Project Controls EXPO
Melbourne, Australia

Project Controls Expo – 22nd November 2018 Melbourne Cricket Ground

Infrastructure Investment Program

Governance and delivery arrangements

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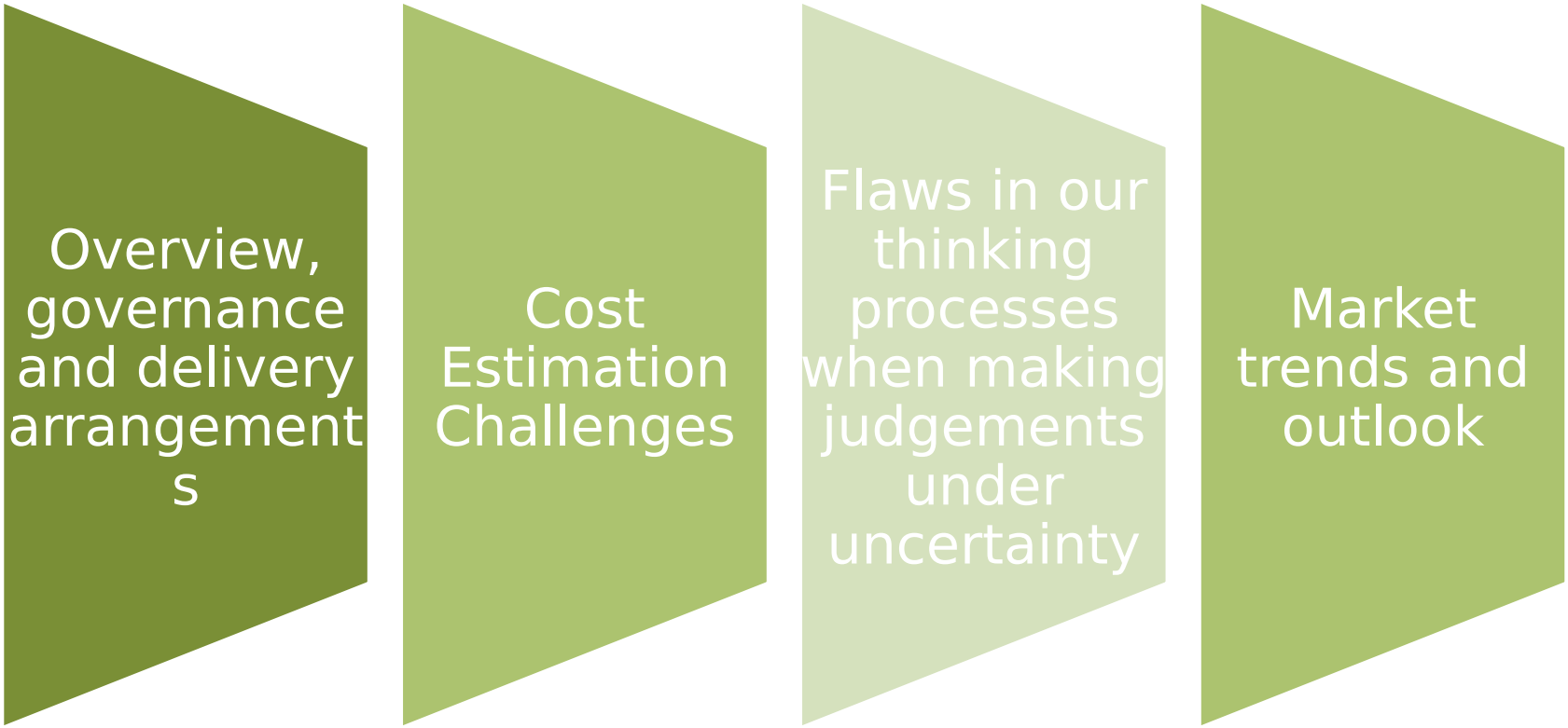
Overview



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Key themes driving the Australian Government's approach to infrastructure investment and planning

Investment in transport to connect freight to markets and people to services/jobs (*Infrastructure Investment Program*)

Active Cities Policy *(2016 Smart Cities Plan and City Deals)*

Investment in city-shaping urban rail and public transport projects

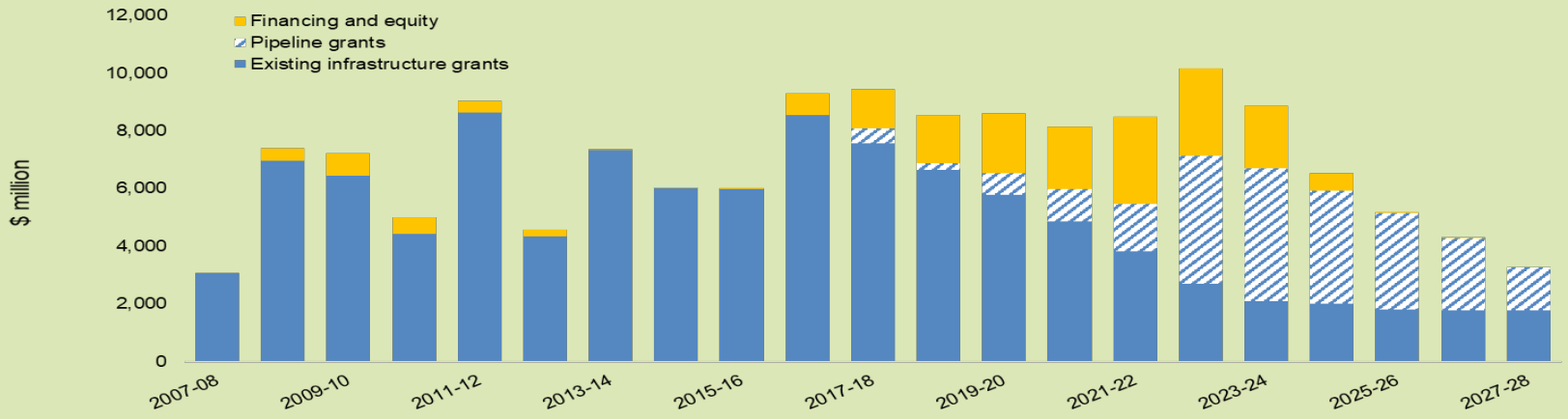
Earlier involvement in planning and business case development

Greater use of innovative financing and direct investment in major projects *(Inland Rail, Western Sydney Airport)*

Infrastructure Investment Program

- The Infrastructure Investment Program (IIP) is the Government's primary vehicle for investing in land transport infrastructure.
- The IIP makes up about 90 per cent of the Government's $75 billion 10 year transport infrastructure investment commitment.

