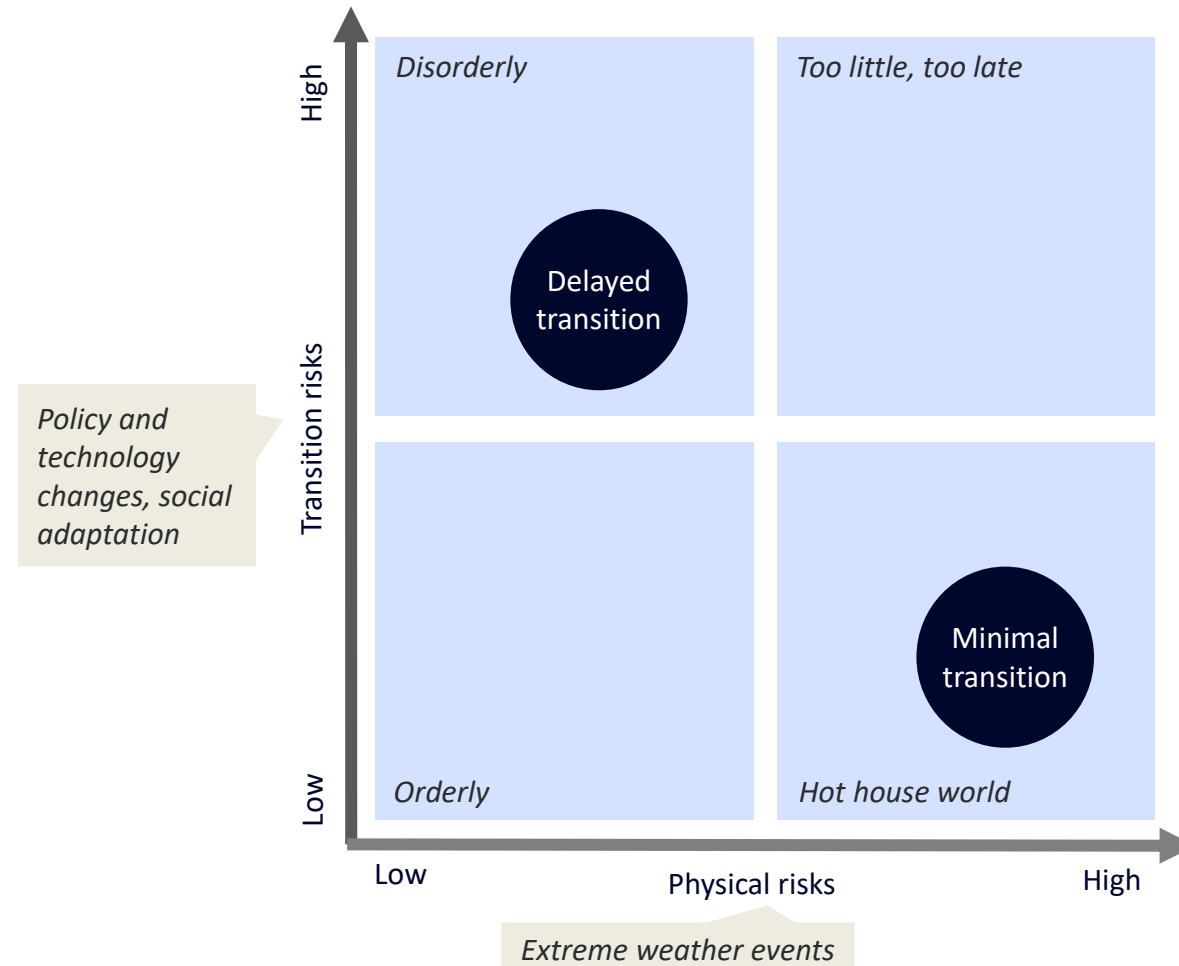
APRA modelled scenarios for Australia based on the work of the Network for Greening the Financial System

The Network for Greening the Financial System is a group of central banks contributing to the development of climate related risk management. In this capacity they developed hypothetical scenarios for how climate change will evolve transition risks and physical risks. APRA then identified two scenarios that Australia was most likely to face.

‘Minimal transition’ scenario: Under this scenario, the world does not adjust sufficiently to avoid a 2 degree increase in temperatures. The future has higher physical risks such as extreme weather events and changing climate conditions which impact businesses and the financial system.

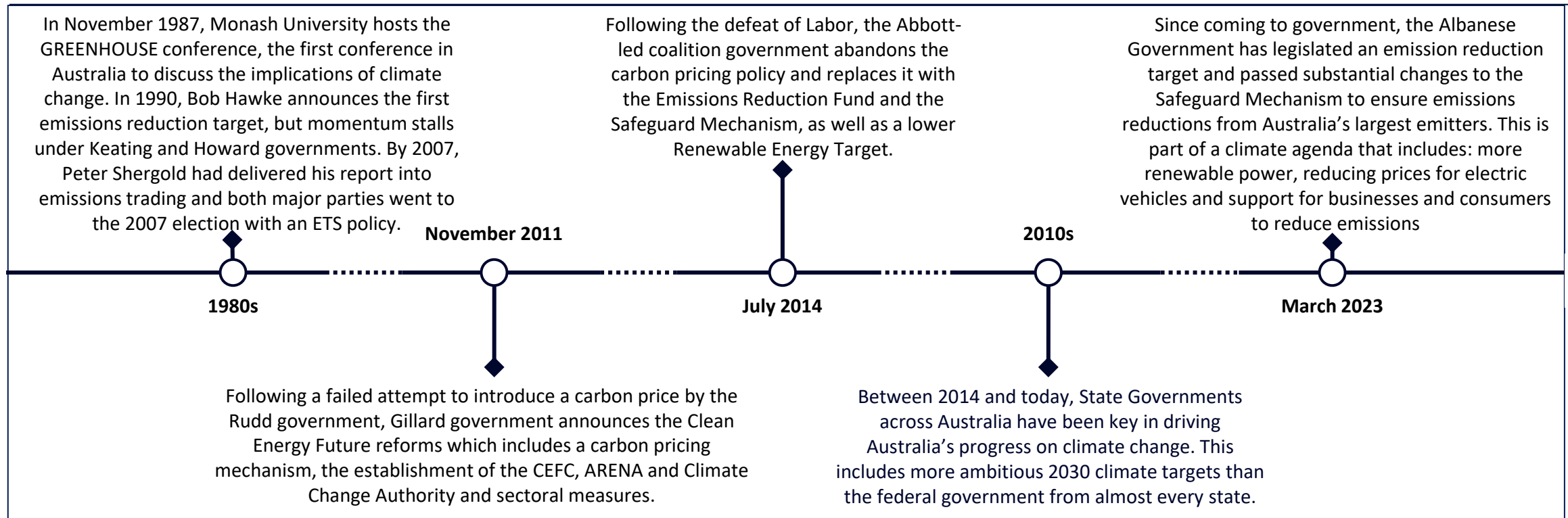
‘Delayed transition’ scenario: Under this scenario, Australia delays the majority of its economic transition until 2030 when it undertakes a rapid reduction in emissions. This has high transition risks as the adjustment of the economy is more disorderly. This scenario includes superannuation regulations preventing capital reallocation.

