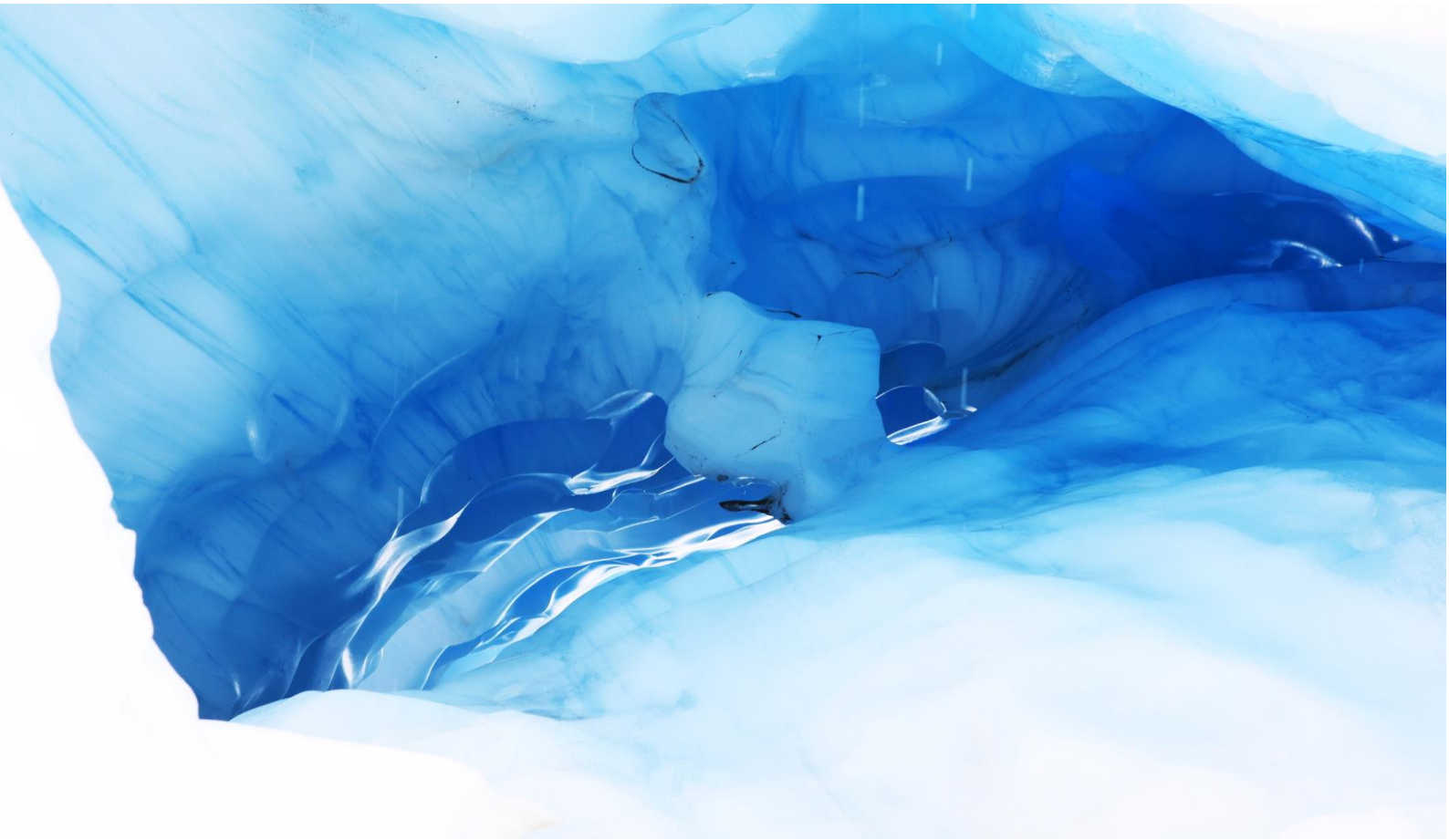
NZIER
NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH



Valuing the indeterminable?

Three perspectives on the value proposition of the New Zealand Naval Combat Force

Summary of the research findings

NZIER final research report to New Zealand Defence Force

February 2023

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice.

We undertake and make freely available economic research aimed at promoting a better understanding of New Zealand's important economic challenges.

Our long-established Quarterly Survey of Business Opinion and Quarterly Predictions are available to members of NZIER.

We pride ourselves on our reputation for independence and delivering quality analysis in the right form and at the right time. We ensure quality through teamwork on individual projects, critical review at internal seminars, and peer review.

NZIER was established in 1958.