Infrastructure investment - 2007-08 to 2027-28, including new pipeline commitments and financing



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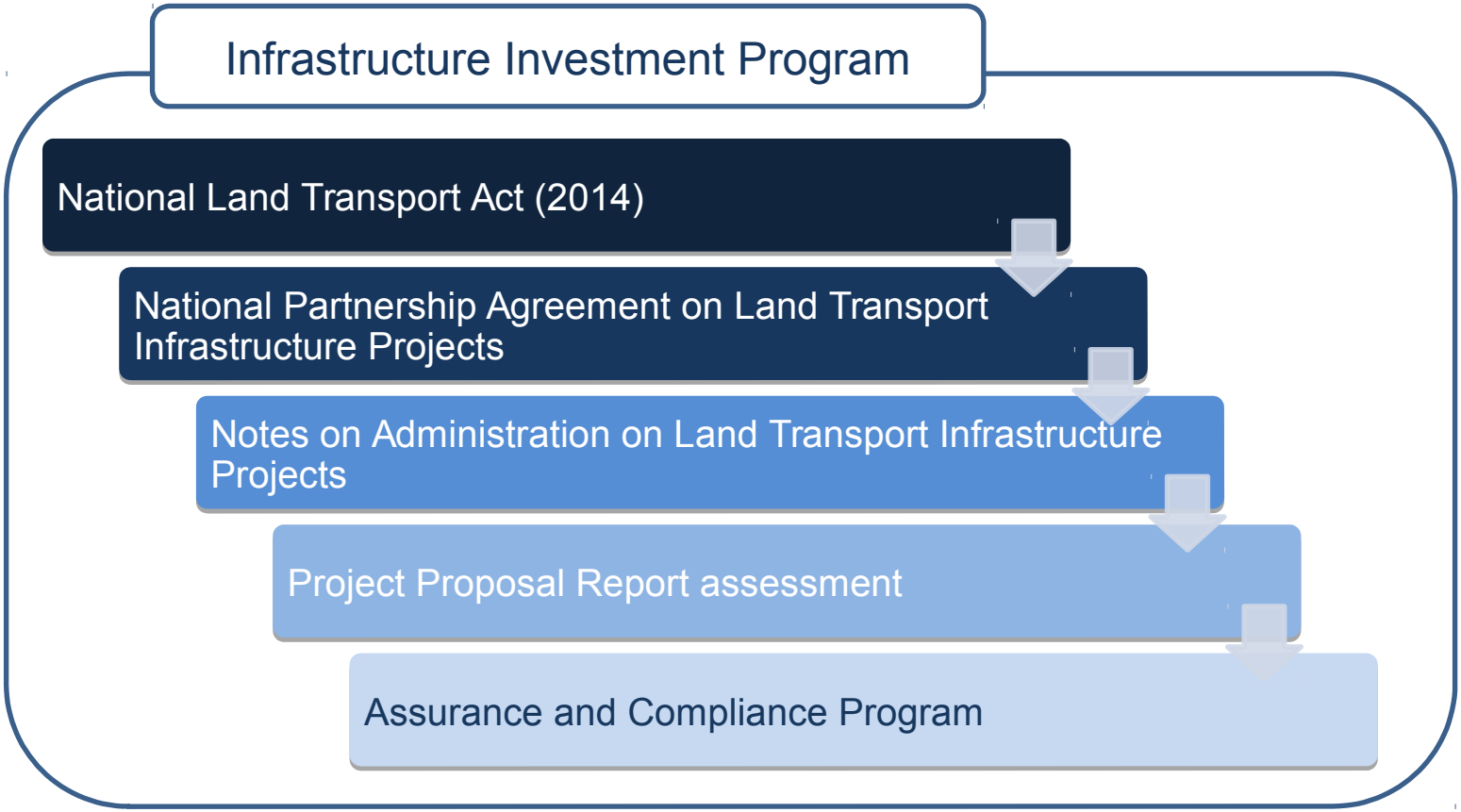
IIP Governance Arrangements



Management of Project and Program Risk

Risk	Mitigation	Practical application
Cost overruns • Insufficient project design • Project delivery issues	• Early and ongoing project oversight • Assess P50 and P90 cost estimates • Assess selected procurement method	• Close engagement with state and territory proponents • Position on project committees • Review of draft and final business cases • Cost estimate reviews
Cost escalation	Monitor infrastructure materials cost data	Maintaining RCOCI (BIS Oxford Economics)

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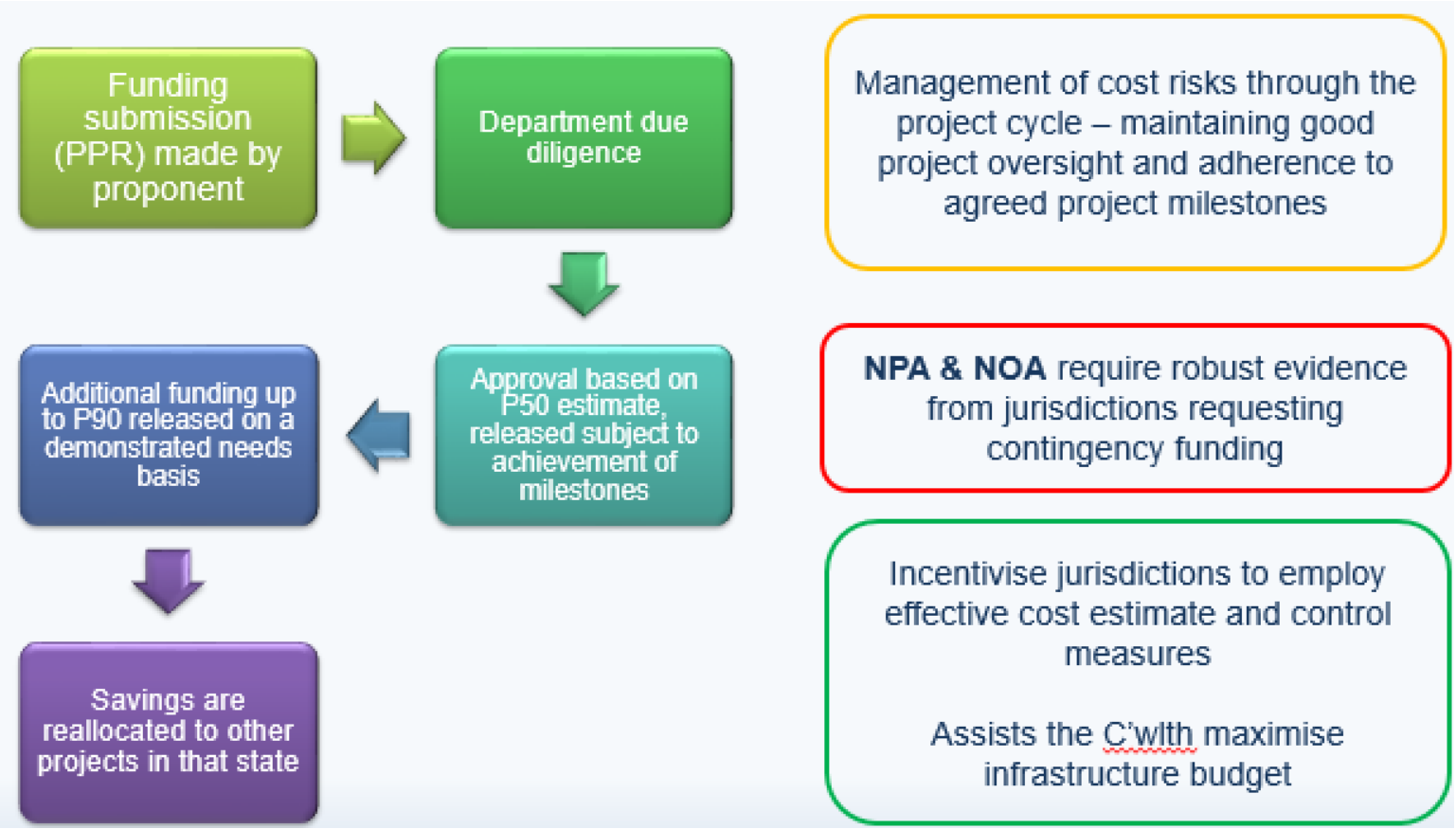
Typical Project Life Cycle



The challenges and environment in which public infrastructure projects are delivered

As end users, taxpayers expect projects to deliver the largest possible benefits to society at:

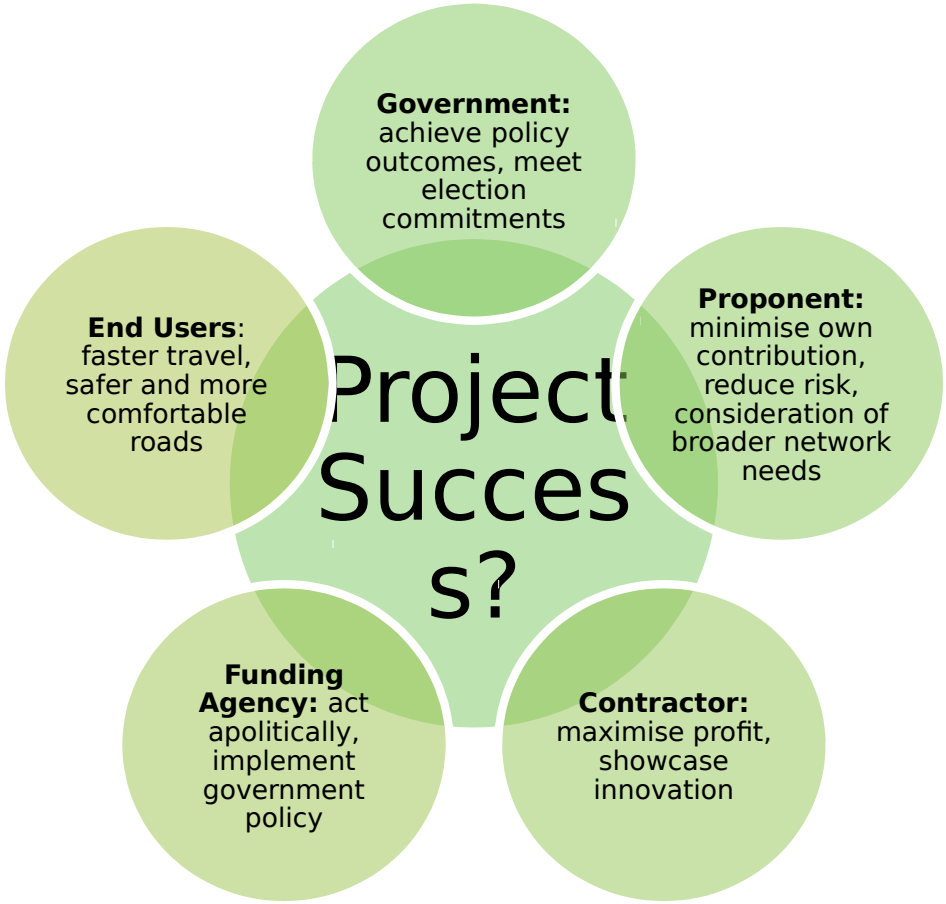
- Minimal cost;
- Minimal risk;
- Minimal disruption; and
- Being completed on time

But, delivering projects involves many stakeholders and the incentives each of them face may not align

Stakeholder Incentives and Behaviours

Entity	Motivation	Clashing behaviours
Owner	Reliably deliver project in timely fashion Receive value for money Avoid high-profile set-backs or failures	Constantly push contractors to expedite delivery Seek cost savings throughout (contractors, suppliers, labour, utilities, etc) Engage the best contractors and offload as much risk as possible onto them
Main Contractor	Maximise profit margin Ensure financial stability	Charge for any scope changes and submit claims, variations, and time extensions Get milestone-based payments; stall work until instalment is paid
Designer	Illustrate creative edge and reputation Minimise effort and resources	Submit drawings and designs in random order and not the always the way required by construction contractors or owners Work according to their own resource availability and timeline, rather than under project timelines

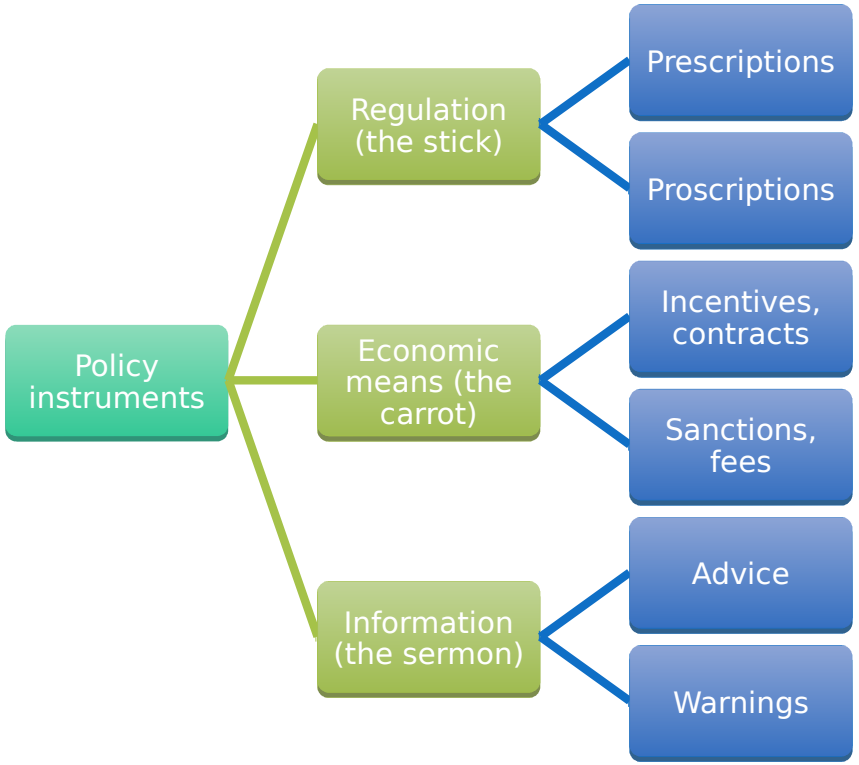
What does project success mean for different stakeholders?



Policy Instruments

In order to counteract these tensions and clashing behaviours the public sector has three policy instruments at its disposal:

- Regulation
- Economic means (incentives, contracts, fees)
- Information (advice and guidelines, warnings)



Why spend so much effort on estimates?

- No shortage of studies or explanations on project overruns:
  - Merrow
  - Terrill and Danks (Grattan Institute)
  - Love
  - Flyvbjerg

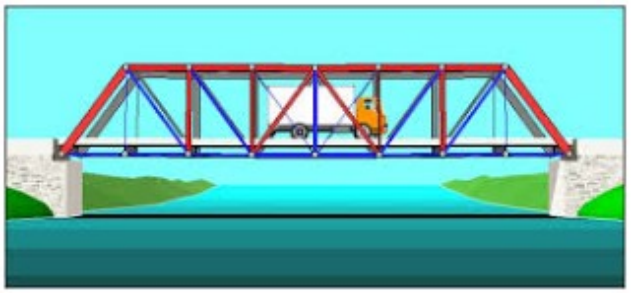
- What are the quantifiable benefits of better cost estimates?
  - Governments must make decisions all the time where the outcome is uncertain
  - Estimates usually have to be made, and converted to budgets while information is still incomplete
  - Understanding the uncertainty can help us make a much better decision

Impacts of Poor Estimates

- Under-estimation of cost and over-estimation of benefits distort decisions regarding which projects to invest in
- Projects for which the estimates have been subject to rigorous review will be disadvantaged over those with poor quality estimates
- When estimates are distorted or unreliable it is impossible for decision-makers to choose the projects with the greatest net benefits to the community