Exhibit 7: Scenarios for the climate transition



Recent changes in climate policy will mean Australia avoids high physical risks, but experts believe Australia will still have high transition risks

Exhibit 8: Simplified timeline of Australian climate policy



Despite substantial recent progress towards the green transition and greater policy certainty for businesses, there is still a belief amongst climate experts that the 'delayed transition' scenario is most likely. This assessment is driven by a belief that while current climate goals are to reach net zero emissions by 2050, the current policy settings are insufficient to reach this goal. This implies a significant increase in transition speed following 2030.

This view has been justified by modelling conducted by the Department of Climate Change, Energy, the Environment and Water that shows current policy settings are insufficient to hit current targets. This position was echoed by the Climate Action Tracker and the Climate Targets Panel Report which found in 2021 that the 2030 target must be lifted to avoid steep transition pathways.

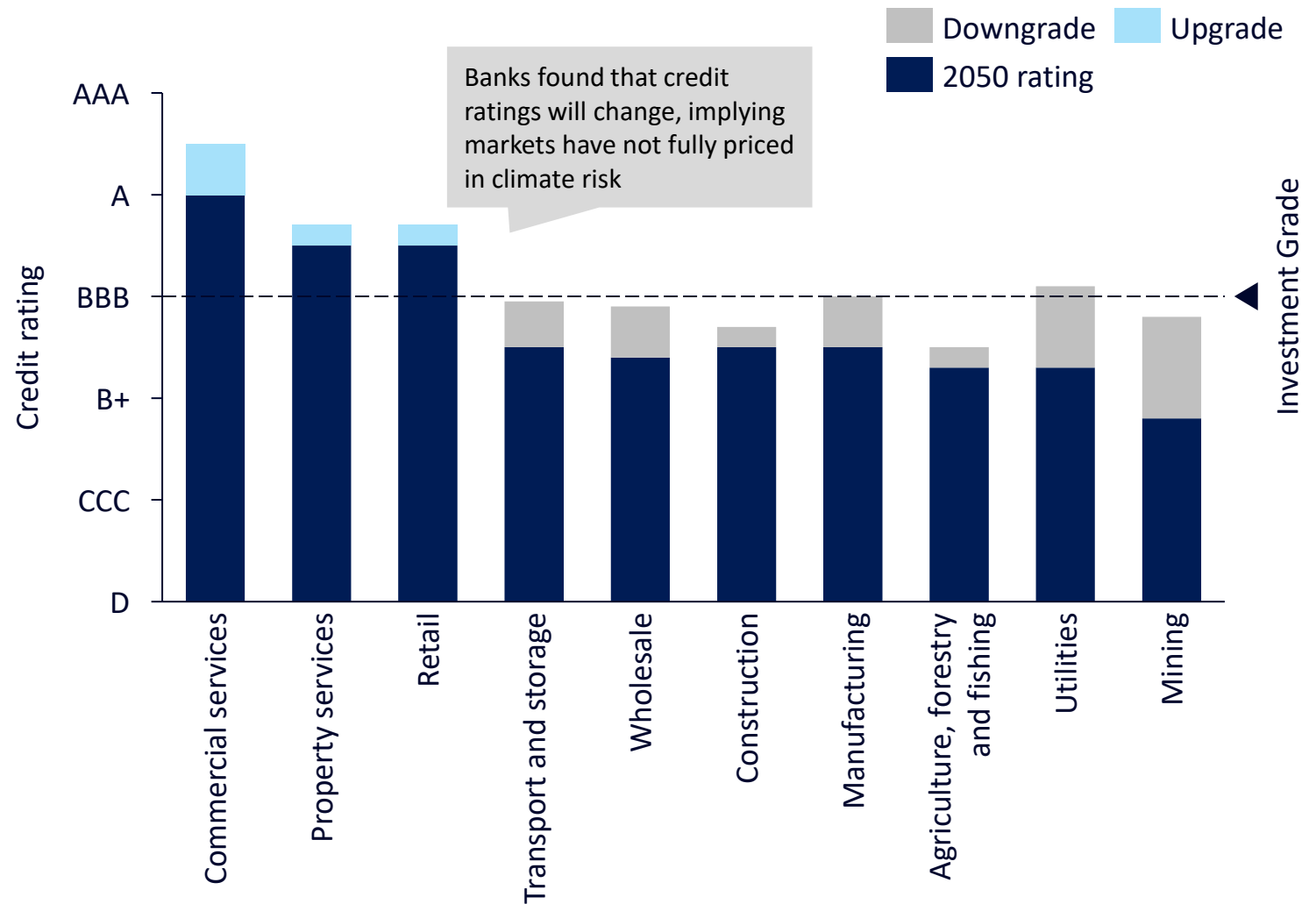
APRA's climate vulnerability assessment finds that some sectors benefit under these scenarios while others suffer

In November 2022, APRA coordinated Australia's five largest banks to conduct a climate vulnerability assessment using the delayed transition scenario to determine the impact of climate risks on credit ratings. The assessment revealed that physical and transition risks can result in negative credit rating impacts and that current credit markets were not fully pricing in these risks.

The impact of the Delayed Transition scenario was prominent, where counterparties from emissions intensive sectors (e.g. fossil fuel extraction and related businesses, mining and certain utilities) were assessed to experience the greatest impact to their credit quality.

Industries that were assessed by the banks as better positioned to transition towards a lower emissions economy, and as a result potentially minimise the impact from external emissions prices, saw more moderate or even positive credit rating impacts.