Authorship

This paper was prepared at NZIER by Derek Gill of the New Zealand Institute of Economic Research and Jim Rolfe of the New Zealand Centre for Strategic Studies.

It was quality approved by John Yeabsley, and the external reviewers were Professor Keith Hartley of the University of York and Professor Paul Hansen from Otago University, who reviewed the material on the Discrete Choice Experiment surveys. Rear Admiral (retired) John Martin acted as a sounding board as the project progressed.

The assistance of the following is gratefully acknowledged: Sarah Spring on the literature scan and document review, the team at 1000minds for assistance with survey design and interpretation, Dr Jelita Noviarini and Dr Andrew Coleman for technical support in the interpretation of the 1000minds results, the defence security experts who took part in the scenarios, Dynata who recruited survey participants and the ordinary New Zealanders who took part in the survey.

How to cite this document:

NZIER. 2023. Valuing the indeterminable? Three perspectives on the value proposition of the New Zealand Naval Combat Force. Final research report for NZDF.

Registered office: Level 13, Public Trust Tower, 22–28 Willeston St | PO Box 3479, Wellington 6140
Auckland office: Ground Floor, 70 Shortland St, Auckland
Tel 0800 220 090 or +64 4 472 1880 | econ@nzier.org.nz | www.nzier.org.nz

© NZ Institute of Economic Research (Inc). Cover image © Dreamstime.com
NZIER's standard terms of engagement for contract research can be found at www.nzier.org.nz.

While NZIER will use all reasonable endeavours in undertaking contract research and producing reports to ensure the information is as accurate as practicable, the Institute, its contributors, employees, and Board shall not be liable (whether in contract, tort (including negligence), equity or on any other basis) for any loss or damage sustained by any person relying on such work whatever the cause of such loss or damage.

Executive summary

Key points

- Placing an economic value on defence forces is something that has been discussed in the literature but never attempted before. This study is an original contribution to knowledge.
- Though initially sceptical, we became increasingly confident about applying this task to the Naval Combat Force (NCF) as we proceeded from a scoping phase to a pilot and then a proof of concept.
- In the final phase, we applied three different approaches to value the NCF. These were from the perspective of Cabinet Ministers, ordinary New Zealanders and security experts.
- Our estimated valuations are ballpark estimates presenting a range of estimates for each analytical approach.
- We expected the different perspectives to yield very different valuations – as we had found that New Zealanders and experts had quite different preferences in the proof of concept phase.
- We found remarkably consistent valuations as that while different stakeholders valued different attributes all placed a significant economic value on the NCF in the range of $3.5B–$10B over 30 years.
- Like any experimental, leading-edge research, this finding is subject to caveats and cautions that are outlined in the Report
- The research suggests that valuing defence forces is not an indeterminable issue and further refinements are possible.

Navigating in unknown waters

The New Zealand Defence Forces (NZDF) sought authoritative advice on whether it is possible to put an economic value on naval combat forces and, if so, what that value would be for New Zealand. The first two phases of this project addressed the first question, and we concluded in our 2019 report that although it has never been attempted, it was feasible to assess the economic value. Our literature scan in 2018 found a sparse literature with no practical examples of defence forces actually being valued. However, techniques developed in fields such as environmental economics could be applied to defence. This conclusion was confirmed by the Rand Corporation in a major study for the UK MoD (Huxtable et al. 2021).

Total value (V) is the sum of capability (C) and direct use (D) value

The original organising value framework for the project was V = C + D, where:

- C is the 'could' use value to protection and security that accrues through possession (rather than use) of the asset's capabilities.
- D is the delivered or 'direct' use value generated from the delivered outputs obtained by physically using the asset.

While conceptually distinct and a useful way of thinking about the issues, in practice, we found it very challenging to unpack C and D in some of the approaches to estimating valuations. So while the surveys used in the research were based on this distinction, other measures presented conflated C and D into one value.

On the cutting edge

Valuing the Naval Combat Force (NCF) requires building on ideas that have been explored but never actually attempted before. To address the question – What might the value of the Naval Combat Force be? – we needed to ask the prior question – Whose valuation do we privilege? We addressed this question by adopting three different perspectives using three different approaches:

- Perspective 1 – Cabinet Ministers' willingness to pay – both stated and revealed by actual decisions
- Perspective 2 – Experts' views using scenarios analysis to develop an overall value derived from the assessed value of economic deterrence
- Perspective 3 – New Zealanders' stated preferences based on two surveys.

We expected these different stakeholders' valuations would differ, perhaps dramatically. as we had found that the general public and experts had quite different preferences in the proof of concept phase. The rest of the section summarises what we found about the economic value of defence forces from various stakeholders' perspectives.