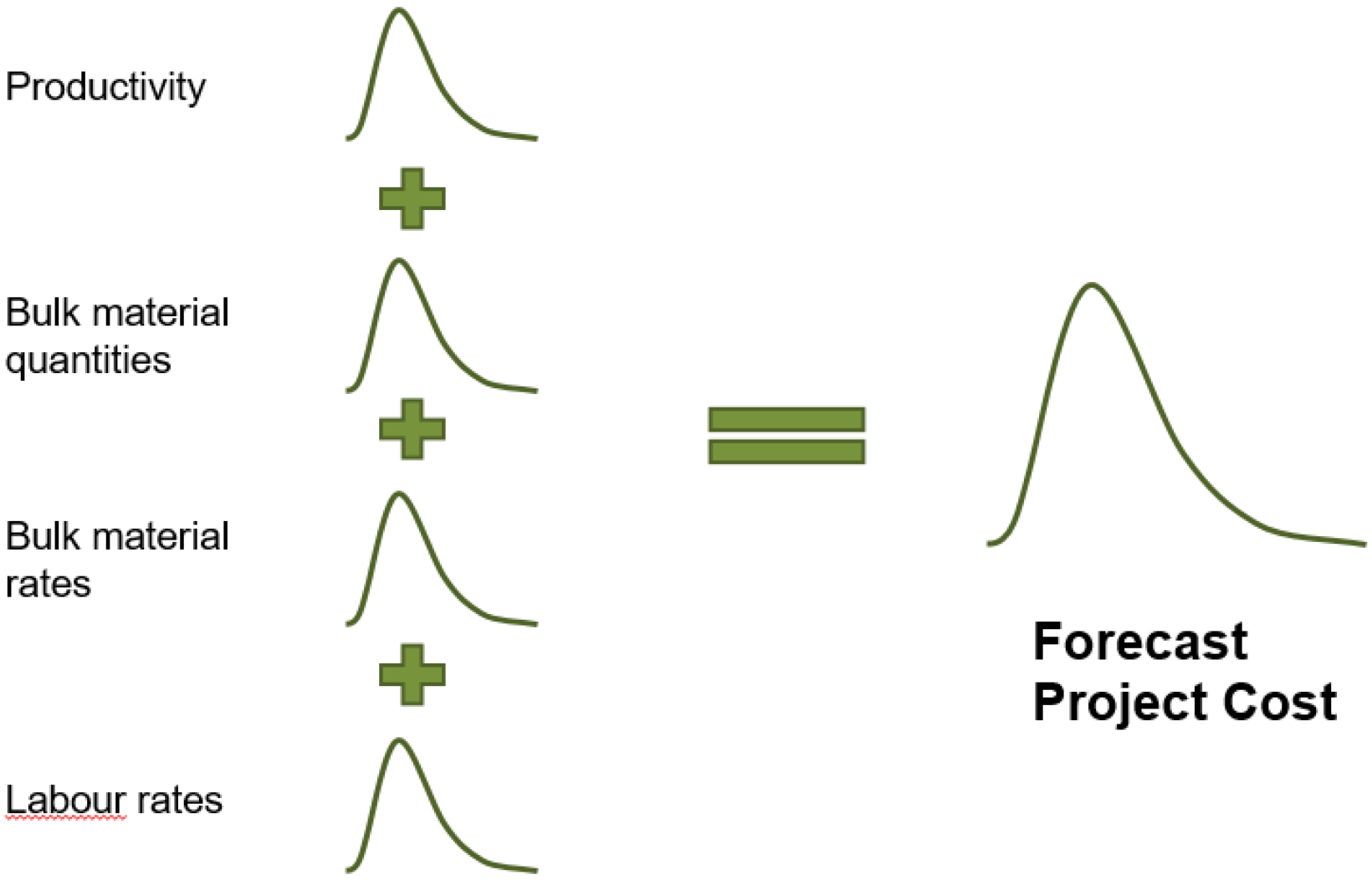
Engineering Measurements vs Forecasts

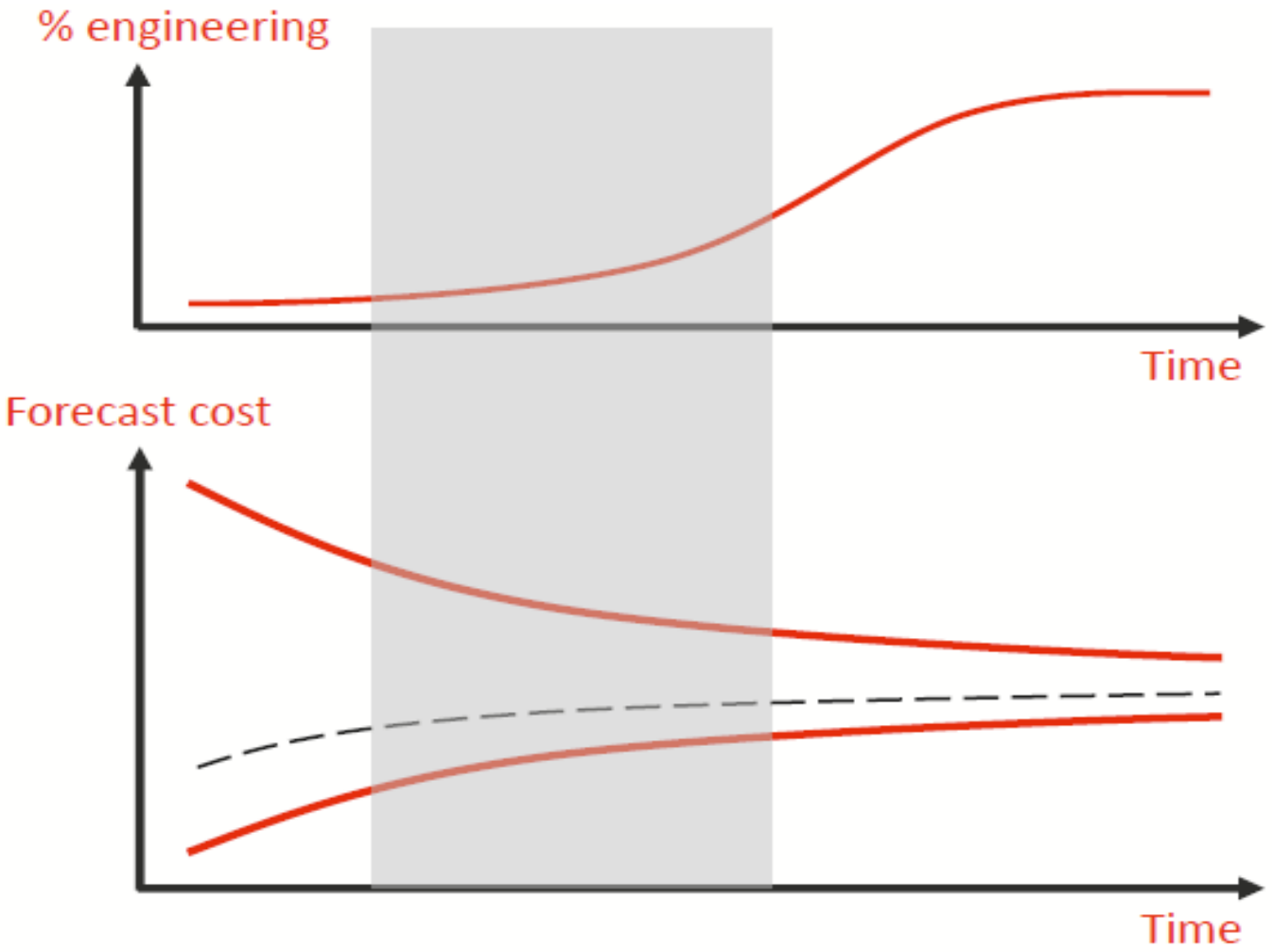
- Engineers and physicists are very good at measurement
- However, it's important to be rational and realistic about our expectations and limitations related to forecasting *uncertainty*