Exhibit 9: Impact of climate risks on firm credit ratings



Source: APRA (2022) Climate Vulnerability Assessments – November 2022

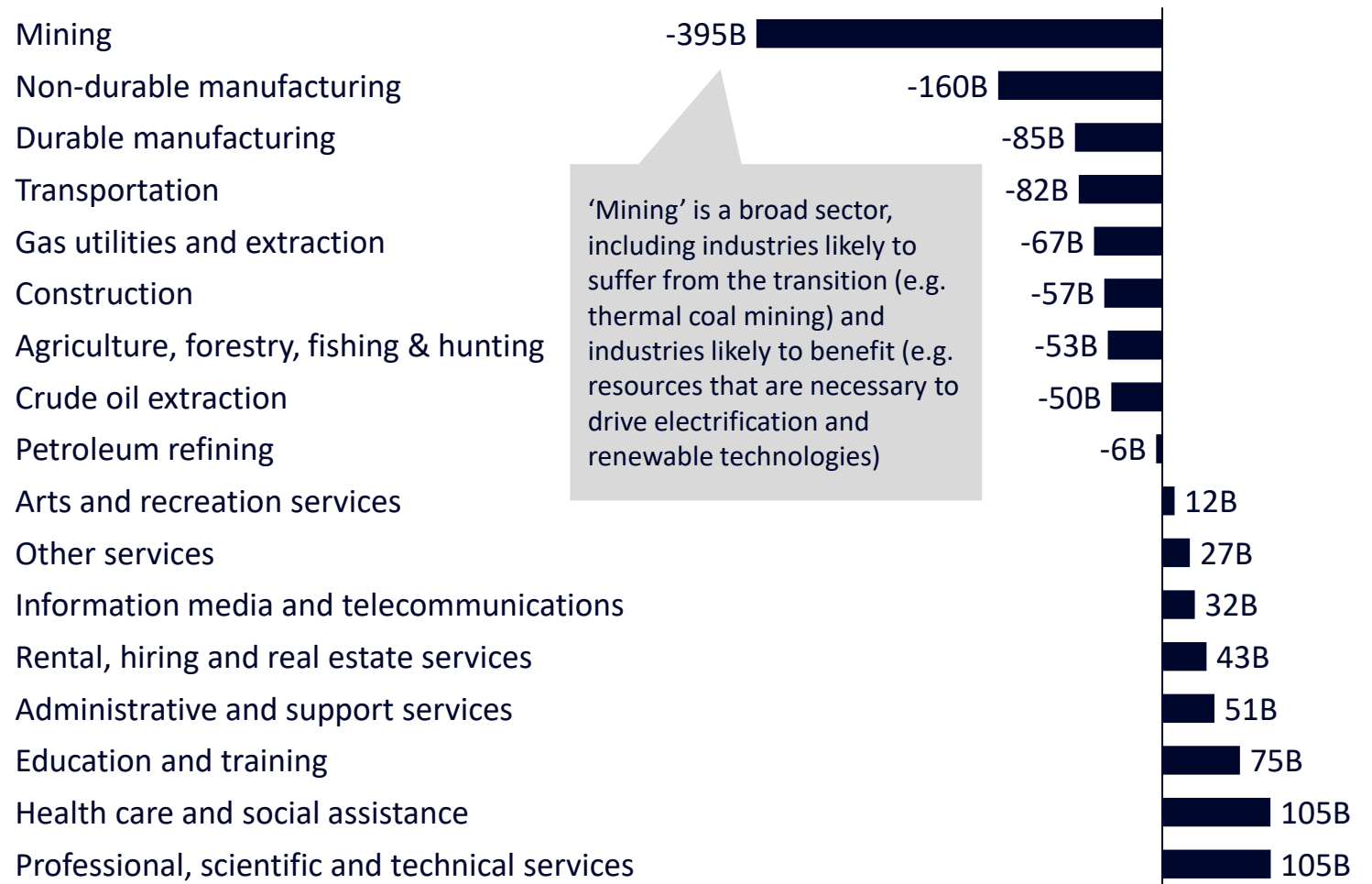
Climate risks result in a significant reallocation of capital across the Australian economy

Mandala modelled the implications of APRA’s credit rating assessments for the Australian economy using the G-Cubed CGE model (Appendix A).

The model found a significant reallocation of capital within the Australian economy under this scenario. The investment reductions were highest in mining and manufacturing between \$395B to \$245B respectively, reflecting the carbon and capital intensity of the sectors. Crude oil extraction and petroleum found lower reductions despite their carbon intensity. This reflects the relative size of these industries in Australia. The least carbon intensive sector, the services sector, saw a cumulative increase in investment of \$450B over 20 years.

This modelling also highlights the harms from delaying Australia’s climate transition. If the rate of change was to increase, capital and businesses would be able to adjust to the clean economy in a more orderly way.

Exhibit 10: Changes in Australia’s capital stock over 20 years after climate risks priced-in
\$AU billions, 2022 dollars



Source: Mandala analysis using the G-Cubed model

Super funds that seize transition opportunities are likely to get better returns for their members

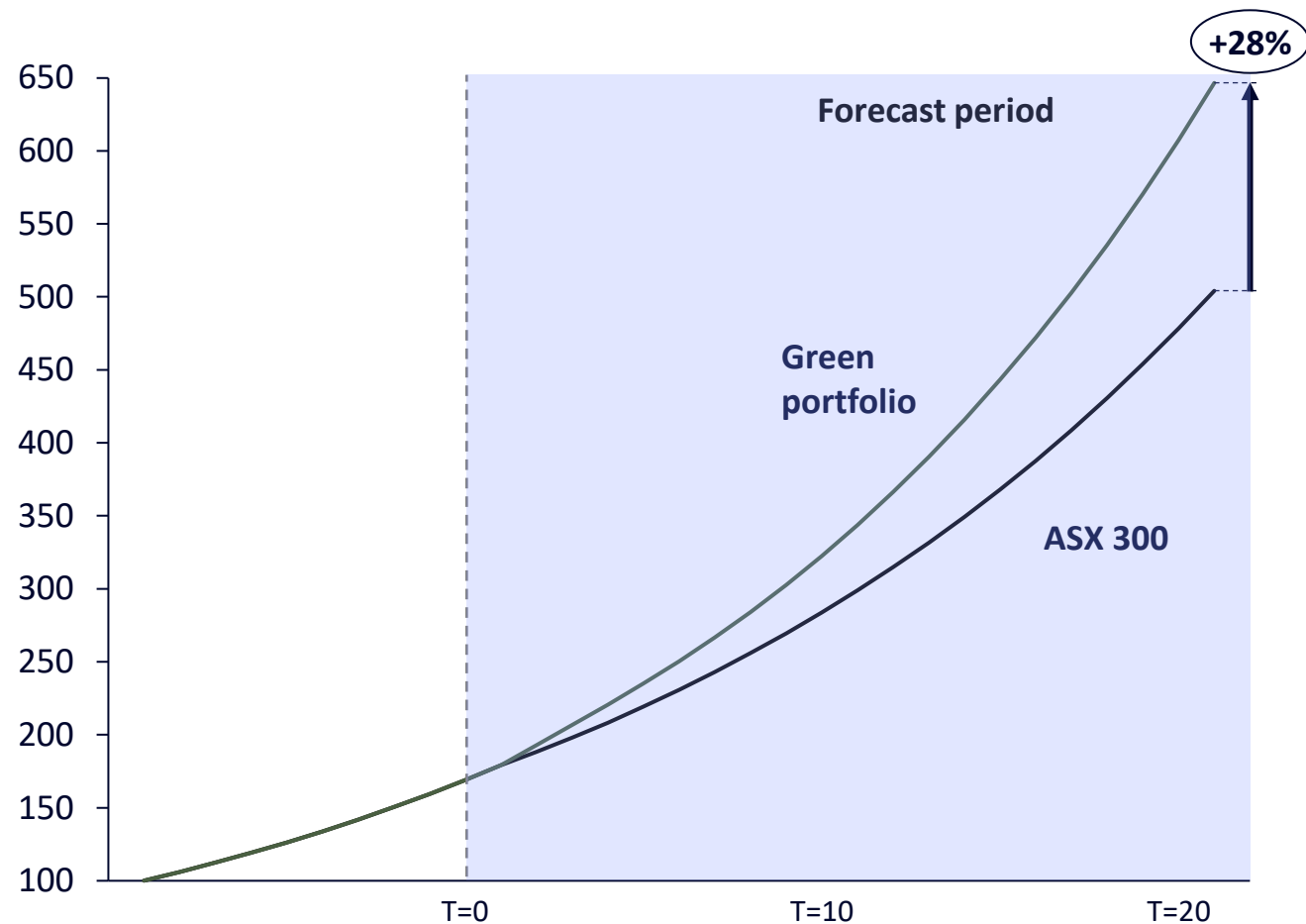
Mandala modelled the implications of lower investment and credit ratings over time on two representative portfolios:

- A 'green portfolio'¹ that was more heavily weighted towards sectors that are poised to benefit from transition; and
- An 'ASX 300 portfolio' that tracks the ASX 300, a similar metric to those used on the performance test

Over the 10 years after the market began to price-in climate risks identified by banks, green portfolios were found to be 15% bigger than ASX 300 portfolios. Over 20 years, it is 28%.