Perspective One: Cabinet Ministers' willingness to pay for the NCF

Willingness to pay can be assessed by what people say (*stated preference*) and what they actually do (*revealed preference*). We started the project by reviewing the government's stated willingness to pay and the revealed preferences through their willingness to use the naval combat force.

Historical willingness to use and pay for the NCF

We reviewed written documents that make up the historical record as part of an earlier stage of the project. In brief, we found clear preference stated in successive Defence reviews since 1978 that the utility of the NCF outweighs the cost.

To assess revealed preference on willingness to pay, we looked at actual decisions on both capability and direct use in delivering outputs. Looking at delivery and willingness to use:

- New Zealand frigates have been deployed into areas of tension, including maritime and other security operations, at least once a decade
- annual exercises have been undertaken with allies and friends, combined with defence diplomacy
- routine support has been provided to other 'like-minded' navies.

To assess willingness to pay for capability, the easiest approach was to use historical cost data to express the cost of the current ANZAC frigates over the first 20 years of the expected thirty-year life. The key weakness of this approach is that it is based on decisions at a point in historical time, and the international strategic context and domestic political environment have altered significantly in the years since the initial acquisition decisions were taken. In other words, we recognise that past experience has limitations for valuing future use.

Contemporary decisions to invest in NCF capability

Recent governments have taken a series of decisions to invest in sustaining the NCF and extend the ANZAC-class frigates' operational life to 2035. Since 2018 these have included: a $638m Frigate Systems Upgrade updating the combat systems, a $100m communications upgrade to retain interoperability and committing to an upcoming $400m five-year frigate life extension project. This reveals a floor value that successive governments have been willing to invest in supporting and sustaining the NCF: a minimum floor value of $NZ90m p.a.

Adding up revealed preferences over the life of the naval combat force

Present value measures the worth of cash flows over a period of time by using a discount rate to allow for the time value of money. The present value of the historic cost of the ANZACs acquisition over 20 years (expressed in 2019 dollars) and discounted using the Treasury's recommended discount rate (5%) is $NZ6.1B (or **$5.1B** at 4%). Recent decisions on the Frigate Systems Upgrade and the frigate 5-year life extension can also be added: $NZ90m. p.a., which at a 4% discount rate yields a present value of $0.7B over 10 years. The historic costs approach provides a lower-bound estimate of the willingness to pay by political decision-makers based on the costs of direct capability (C) and direct use or delivered outputs (D) combined.

The present value of costs gives a lower-bound estimate

Taken together, these cost data suggest from a whole-of-life perspective, Ministers have valued the NCF at **$5.8B** over 30 years. There are two important caveats. 1) the precise value derived depends upon the discount rate used – a 1% change in the rate changes the assessed value by around 20%. 2) This is a lower bound estimate based on value equals cost, and it doesn't test how much more Ministers would have been prepared to pay for the capability or its use.

Perspective Two: Scenarios analysis using experts' views

Defence analysts' perspective on the value proposition of the NCF is likely to be different to Cabinet Ministers and ordinary New Zealanders. We developed an innovative approach to assessing experts' views using a methodology not found anywhere in the literature that we can locate. In brief, this approach involves working from an assessed value – the value of deterring attacks on maritime trade over time – and scaling this up to an overall value. This scalar is based on experts' judgements about the relative importance of deterrence compared to other functions of the NCF.

Deriving a value for deterrence

Our starting point for determining the value of the NCF was to assess the value of its ability to deter future attacks on maritime trade. The potential disruption to merchant shipping was illustrated by five scenarios ranging from a relatively benign environment to generalised warfare between groups of states.

We used a Delphi-type process with twelve New Zealand defence experts outside the New Zealand Government to assign probabilities to the different environments. As a group, they assessed the likelihoods over time as set out in the table below (along with the associated derived deterred trade values). The scenarios cover a range of potential states of the world, different weightings and derived deterrence values. They range from scenario 1, a benign international environment, with a 15% probability where the deterrence effect is negligible, through to a more high-intensity regional conflict, with a 22% probability and the assessed deterrence effect of $44m p.a., through to Scenario 5 international conflict, with a 15% probability and deterrence effect is worth $50m p.a. Table 1 shows the data with the likelihood of each scenario, the value if that scenario were the only consideration and the derived value across all scenarios.

Table 1 Scenarios – likelihood over 30 years and derived values

Scenarios	Likelihood	Value	Derived value
Benign	15%	Negligible value	Negligible value
Regional disturbance	36%	$10.7m p.a.	$3.9m p.a.
Regional conflict	22%	$44m p.a.	$9.7m p.a.
Piracy	12%	$17m p.a.	$2.1m p.a.
Global conflict	15%	$50m p.a.	$7.0m p.a.