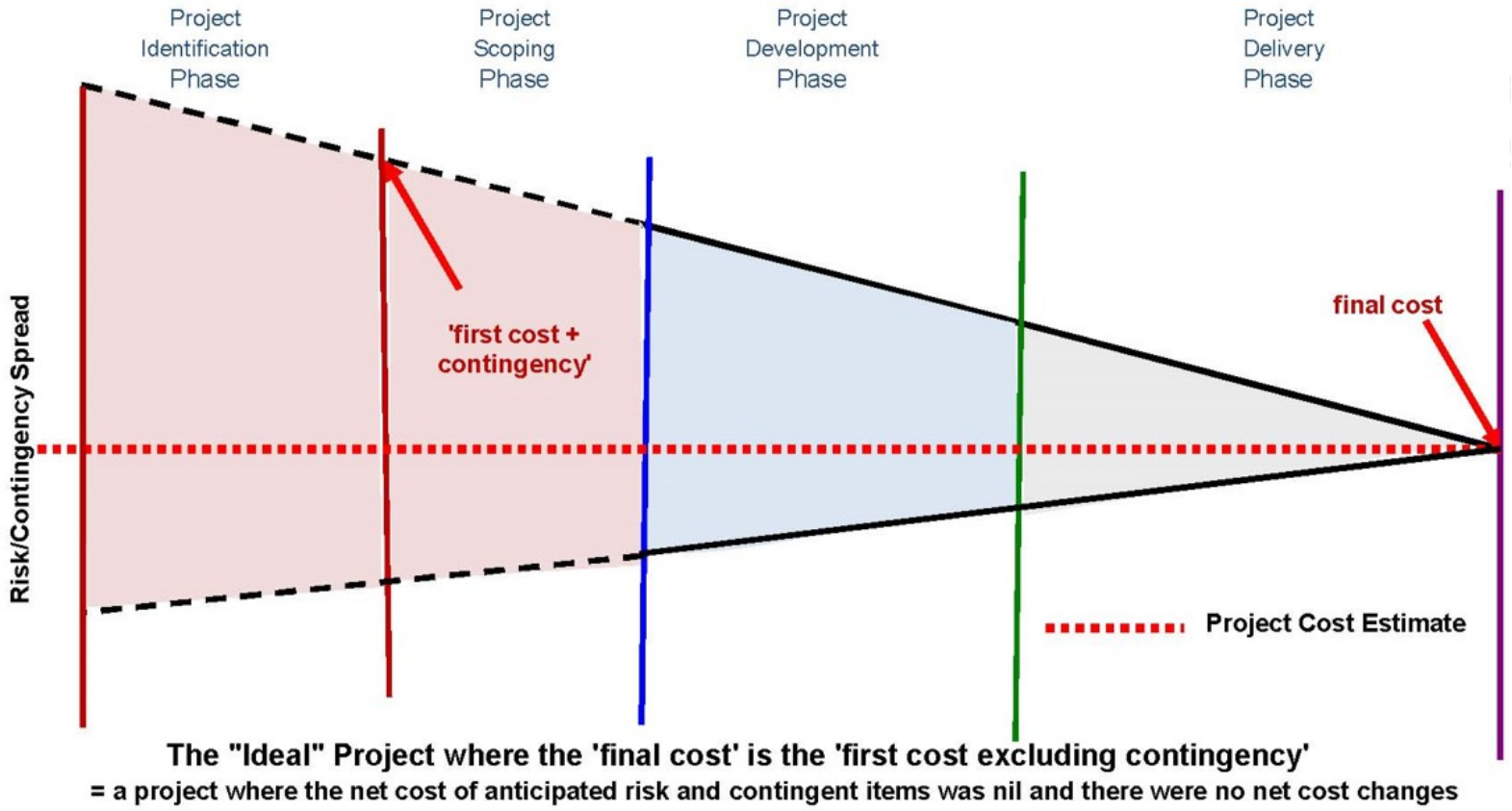


Probabilistic Nature of Estimates

- An estimate is not a single number but a range of possible outcomes
- Some outcomes are more likely than others
- Estimated cost can be represented mathematically by a probability distribution function reflecting the probability of the values that could occur

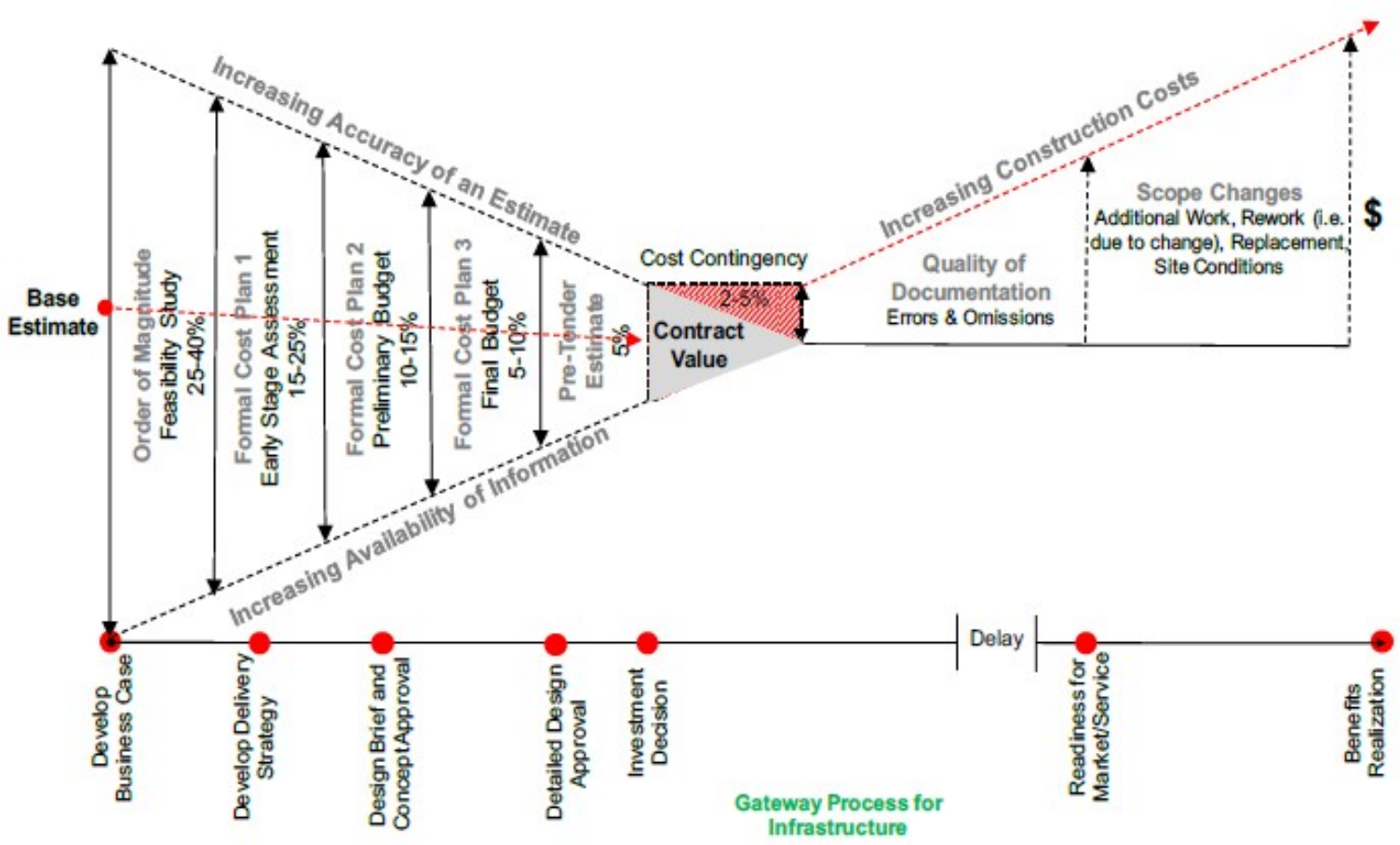






The "Ideal" Project where the 'final cost' is the 'first cost excluding contingency'

= a project where the net cost of anticipated risk and contingent items was nil and there were no net cost changes



Source: Love *et al.* (2017c:p.1082)

Two Quick Questions

How many animals of each kind did Moses take into the Ark?