To complete this modelling, Mandala assumed that the climate risks identified in the APRA Climate Vulnerability Assessment were priced-in at time T=0. Portfolios are assumed to grow at 6 per cent before that point and grow at the adjusted rates reported in the CGE modelling after that point.

Exhibit 11: Returns of a \$100,000 green portfolio against the ASX 300 over 20 years
\$AU,000s



Source: Mandala analysis using the G-Cubed model

Source: APRA (2022) Climate Vulnerability Assessments – November 2022

Note: 1 Green portfolio was assumed to consist of sectors identified by APRA's climate vulnerability assessment as benefiting from the climate transition

1

Your Future, Your Super Performance Tests are limiting funds from fully participating in the green transition

2

Climate risks will structurally change the Australian economy, but superannuation funds that are forward-looking have the opportunity to benefit members

3

If funds aren't prevented from investing in green assets, the economy will gain \$170 billion and 620,000 jobs will be supported



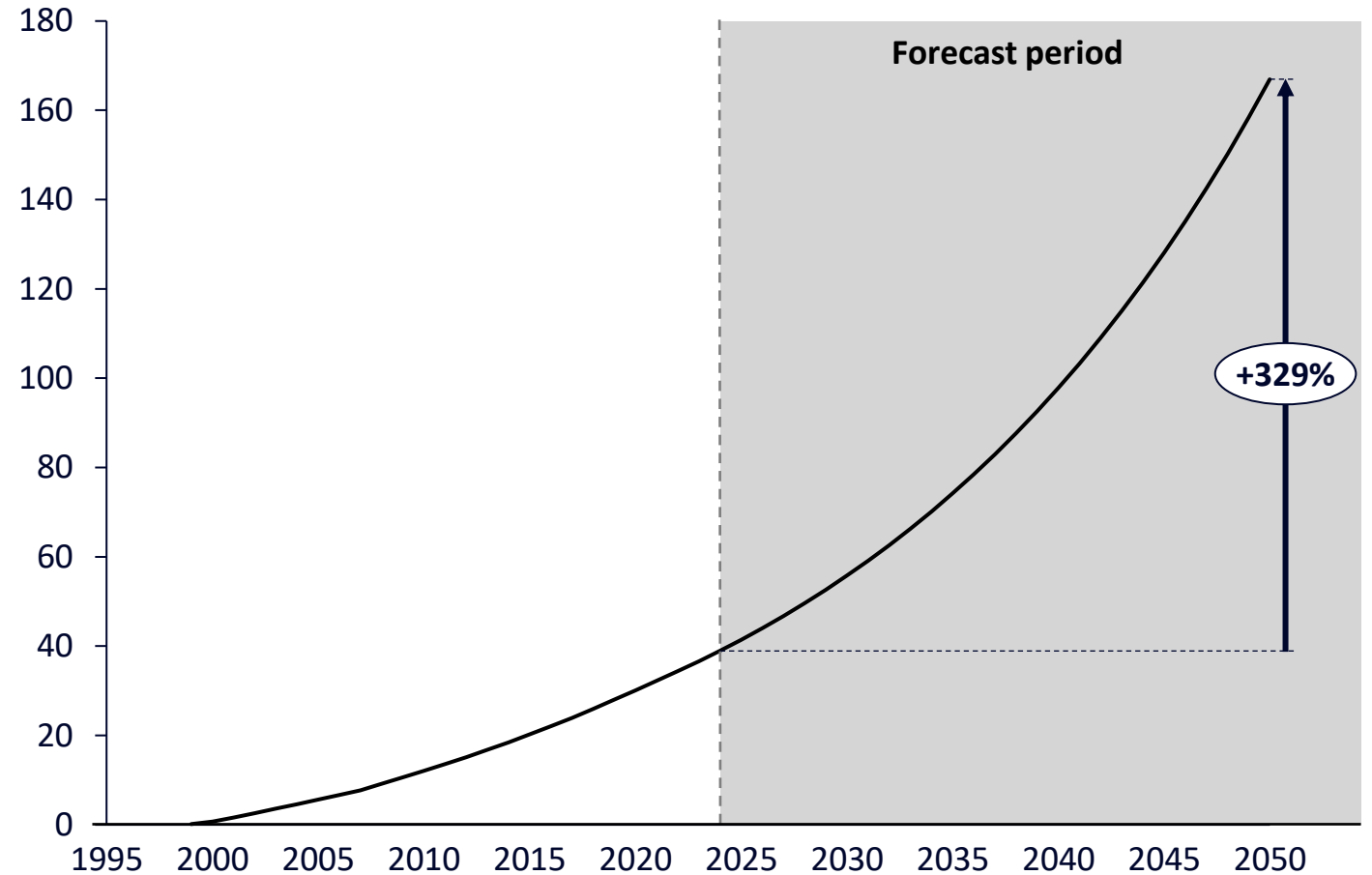
On the current trajectory, an additional \$167 billion in super could be invested in green assets by 2050

The demand for green superannuation products with exclusions in the Choice market has grown exponentially since the 1990s¹. In 2022, the total funds under management in these products reached \$35 billion. Green products are overwhelmingly Choice funds, these are products that are not the default accounts for members and face fewer regulations. They allow members greater control and flexibility. They currently do not face performance tests; however, they will face them as early as August this year.

If the value of green products grows at the rate of the superannuation industry, more than \$167 billion will be invested in green products by 2050. This represents a 329% increase from 2022 to 2050.

However, this \$167 billion is at risk. As outlined in the previous section, regulatory pressures are preventing funds from offering these products if YSYF results in the merging of green funds into non-green funds.

Exhibit 12: Total amount invested in green superannuation products
\$AU Billions



Notes: 1. Green superannuation products have been defined as products with coal, oil and gas exclusion policies that exclude investments in companies deriving 33% or more of their revenue from coal, oil and gas.