Source: NZIER

From deterrence value to total value

To move from the assessed deterrence value ($23m p.a.), which we take as 'known', we used a scalar based on experts' judgements about the relative importance of deterrence (13%) compared to other functions of the NCF. The other functions based on Huxtable et al. (2021) include national protection, deterrence, projection, international presence and signalling, international order, workforce and industry, and whole-of-government activities. This enables a move from deterrence value to total value.

Sensitivity of the derived NCF's value to assumptions and to the process

Though innovative, using scenarios in this way is subject to several limitations. Most importantly, any error in the derived deterrence value ($23m p.a.) would be compounded in estimating the total value. In addition, the approach implicitly assumes a counterfactual of reduced deterrence without the NCF.

Moreover, the derived valuation is very sensitive to the base level of maritime trade – the fall in New Zealand's maritime trade from 2017 to the base year used in 2021 reduced the value by some 30%. Given the deterrence value ($23m p.a.) and the weighting (13%), it is a matter of simple arithmetic to derive an estimated total value – in this case, $176m p.a. This derived value would increase to $237m with 1.0% p.a. maritime trade growth over three decades, $380m with 2.6% p.a. trade growth, and $760m with 5.0% p.a. growth.

Using Oxford Economics (2020) ten-year forecast of a 2.6% p.a. increase in maritime trade and a 4% discount rate, the mid-point estimate of the present value of the NCF over a 30-year life span is **$3.7B**. This estimate ranges between $3.0B, with no growth and $4.5B, with 5.0% growth in maritime trade. However, these estimates are conservative as they ignore the benefits to New Zealand from our trading partners, avoiding disruption and any deterrence of risk to coastal shipping (4% of New Zealand's maritime trade by volume). And the focus is on the economic value of deterrence from the disruption in international trade and not the wider social value of deterrence of conflict.

Perspective Three: New Zealanders' stated preferences – 1000minds DCE surveys

The third perspective assessed ordinary New Zealanders' willingness to pay for the NCF. We undertook a discrete choice experiment (DCE) (McFadden 1974), implemented using the 1000minds DCE survey platform (www.1000minds.com). A DCE, also known as conjoint analysis, is a popular survey-based methodology for discovering how people feel about a product's various attributes or characteristics or other areas of interest like government policy, as in the present setting.

We ran two parallel DCE surveys simultaneously to explore people's stated willingness to pay for the NCF's capability (N = 1032) and direct use of delivered outputs (N=1002), respectively. Plausible, consistent results emerged from both surveys and based on consistency testing, we are satisfied with their face validity and reliability.

Table 2 Ranking of the attributes in the delivered outputs survey linked to attributes in the capability survey

Delivered Survey Attributes	Capability Survey Attributes
Protecting our people = 1	Defending New Zealand = 1
Protecting our resource= 2	Keeping options open = 2
Promoting free movement of trade = 3	Supporting our friends in the South Pacific = 3
Supporting our regional partners = 4	Supporting Australian allies = 4
Supporting global security = 5	Supporting a safer world = 5

Source: NZIER

Each survey elicited New Zealanders' preferences by having them repeatedly choose between two attributes (shown in Table 2 above). From each participant's answers (~30 per person), the software determines weights on the attributes, representing their relative

importance to the person. One of these attributes was willingness to pay taxes for the NCF, which enables a valuation to be estimated. The defence-specific attributes range from defending New Zealand to supporting our Australian allies and regional partners, including our friends in the South Pacific and wider global security.

The two surveys bring out complementary overlapping perspectives and provide evidence to answer three questions: 1) what attributes of the NCF do Kiwis most value? 2) which Kiwis value the NCF? and 3) how much do Kiwis value the NCF?

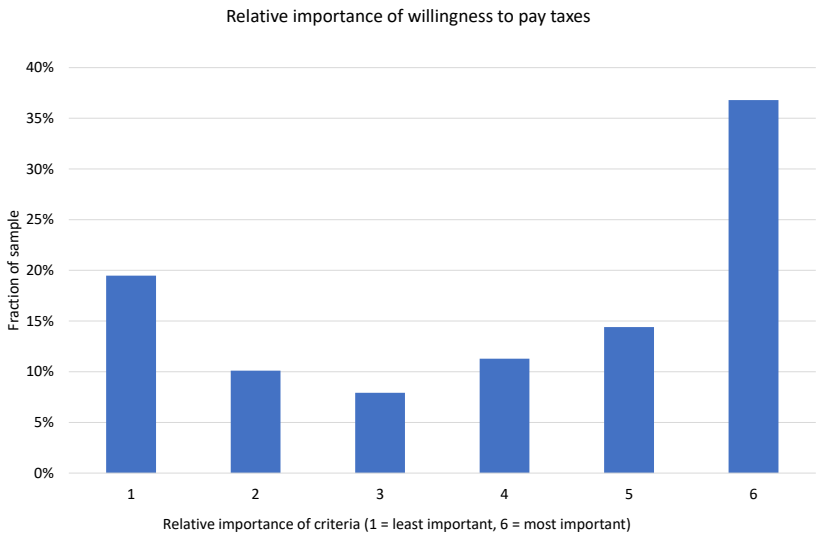
What attributes of the NCF do New Zealanders most value?