A bat and a ball cost $1.10

The bat costs one dollar more than the ball

How much does the ball cost?

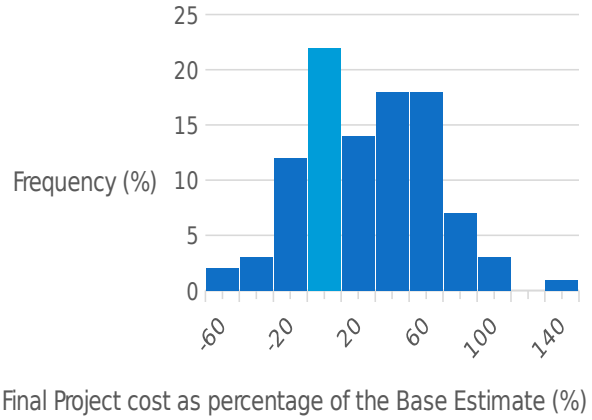
Naïve Empiricism

Consider the following:

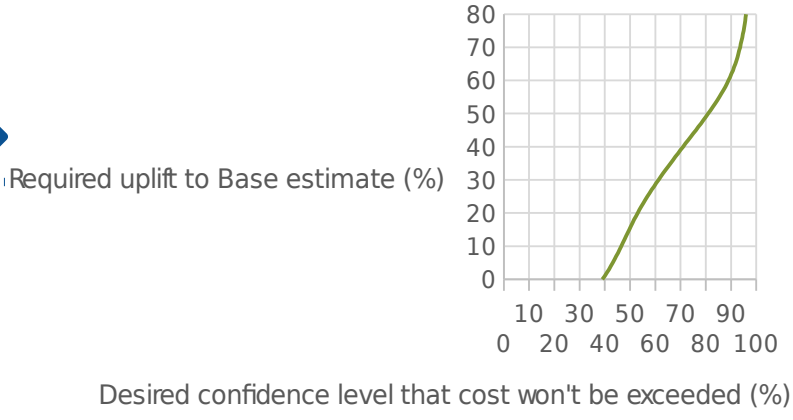
I have just conducted a thorough statistical examination of the life of President Trump. For seventy-two years, over 26,000 observations he did not die once. I can hence pronounce him immortal, with a high degree of statistical significance

Reference Class Forecasting?

Probability distribution of reference set of projects



Reference Class Forecast Example Tool



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The narrative fallacy (being wrong with infinite precision)

On December 13 2003 at 13:01 Bloomberg News ran the following headline:

"U.S. TREASURIES RISE; HUSSEIN CAPTURE MAY NOT CURB TERRORISM"

But… at 13.31 Bloomberg issued the next bulletin:

"U.S. TREASURIES FALL; HUSSEIN CAPTURE BOOSTS ALLURE OF RISKY ASSETS"

The narrative fallacy (being wrong with infinite precision)

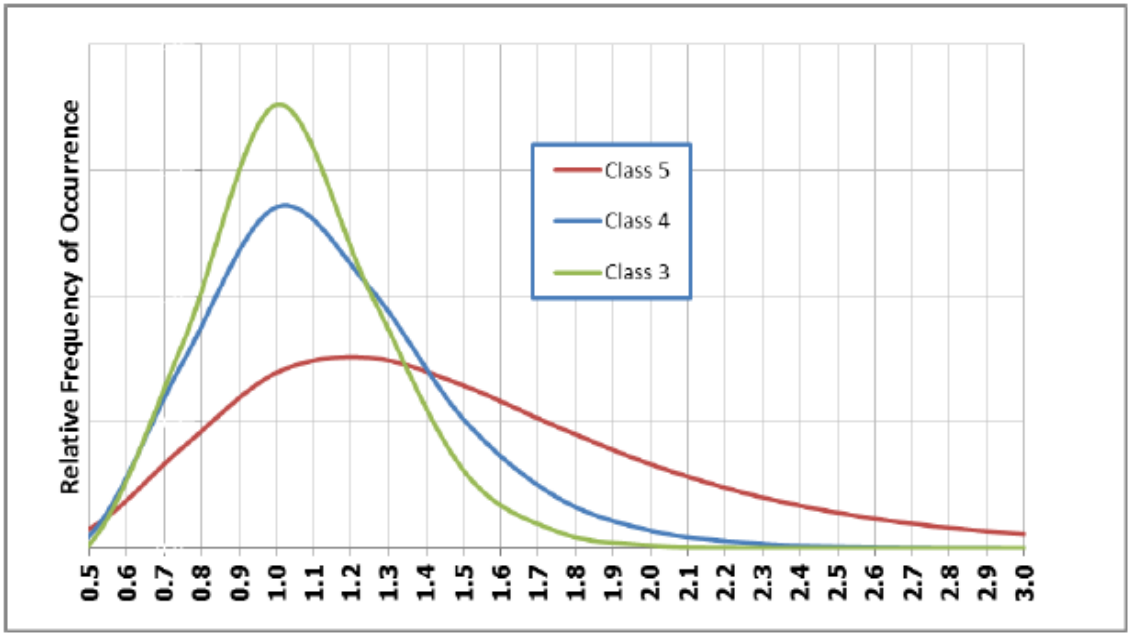
Hussein's capture was obviously the event of the day, and because of the way the automatic search for causes shapes our thinking, that event was destined to be the explanation of whatever happened on the market that day

Recognise when it is better to be approximately right, rather than be wrong with infinite precision

Calibration and Consequence

- We are not very good at calibrating our predictions or understanding our own state of knowledge
- Most of us think we are better than average at most tasks
- We rarely consider the full range of possibilities
- Projects generally have more tail risk than estimators and decision makers either forecast, or are willing to admit to

Estimate accuracy at different phases of scope development



Source: Hollmann (2014) RISK.1584 Risk Analysis at the Edge of Chaos

Law of Iterated Expectations

- To understand the future to the point of being able to predict it, you need to incorporate elements from this future itself
- We are not easily able to conceive of future events (we do not know what we will know)
- Projecting into the future requires an increasing amount of precision because the error rate grows very quickly

Degradation of Forecasts

- Say we have a model with 10 inputs and are 95% certain that the probability distributions representing these uncertainties are correct
- What is the chance that the complete assumption set is correct?

$$0.95^{10} = 60\%$$

- Let's say we add more detail and have a model with 50 inputs. Now, the chances that our entire assumption set is correct is

$$0.95^{50} = 7.7\%$$

Tunnelling, or the Fallacy of Misplaced Correctness

- The mistake of confusing a model with the physical entity it is meant to describe
  - A model is not meant to represent the real world
- Models are meant to capture some features of the natural world in an idealised form, simple enough for us to analyse

"All models are wrong, but some are useful"

(Professor George E.P. Box)