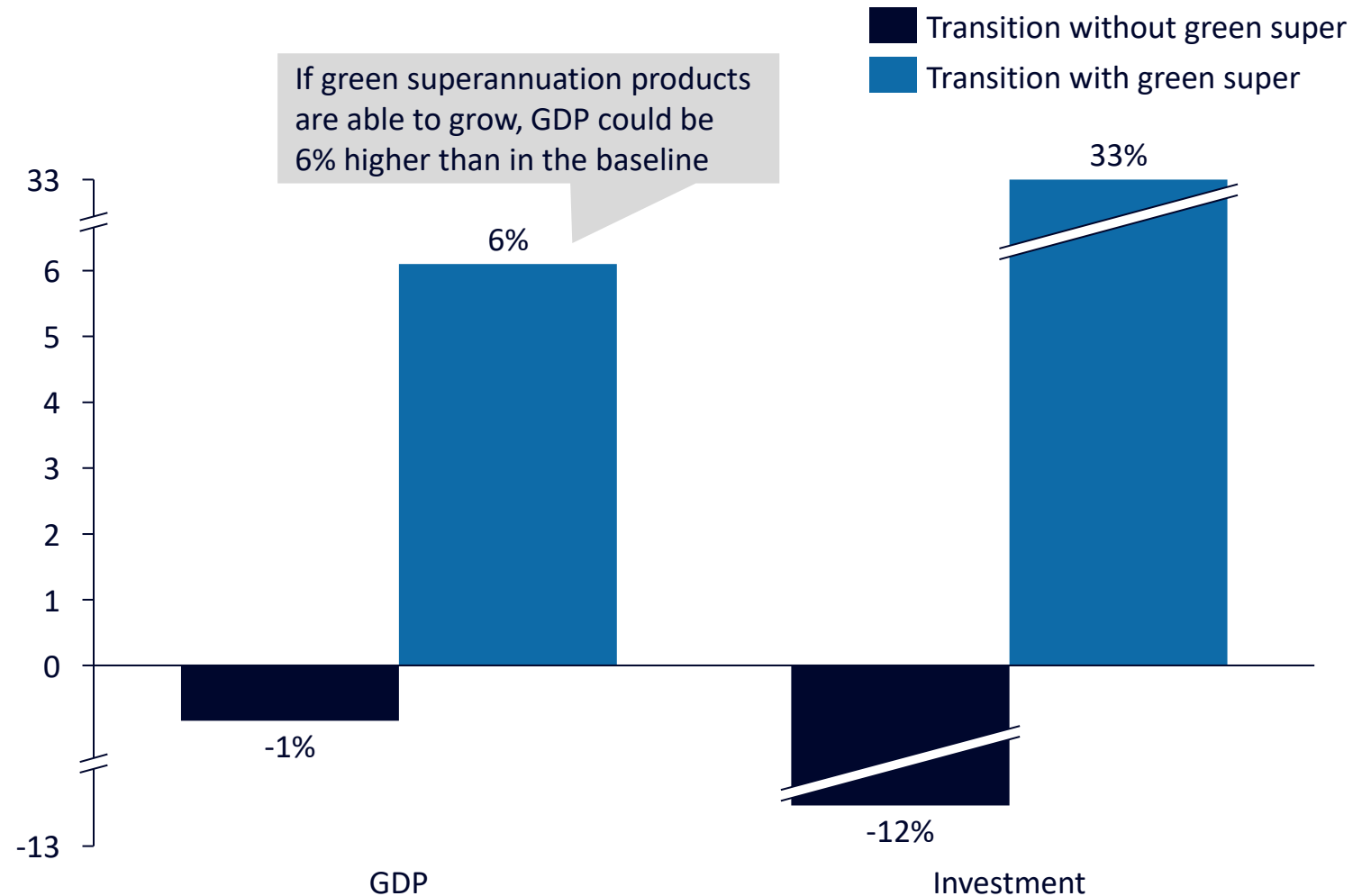
Allowing super funds to support the transition produces a more orderly and cheaper climate transition

Regulations that slow the capital reallocation necessary for Australia's green transition will make that inevitable transition more costly.

The pricing-in of climate risks results in a significant reallocation of capital in the economy. Capital leaves 'brown' sectors and moves towards 'green' sectors. This is a costly transition. However, if regulations prevent superannuation funds entirely divesting in brown sectors, the transition will become more costly. The capital reallocation implied by APRA's forecasts could see GDP contract by 1 per cent and investment contract by 12 per cent over 10 years.

If green superannuation funds are able to grow and support the capital reallocation through exclusions, this will offset this cost. GDP could grow by up to 6 per cent and investment could grow by up to 33 per cent over the same 10 year period. This is compared to a scenario where green superannuation funds are forced to close and their capital is invested in the same way as other superannuation capital currently.

Exhibit 13: Australia's green transition: with and without green superannuation investment
Percentage deviation from the baseline over 10 years



The additional investment spurs GDP growth, wages, investment, and job creation while easing cost of living

By changing performance testing regulations to support green funds, these funds will help to offset the transition risks to the Australian economy and society.

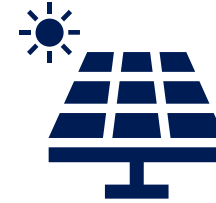
Over 10 years, it increases real GDP by \$170 billion. It provides an additional \$305 billion of investment from crowding-in affects. It creates more than 620,000 new green jobs. It reduces the cost of living by pushing down prices and easing inflationary pressures by 7 per cent. It pushes up real wages by 6 per cent and boosts government tax revenues through increased corporate and income taxes. This is compared to the scenario before where green superannuation funds are forced to close.

These outcomes strongly align with the objectives of federal, state and territory governments: higher growth, more jobs, higher real wages, a lower cost of living and more sustainable government budgets.

Exhibit 14: The macroeconomic benefits of green superannuation investments
2023 Australian dollars, over 10 years