While the two surveys' questions have used different attributes, some consistent patterns emerged across both surveys. The surveys had a range of attributes relating to the functions of the NCF as well as a tax attribute to assess willingness to pay. Looking at the non-tax attributes:

1. Defending New Zealand is the most important attribute of the NCF
2. "Keeping our options open so the country can use our Navy 20 to 30 years into the future" also ranked highly in the capability survey
3. Supporting friends and allies are middle-ranking attributes of the NCF
4. The NCF's role in global security is the least important attribute.

Willingness to pay tax was a very important attribute (ranked most important in the capability survey and 2nd in the delivered outputs survey). While highly ranked, people were sharply divided on willingness to pay taxes for the NCF: the 'hawks' for whom tax was relatively unimportant, versus 'stoic Kiwis' where tax was a middling priority and finally 'doves' for whom tax was the most important attribute. Figure 1 shows that for 20% of New Zealanders (the hawks), tax was the least important attribute, while the doves comprise the 35% for whom it was the most important attribute and the 15% for whom it is the second most important.

Figure 1 New Zealanders sharply divided on their willingness to pay for the NCF



Source: 1000minds

Which New Zealanders value the NCF?

The bar chart in Figure 1 reveals the significant variation in how different people value NCF capability and delivered attributes – tax was the most important attribute for some and the least important for others. We undertook regression analysis of both surveys to determine what variables explain the differences in people's views on the NCF attributes. The main finding from the regression analysis was that the variation of people's preferences is not explained by the basic objective socio-demographic characteristics collected – age, gender and regional location. Cluster analysis, however, identified distinct groupings with diverse socio-demographic characteristics but very similar preferences about the NCF.

Three distinct clusters: hawks, stoic Kiwis and doves

Both surveys had three distinct groupings: 'hawks', 'stoic Kiwis' and 'doves'.

- Cluster 1: hawks – the smallest and tightest cluster, the most willing to fund the NCF and to support attributes directly related to defending NZ.
- Cluster 2: stoic Kiwis – have moderate willingness to pay and are very diverse in the NCF capabilities and delivered activities they support.
- Cluster 3: doves – have the lowest willingness to pay and low mean weights on all NCF capabilities and activities.

Cluster 2: stoic Kiwis – are the largest group in both surveys and almost constitute a majority. No cluster had strong discernible socio-demographic characteristics that were statistically significant. For example, although older people are more willing to fund the NCF, they are not the dominant members of cluster 1 (hawks), and the age effect was not statistically significant.

New Zealanders' stated preferences show a significant willingness to pay for the NCF

To calculate New Zealanders' stated preferences of willingness to pay for the NCF capability, we looked at the average per person willingness to accept forgoing each of the four NCF capability attributes, added these up and scaled that up by the adult tax-paying population. The resulting valuation of the amount people are willing to accept to forgo the NCF capability was $570m p.a.

We followed a similar procedure for the delivery survey using the five delivered functions. Unsurprising, the willingness to pay for delivered outputs was significantly lower than for capability: $221m p.a.

Where possible, we took a conservative approach to derive the values. For example, we have used the adult population (4.0 million) to scale the individual estimates rather than the total population (5.1 million): using the latter would increase the total valuations by over 27%.

The whole-of-life value depends on the discount rate

The estimates reported above are per annum. The present value over the whole-of-life of the platform (assumed to be 30 years) depends crucially on the discount rate selected. (The discount rate is the interest rate reflecting the time value of money). Discounting the annual willingness to pay (WTP) for NCF capability ($570m) at the current discount rate (5%) recommended by the Treasury yields a present value of **$8.7B**. Using the lower social

time preference rate, say 3%, yields **$11B**. The mid-point between the two (4%) yields **$9.8B**.

Taking estimated WTP for delivered outputs ($221m p.a.) yields a mid-point of **$3.9B** with a range of $3.4B (at 5%) to $4.3B (at 3.0%) over 30 years.