  - We must not confuse precision with accuracy

Common Biases

Bias	Outcome
Anchoring and adjustment	Estimates remain too close to initial values
Availability	Readily retrieved information is over-weighted; recent or spectacular events, irrespective of their real frequency
Confirmation	Evidence that supports an initial hypothesis or explanation is over-weighted
Conservatism	Sample information is under-weighted
Framing	Form of data presentation influences judgement
Illusion of control	Belief that management action can influence the outcomes of external or random events
Optimism	Predicted ranges are too narrow; estimators are less accurate than they

Cost Estimation Guidance Notes

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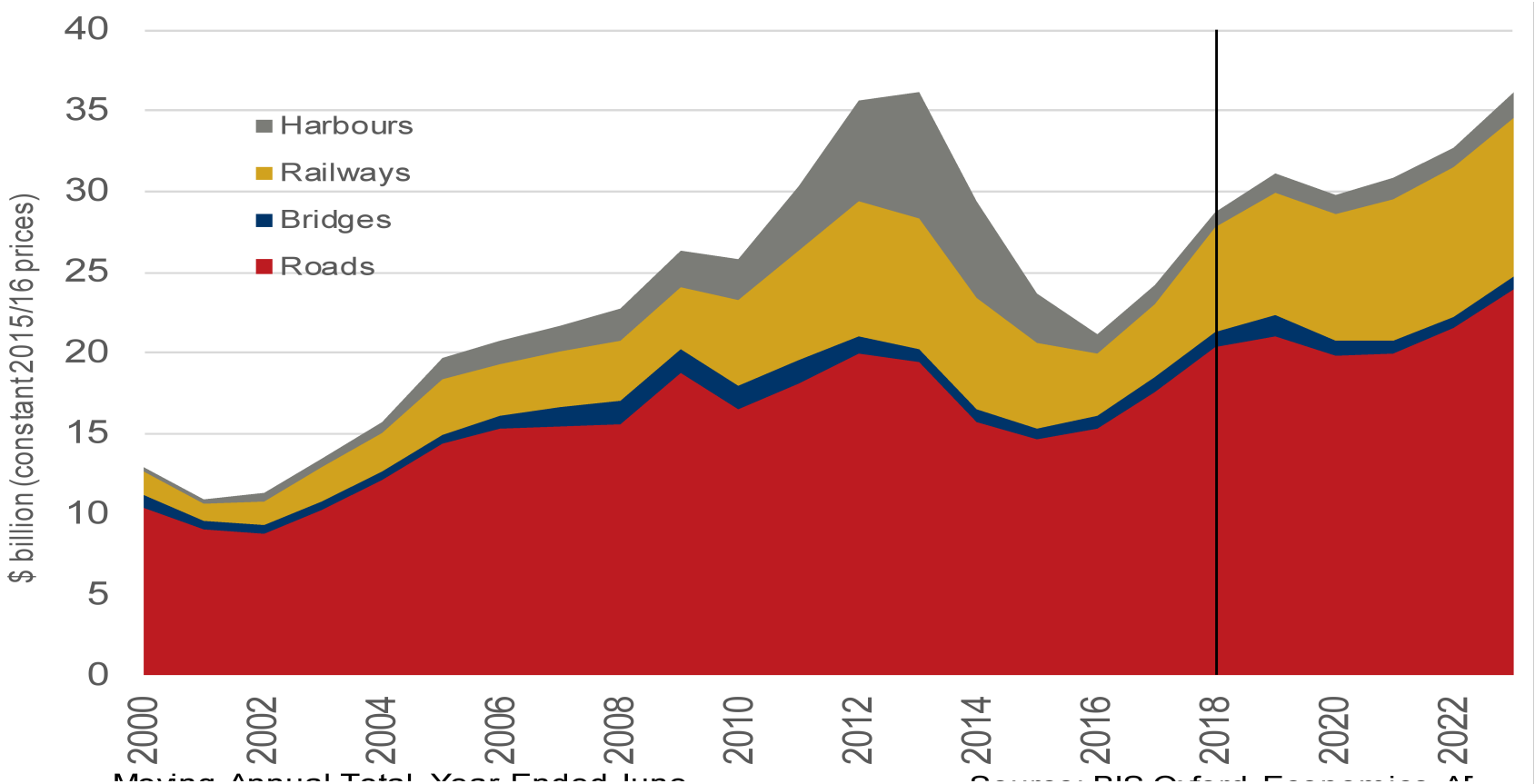
Transport construction trends and outlook



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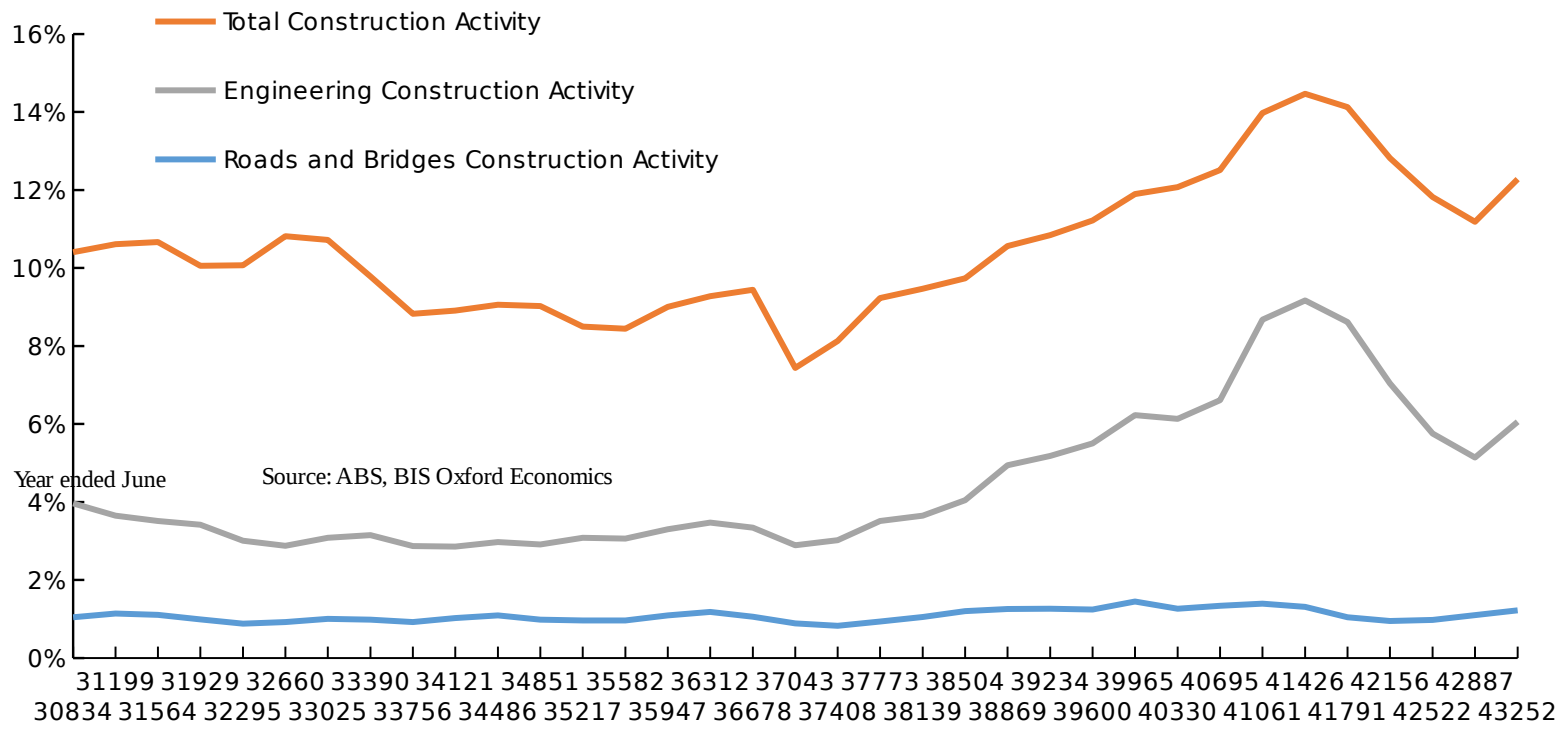
Road and bridge construction activity as a proportion of the total economy