**\$170 billion
increase in real
GDP**



**Additional \$305
billion of
investment**



**620,000 new
green jobs**



**Prices down 7 per
cent**



**Real wages up 6
per cent**



**Increased
government tax
revenues**

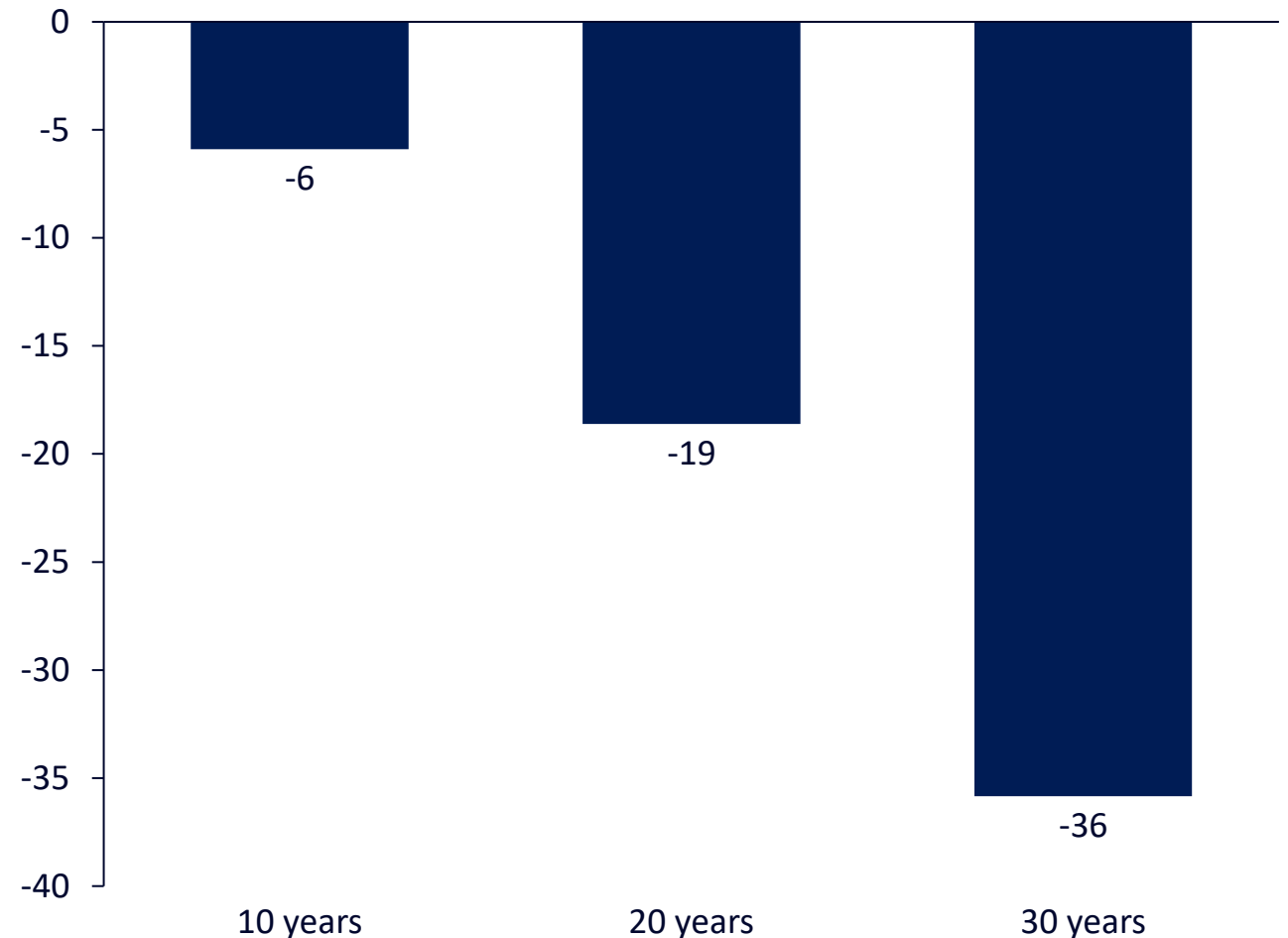
The additional investment will help achieve net zero targets by reducing emissions by up to 36 million tonnes

The reallocation of capital in the Australian economy, supported by exclusions and green investment from green superannuation funds, significantly reduces Australia's carbon emissions.

As Australia's growth industries shift from polluting industries to green industries, carbon emissions fall by 6 million tonnes in the first 10 years. By way of comparison, Australia's carbon price introduced under the Gillard government saw emissions fall by 15 million tonnes over a 10 year period.

After 30 years, the cumulative reduction in Australia's carbon emissions exceeds 30 million tonnes. While the Safeguard Mechanism will do the heavy lifting in reducing Australia's carbon emissions, green investment by superannuation funds will play an important role in reducing the cost of Australia's transition while reducing emissions.

Exhibit 15: Reduction in Australia's emissions from increased investment by green funds
CO₂, Millions of tonnes



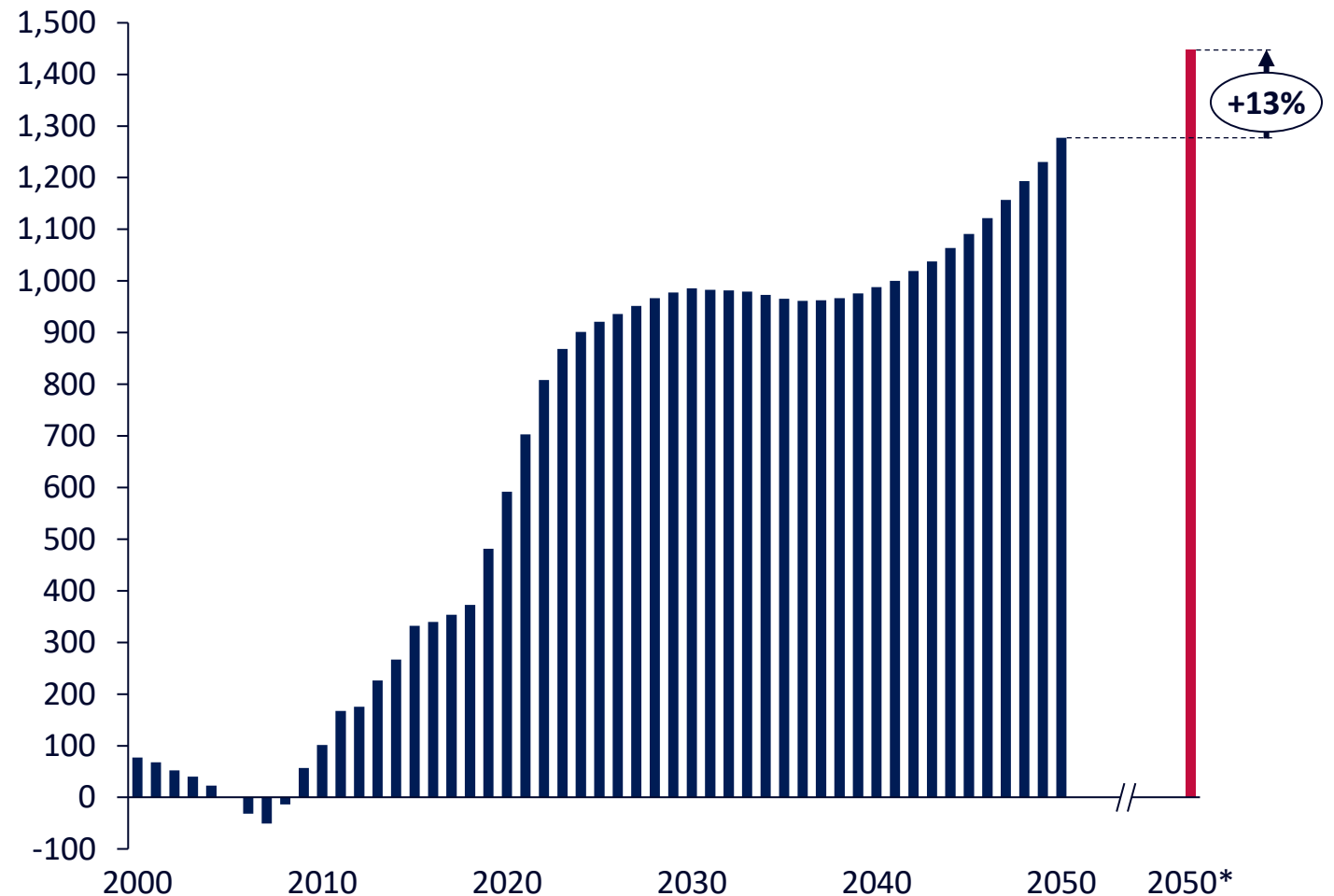
The Commonwealth cannot fund the transition alone; filling the gap left by super would increase net debt 13%

The COVID-19 pandemic and the decade of budget deficits that preceded it have reduced Australia's fiscal space.

If the Federal government was to fund the green investment shortfall left by superannuation, federal government net debt would increase by 13 per cent. It would take decades to grow out of this debt, meaning that future generations would likely pay the bill.