With offsetting sources of bias

There are two offsetting sources of bias.

First, in principle, the two survey results are independent, and the framework developed for this project suggests we could add the valuations arising from the capability ($9.8B) and delivery ($3.9B) surveys. In practice, however, the surveys overlap in terms of their content, and it is implausible that survey respondents distinguish between capabilities and direct use of delivered outputs.

Second, there is a risk of overestimating the total value of the NCF by simply adding up the WTP for all the attributes. WTP estimates are intended to capture the value of (marginal) changes to the levels of one attribute at a time while all the other attributes are constant. Simply summing WTPs across the attributes ignores that cumulative changes to the NCF are likely to yield diminishing returns. In addition, of course, DCE surveys are based on hypothetical, not real, choices. Therefore, valuations need to be interpreted with caution, and the derived valuations need to be interpreted as an upper limit.

Summary – Pulling it together: what valuations emerge from the three approaches?

Trying to estimate a valuation for the NCF using three different approaches from three different perspectives was a risky research strategy. We expected the different perspectives to yield very different valuations, as we had found that New Zealanders and experts had quite different preferences in the proof of concept phase. We found the economic valuation from different stakeholders' perspectives was of the same order of magnitude when expressed as the whole-of-life cost:

1. Cabinet Ministers' willingness to pay has a mid-point of **$5.8B** with a range of $5.0B to $6.8B.
2. Scenario analysis has a mid-point of $**3.7B** with a range of $3B to $4.5B.
3. Two surveys of the public's stated preferences had mid-points of **$9.8B** ($8.7B to $11B) for capability and mid-point for delivered outputs of **$3.9B** ($3.4B to $4.3B).

Obviously, the values depend on the discount rate chosen, as shown in Table 3 below. The Treasury's social opportunity cost (currently 5%) or social rate of time preference (3–4%).

Table 3 Valuations from the different perspectives and approaches

Perspective	Annual Value	Present Value (and range)
Cabinet Ministers	NA	**$5.8B** ($5 to $6.7B)
Scenarios using experts	$176m p.a.	**$3.7B** ($3B to $4.5B)
Public's WTP Delivery	$221m p.a.	**$3.9B** ($3.4B to $4.3B)
Public's WTP Capability	$570m p.a.	**$9.8B** ($8.7B to $11B)

Source: NZIER

While the results from three perspectives using three different approaches yield reasonably consistent valuations, it would be misleading to simply rank high to low by valuation. The different valuations are not strictly comparable. Cabinet Ministers' WTP is a lower bound estimate, and the public's WTP is an upper bound estimate. Also, the different approaches measure subtly different dollar values – one measures trade in dollar terms, one measures fiscal expenditure and the third notional tax. But taken together, they suggest different stakeholders all place a significant economic value on the NCF in the range of **$3.5B to $10B** over 30 years.

Conclusion – Valuing the NCF is a worthy quest rather than a holy grail

This is leading edge, if not bleeding edge work – nothing of this kind has been attempted anywhere else in the world – although the UK has undertaken a very comprehensive scoping study. In interpreting the research findings, it is important to remember that these results can't be benchmarked or compared.

We have presented our estimated values for each perspective as a range with a midpoint – not a precise point estimate. That is because these are ballpark estimates that are sensitive to key assumptions. For the 1000minds DCE surveys, a key assumption is the population scalar; for scenarios, the weights and assumed growth in maritime trade and, for all cases, the discount rate adopted. There are also technical caveats to be borne in mind with each approach.

This research was technically very challenging and has significantly benefited from the peer review by Dr John Yeabsley of NZIER and the external reviews by Rear Admiral (retired) John Martin, Professor Paul Hansen from Otago University on the DCE survey and Professor Keith Hartley of the University of York. Professor Hartley's comment on this draft report was:

"This is an impressive and pioneering contribution to our knowledge in this important field. The authors are to be congratulated on their novel approach to a completely new and important part of defence economics. Scholars have recognised the challenge of defining and measuring defence output; but this is the first attempt at empirical measurement. Extremely well done is my judgement on the Report."

Contents

Appendices

Figures

Tables

1 Our approach to the task

The Defence Forces want to understand the economic value of naval combat forces

We were asked to develop a pilot project to explore how to put an economic value on naval combat forces and, if so, what that value might be. This paper addresses the second question and follows our 2019 report, which addressed the first issue.