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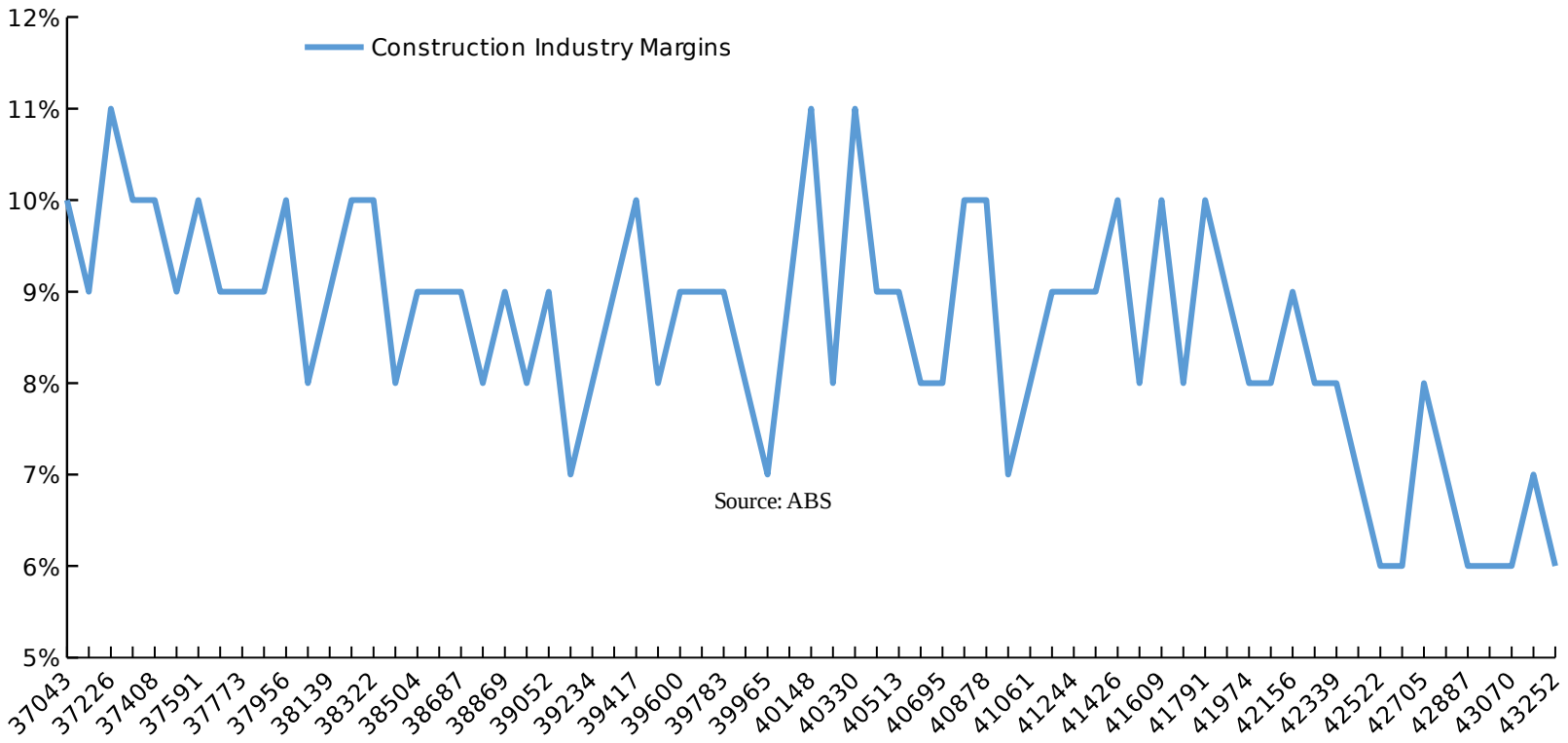
Construction Industry Margins



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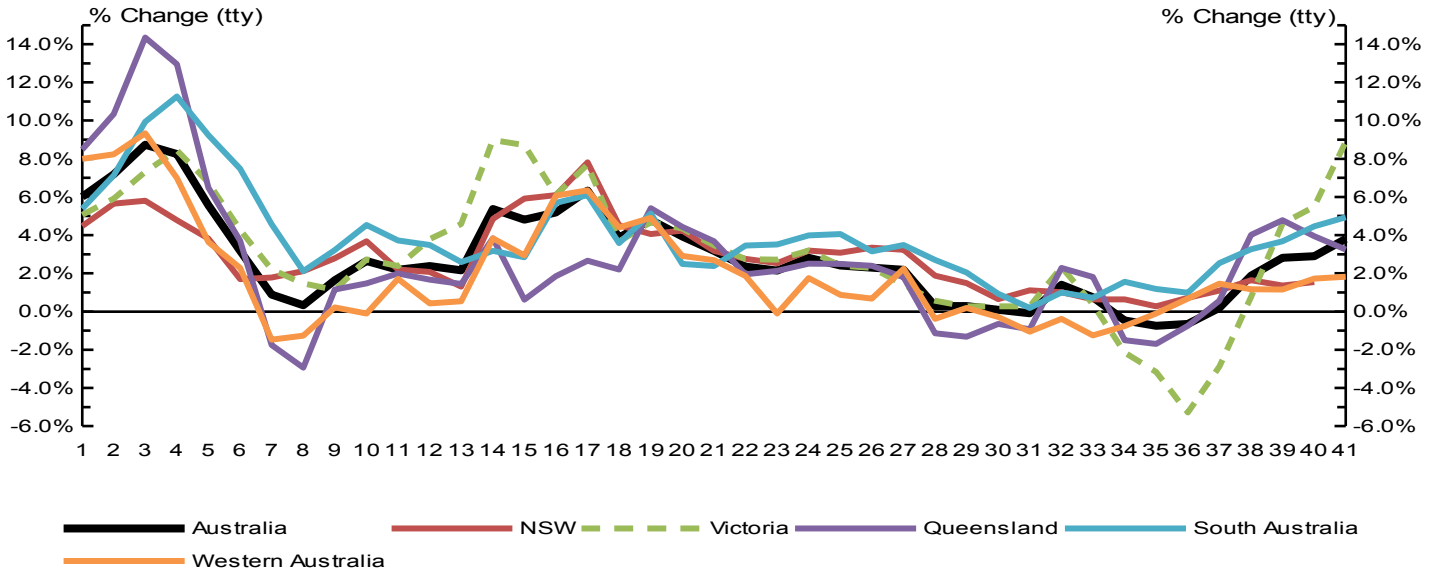
Construction Costs - Road and Bridge Index



Source: Producer Price Indexes, Australia (ABS cat. No. 6427.0)

Summary

- Important to establish robust governance structures and frameworks
- Governments need to use all policy instruments available
  - Understand incentives influencing different stakeholders
- Work towards more realistic cost estimates:
  - Collect data to validate estimates and to build empirically-based parametric tools
  - Build estimates using best practice techniques that are mathematically and theoretically sound Be aware of biases and how to account for them
  - Be humble about our true state of knowledge