If the Federal government didn't fund the gap, the investment shortfall would be funded by drawing savings from elsewhere in the economy, brought about by higher interest rates. This would add further pressure to the cost of living and would result in the higher-cost transition outlined earlier.

Exhibit 16: Net debt if the federal government filled the green investment gap left by super
Federal government net debt, \$AU Billions, 2000-2050 (in 2021 dollars)



Conclusion and principles for reform

Conclusions

- **The *Your Future, Your Super* reforms were well-intentioned. Their goal was to increase member engagement, reduce fees, increase performance, and hold trustees to account for the decisions they make. But the reforms have had unintended consequences and implementation issues.**
- The current rules make it more difficult for superannuation funds to participate in the green transition and have detrimental impacts on:
 - **People saving for their retirement:** it reduces their retirement incomes by around 1.5 per cent each year
 - **The national economy:** barriers to green investment make Australia’s climate transition more costly
 - **Our environment:** lifting private sector investment will play a critical role in reducing carbon emissions
 - **Government Budgets:** less investment from the private sector means more of the heavy lifting needs to be done by government budgets

Principles for reform

- **The government is reviewing the *Your Future, Your Super* reforms to ensure they are fit for purpose. The government should be guided by four key principles in considering these reforms:**
 - **Benchmarks need to be appropriate for the fund:** Benchmarks help savers identify whether their fund is performing well, but these benchmarks need to be appropriate for the fund. The government should assemble a taskforce – including super funds, external fund managements and relevant representatives from the green sector – to identify the appropriate benchmarks in time for the implementation for the 2024 performance test.
 - **Benchmarks need to be assessed over an appropriate time period:** Assessing fund performance over 10 years can be misleading if the benchmark is a poor fit for the fund especially ones that relate to retirement incomes. More than 20 per cent of the impact of shocks on equity prices occur after 10 years.
 - **People should be allowed to invest in line with their values and preferences:** Those saving for their retirement should be able to invest in-line with their values and preferences and funds should be allowed to deliver on these choices without being penalized for doing so
 - **Sustainability should not be allowed to be an excuse for poor performance:** With the right benchmarks and effective enforcement agencies, we can ensure sustainability is not an excuse for poor performance

Appendix

This study used a range of publicly available data in combination with financial data and extensive stakeholder interviews



APRA Data

- Publicly available Annual Fund-level Superannuation Statistics
- Climate Vulnerability Assessment



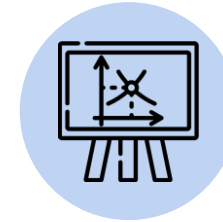
Superannuation Fund Data

- For the largest 30 superannuation funds and explicit green products:
 - Portfolio Holdings Disclosures
 - Product Disclosure Statement



Morningstar ASX Data

- Morningstar data on the performance of ASX200 stocks over time



CGE Modelling

- Mandala utilises the G-cubed model that was developed by Warwick McKibben and Per Wilcoxon. We used v169 of the 20-sector model.



Stakeholder Interviews

- Undertook x interviews across the sector including:
 - Superannuation funds
 - Government including with regulators and policy teams
 - Advocacy groups
 - Ministers office
 - Think tanks

Approach to economic modelling and assumptions (1/2)

Estimates	Method summary	Key assumptions
Impact on the ASX of the Russian invasion of Ukraine	<ul style="list-style-type: none"> ▪ Mandala analysis using G-cubed CGE model of the impact of increased risk in investing in Russia, based on the application of economic sanctions ▪ Modelled the impact of a 50% increase in the risk premium for investing in Russia on the market capitalisation of the Australian stock market against the base case ▪ This model and the base case is discussed further on the following pages 	<ul style="list-style-type: none"> ▪ 50% increase in risk premium for investing in Russia due to the invasion of Ukraine
Tracking error associated with sector exclusions	<ul style="list-style-type: none"> ▪ Mandala estimated the tracking error between portfolios that tracked the ASX 200 against those that made sectoral exclusions of coal mining, oil and gas, and gambling. ▪ For the past 4 years (2022-2019), the monthly % change in stock value of each firm in the ASX200 was found ▪ We then took market capitalisation-weighted averages of the returns for the ASX200 and the ASX200 with sectoral exclusions ▪ The standard error of the difference between the monthly returns for the ASX and the ASX with a sectoral exclusion over a year provided the tracking error associated with an exclusion for that year. The four years were then averaged 	<ul style="list-style-type: none"> ▪ Firms were included in the coal sectoral exclusions if the firm ran coal powered power plants, a coal mine or did substantial contracting for coal mines ▪ Firms were included in the oil and gas sectoral exclusions if the firm generated the majority of its revenue from selling, refining or producing oil or gas ▪ Firms were included in the gambling sectoral exclusions if the firm generated a majority of its revenue from gaming
Changes in Australia's capital stock	<ul style="list-style-type: none"> ▪ Mandala analysis using G-cubed CGE model of the impact of APRA's Climate Vulnerability Assessment on capital stock ▪ Modelled the impact of climate risk on capital stock of different sectors of the Australian economy against the base case using APRA's Climate Vulnerability Assessment to estimate the climate impact on the risk premia for investing in different sectors of the economy 	<ul style="list-style-type: none"> ▪ The pricing of climate risk identified by banks happened uniformly and at the same time ▪ Used the findings from the literature¹ on the relationship between changes in credit ratings on credit default swap spreads as inputs into G-Cubed
Returns of a \$100,00 green portfolio against a brown portfolio	<ul style="list-style-type: none"> ▪ Mandala analysis using G-cubed CGE model of the impact of APRA's Climate Vulnerability Assessment on a green portfolio ▪ Modelled the impact of climate risk materialising over 10 years on a green portfolio using the changes in Australian capital stock derived above to model the impact of the climate risk on stock markets returns per sector. 	<ul style="list-style-type: none"> ▪ Constant ASX200 returns of 6% ▪ Green portfolio was assumed to consist of the sectors identified in APRA's climate vulnerability assessment as benefiting from the climate transition

Notes: 1. Made, O. and Olszowski, T. (2020), The effect of changes in credit ratings on CDS spreads. Stockholm School of Economics. <http://arc.hhs.se/download.aspx?MediumId=578>

Approach to economic modelling and assumptions (2/2)