Our approach builds on the literature

In the feasibility phase, Phase 1, we explored the available literature in order to undertake the detailed project design. Our report in April 2018 covered the findings from the literature scan, and the details are included in Appendix C for ease of access. Total Economic Value is the sum of all benefits obtained from a resource or capability. We found that the literature on valuing defence assets is sparse, and practical applications of the possible techniques are rarer still. The challenges for valuing defence have been explored in the defence economics literature. The conventional wisdom is that 'valuing' defence capabilities is so difficult that most defence economics literature uses the standard assumption that 'value equals cost'. This is because the capability would not have been paid for at the level it cost if it had not been valued. In other words, the literature is implicitly arguing that inputs equal outputs.

The literature scan identified proven techniques from other fields that could be applied to valuing naval capabilities

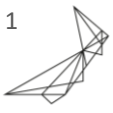
However, more recent contributions, in particular The Rand Corporation (Huxtable et al. 2021), emphasise the role of non-market valuation techniques developed in other domains that are applicable to the problem at hand. There is a separate literature on the range of techniques for non-market valuation. Initially developed in environmental economics, these are increasingly being applied in transport and health economics. To date, these approaches have not been applied to defence forces. Although our approach is innovative, the innovation is in terms of the application to valuing defence assets.

On the leading edge

This is ground-breaking work: it is conceptually challenging and requires developing bespoke techniques that are difficult to implement. The project design uses various complementary perspectives and techniques to ensure that any conclusions are robust and not a one-off result from a particular approach.

The pilot project's focus has been on the frigates that comprise the Naval Combat Force (NCF). The NCF was selected for the pilot as it combines warfighting capability with direct use in delivering defence outputs. A wider project should also explore other naval and maritime capabilities. Ultimately, the approach has been designed so that it could be extended to consider other New Zealand Defence Force (NZDF) capabilities.

One potential limitation of our approach is that we have focused initially on the NCF when the NCF is just one component of a wider maritime and, ultimately, NZDF system. One risk is that any final substantive valuation may not be entirely accurate because the NCF is not a discrete entity, and the accrued value of the system and the synergies within it are not



captured. Another risk is that any values attributed to NCF could also be delivered, in part at least, by other platforms such as Offshore Patrol Vessels or Maritime Patrol aircraft. These risks will need to be addressed as part of any subsequent work once the value of the NCF has been explored.

What we covered in the project phases

We have adopted a phased approach with off-ramps after each phase:

- Phase 1 feasibility study (2018)
- Phase 2A prototyping
- Phase 2B1 pilot
- Phase 2B2 proof of concept (2019)
- Phase 3 (2022) applies the techniques developed.

This report documents and summarises the work undertaken in the final stage of the project to address the question – What is the economic value of the NCF? This is not intended as a full research report, which is beyond the scope of the brief, but a summary of what we have done, what we found and what it does and does not mean. A technical background paper on interpreting the 1000minds DCE survey and the Fractional Multinomial Logistic Regression Analysis (Gill, Coleman, and Noviarini 2022) is available from NZIER on request.

To provide that summary, we discuss the approaches we adopted from three different perspectives: 1) Cabinet Ministers revealed preferences through the ANZAC acquisition and naval combat force life extension (section 2), 2) Scenario analysis with defence experts' support (section 3), and the general public through the 1000minds DCE survey (section 4). We summarise our findings in section 5, and the last section on the next steps (section 6) sets out the directions for further work.

The Appendices contain a summary of the work undertaken in the earlier stages of the project (Appendix A), our original framework (Appendix B), the results from the initial literature scan (Appendix C), and a description of the historical patterns of the use of the NCF (Appendix D). Appendix E discusses the link between this research and the NZ Treasury's 2021 Living Standards Framework.

2 Cabinet Ministers' willingness to pay

Willingness to pay (WTP) can be assessed by what people say (stated preference) and what they actually do (revealed preference). We started the project by reviewing Cabinet Ministers' stated WTP and the revealed preferences through their willingness to use the naval combat force.

2.1 Historical willingness to use and pay for the NCF

To assess stated preferences as part of Stage 2, we reviewed written documents that make up the historical record. Appendix D sets out in more detail what we did and what we found.

In brief, we found clear preference stated in successive Defence reviews since 1978 that the utility of the NCF outweighs the cost.

To assess Cabinet Ministers' revealed preference on willingness to pay, we looked at actual decisions on both capability and direct use in delivering outputs. Looking at delivery and willingness to use:

- New Zealand frigates have been deployed into areas of tension, including maritime and other security operations, at least once a decade
- annual exercises have been undertaken with allies and friends, combined with defence diplomacy
- routine support has been provided to other 'like-minded' navies.