Estimates	Method summary	Key assumptions
Total amount invested in green superannuation products	<ul style="list-style-type: none"> Mandala estimated the current size of green superannuation products using portfolio holdings disclosures of products that satisfied the green superannuation product definition Mandala forecasted the future size of assets in green superannuation products by assuming they grew at the same rate as the entire superannuation industry out to 2050. This was modelled by Deloitte in 2021 in their Dynamics of the Australian Superannuation System report 	<ul style="list-style-type: none"> Green superannuation products have been defined as products with coal, oil and gas exclusion policies that exclude investments in companies deriving 33% or more of their revenue from coal, oil and gas Compound annual growth rate of 5.1%
Impact of green superannuation investment on the green transition	<ul style="list-style-type: none"> Mandala analysis using G-cubed CGE model of the impact of green superannuation investment Modelled two scenarios of the impact of green superannuation investment on GDP and investment against the base case. The first scenario looked at the transition without green superannuation, modelling the impact of climate risk against the base case using the method previously discussed. The second scenario looked at the transition with green superannuation, this modelled the previous scenario and included the total amount of green superannuation investment against the base case. 	<ul style="list-style-type: none"> All green investment by superannuation funds is assumed to go into the sectors that benefit from the economic transition according to the findings from APRA's climate vulnerability assessment Assumes no government intervention and no change to RBA inflation target
Macroeconomic benefits of green superannuation investments	<ul style="list-style-type: none"> Mandala analysis using G-cubed CGE model of the impact of green superannuation investment Modelled the second scenario discussed in the previous estimate and found the impact on real GDP, investment, employment, prices and real wages 	<ul style="list-style-type: none"> Assumes no government intervention and no change to RBA inflation target Assumes economic agents adhere to their objective functions, outlined below
Reduction in Australia's emissions from increased investment	<ul style="list-style-type: none"> Mandala analysis using G-cubed CGE model of the impact of green superannuation investment Modelled the second scenario discussed in the previous estimate and found the impact on CO2 emissions. This is done by looking the emissions by sector and how they vary with sectoral outputs under our scenarios. 	<ul style="list-style-type: none"> Industry-level carbon emissions use baseline data from the International Energy Agency and Global Trade Analysis Project
Net debt if the federal government filled the green investment gap	<ul style="list-style-type: none"> Mandala estimated the size of net debt in 2050 if the federal government invested in the economy at the same value as the size of green investments in superannuation funds Mandala used the Treasury's 2021 Intergenerational Report as the baseline forecast for net debt and calculated the percentage increase if the government filled the gap left by super 	<ul style="list-style-type: none"> Adopts all assumptions used by Treasury in its 2021 Intergenerational Report, including assumptions on commodity prices, population growth, participation and productivity

G-cubed Model (v169, 20-sector): model specifications

- G-Cubed is a multi-country, multi-sector, intertemporal general equilibrium model summarized in McKibbin and Triggs (2018)¹. It is used by the Australian Treasury, the Reserve Bank of Australia, the Bank of Canada, the International Monetary Fund and has been extensively peer reviewed through dozens of publications.
- The model has been used extensively in Australia's climate modelling
- The model represents the world as 24 autonomous blocks. Each region in G-Cubed is represented by its own multi-sector econometric general equilibrium model with highly disaggregated, multi-sectoral flows of goods and assets between them

24 countries/regions

- | | |
|----------------------|-------------------------|
| 1. Australia | 13. Korea |
| 2. Argentina | 14. Mexico |
| 3. Brazil | 15. Russia |
| 4. Canada | 16. Saudi Arabia |
| 5. China | 17. South Africa |
| 6. Rest of euro zone | 18. Turkey |
| 7. France | 19. United Kingdom |
| 8. Germany | 20. United States |
| 9. Indonesia | 21. Rest of OECD |
| 10. India | 22. Rest of Asia |
| 11. Italy | 23. Other oil producers |
| 12. Japan | 24. Rest of world |

12 sectors used in our analysis

1. Electric utilities
2. Gas utilities and extraction
3. Petroleum refining
4. Coal mining
5. Crude oil extraction
6. Construction
7. Mining
8. Agriculture, forestry, fishing & hunting
9. Durable manufacturing
10. Non-durable manufacturing
11. Transportation
12. Services

4 economic agents

1. A representative households
2. A representative firm (in each sector)
3. A Government
4. A central bank

Households and firms are forward-looking and backward-looking

3 markets

1. Goods and services
2. Factors of production
3. Money and financial assets (bonds, equities and foreign exchange)

G-cubed Model: objective functions of economic agents

Full details on the specifications of the model are available at McKibbin, W.J. and Triggs, A.J. (2018). Modelling the G20. Centre for Applied Macroeconomic Analysis



Households

- Households maximise an intertemporal utility function subject to a lifetime budget constraint that the present value of their consumption equals the present value of their future stream of after-tax labour income (plus transfers from the government) and their initial financial assets
- For households, aggregate consumption is therefore a weighted average of consumption based on wealth (current asset valuation and expected future after-tax labour income) and consumption based on current disposable income.



Firms

- Firms choose their production inputs (labour, capital, energy and materials) and make investment decisions to maximise their stock market value (represented by the present value of the future stream of dividends). They are assumed to be price-taking.
- For firms, aggregate investment is therefore a weighted average of investment which, in turn, is based on Tobin's q (market valuation of the expected future change in the marginal product of capital relative to the cost) and is based on a gradually learning Tobin's q which partially adjusts to the forward-looking Tobin's q .



Government

- Finally, the government spends money on goods and services, interest payments on government debt, investment tax credits and transfers to households. It receives revenue from sales taxes, capital and labour taxes, tariffs and from the sale of new government bonds.
- A closure rule prevents governments from borrowing or lending forever without undertaking the required resource transfers necessary to service outstanding liabilities. This closure rule is important since, otherwise, agents would be unwilling to hold government debt.



Central bank

- Money is introduced into the model as a constraint on transactions. To purchase goods and services, households require money. Unlike other financial assets in the model, money bears no interest. On the supply-side, central banks operate according to a Henderson-McKibbinTaylor rule where interest rates evolve as a function of actual inflation, actual output growth and actual exchange rates (where there is a partial exchange rate peg) relative to their respective targets.
- The supply of money then clears the money market. This allows the model to differentiate between the monetary policy regimes of different G20 countries which, as the simulations below show, can significantly affect how shocks are transmitted.

Sources

No.	Source
1.	Australian Prudential Regulation Authority (2022) <i>Climate Vulnerability Assessments – November 2022</i>
2.	Clean Energy Regulator (2023) <i>The Safeguard Mechanism</i>
3	Climate Action Tracker (2022) <i>Country Summary</i>
4	Climate Targets Panel (2021) <i>Australia’s Emissions Reduction Tasks Over Coming Decades</i>
5.	Conexus Institute
5a.	(2022) <i>Assessing the impact of YFYS through interviews with CIOs of funds with performance buffe</i>
5b.	Conexus Institute (2022) <i>Constraints and Sustainable Tracking Error</i>
6	Crowley, Kate
6a.	(2021) <i>Fighting the future: The politics of climate policy failure in Australia (2015–2020)</i>
6b.	(2017) <i>Up and down with climate politics 2013–2016: the repeal of carbon pricing in Australia</i>
6c.	(2013) <i>Pricing carbon: the politics of climate policy in Australia;</i>
7	Department of Climate Change, Energy, the Environment and Water (2022) <i>Australia’s emissions projections 2022;</i>
8	Department of the Treasury, (2021) <i>2021 Intergenerational Report</i>
9	Federal Register of Legislation (2021) <i>Your Future Your Super Act</i>
10	Productivity Commission (2019) <i>Superannuation Inquiry Report</i>

ABOUT MANDALA

Mandala is an economics, strategy, and policy consulting firm. Mandala's staff include former advisors to Prime Ministers and senior officials across Australia's economic regulators, global leads at companies, researchers and data scientists, and strategy consultants. We serve governments in Australia and abroad, as well as globally significant firms. We have presented our work in prestigious economics and policy journals, and in partnership with leading think tanks and universities.