2.2 Revealed preference – ANZAC frigate acquisition

To assess WTP for capability, the easiest approach was using historical cost data to express the cost of the current ANZAC frigates over the first 20 years of the expected thirty-to-forty-year life. We analysed historical cost data provided by NZDF to estimate the present value of the costs of the ANZAC frigates. (Present value measures the worth of cash flows over a period of time by using a discount rate to allow for the time value of money.) Our focus was on actual cash expenditure on capital and operating and didn't include non-cash line items such as depreciation or capital charge as this would have involved double counting.

The frigate cost line items used were derived from NZDF's operating and capital budgets:

- direct operating
- personnel
- platform upgrades
- capital expenditure
- Defence Major Platform Restoration (DMPR)
- frigate acquisition.

Selected inflation and discount rates were used to express all historical costs in 2018/19 New Zealand dollars. The deflators used included:

- Consumers Price Index (CPI)
- Central Government Administration, Defence and Public Safety
- Capital Goods price index.

Table 4 Historical willingness to pay

Using CPI as the deflator

Discount rate	WTP ($ billions)
2.8%	4.1
4.0%	5.1
5.0%	6.1
6.0%	7.4
7.0%	8.9

Source: NZIER, NZDF

Table 4 shows the present value of the mid-life cost of the two current ANZAC frigates over the first 20 years of their expected thirty-to-forty-year life. The historic costs were dominated by the acquisition costs (approximately $1B per frigate in 2019 dollars) rather than operating costs ($30-40m p.a. in 2019 dollars in the later years of operations).

The present value is very sensitive to the choice of discount rate, i.e. the interest rate reflecting the time value of money. A 1% change in the discount rate leads to approximately a 20% value change. By contrast, WTP based on historic costs is NOT sensitive to the choice of deflator.

Treasury's CABX (n.d.) currently recommends using a 5% real discount rate, based risk-free rate of 2.8%, using the concept of the *social opportunity cost of capital based*. Social time preference estimates typically suggest lower rates of 3–4% (see Creedy and Passi 2017).

Using the risk-free rate, the historical WTP of New Zealand's NCF is **$4.1B**. Spreading this over a 21-year life (between 1997 and 2019) and dividing it by an adult population of 3.9 million gives a WTP of approximately **$50 per adult per year.** This number is the basis of the tax attribute in the 1000minds DCE survey discussed in section 4 below.

There are two offsetting sources of bias with this approach. We have taken a narrow view of the NCF and have not included the costs of the naval helicopters (capital spending of $326m approved in 2003 and $242 approved in 2013). While embarked helicopters are an integral part of the NCF, they are also used for other purposes. Adding in naval helicopters would increase the assessed revealed preference value of the NCF.

The other source of bias that we have not considered is the potential value of procurement offsets. An offset is a requirement in a defence contract, such as the ANZAC ships acquisition, that specifies the percentage of the contract being sourced from firms in the purchaser's country. Offsets are hard to value for many reasons, including because the counterfactual is unclear (how much would have been sourced from New Zealand anyway) and meeting the offset contract diverts scarce resources from meeting other market demands. To the extent that offsets did generate defence export sales that would not have occurred otherwise, there is an argument that the assessed revealed preference value of the NCF is overstated. However, the extent of any overestimation is unknown.

The estimated value generated by these methods sets a lower bound to the value of the NCF as it measures WTP rather than the value generated. It combines the value for capability (C) and direct use of delivered outputs (D). It is not possible to decompose these components precisely. However, from the documents we examined on the ANZAC frigates

acquisition decision, it was clear that the main driver for the decision was capability development rather than operational imperatives for direct use for delivered outputs. The key weakness of this approach is that it is based on decisions at a point in historical time, and the internal strategic context and domestic political environment have altered significantly in the 30 years since the initial acquisition decisions were taken. However, based on the historical record discussed above in section 2.1 and the recent decisions to invest in sustaining the NCF discussed in the next section, our judgement would be that this is still a valid lower estimate measure of value.

2.3 Contemporary decisions to invest in NCF capability

Recent governments have taken a series of decisions to invest in sustaining the NCF and "*extend the Anzac-class frigates' operational life out to 2035*".[1]

These have included: a $65m Platform Systems Upgrade initially approved in 2007, a $638m Frigate Systems Upgrade updating the combat systems, which commenced in May 2018 and is just being completed in early 2023, a $100m communications upgrade to retain interoperability, expected to be completed in 2024 and committing to an upcoming $400m five-year frigate life extension project.

Box 1: Excerpt from 2019 Defence Capability Plan on extending the life of the ANZAC Frigates

" The Government has already made a significant investment in the ANZAC frigates, Te Mana and Te Kaha. These upgrades have been undertaken to ensure that the frigates remain world-class maritime combat capabilities for the full duration of their service, and include:

90. The maintenance of a discrete defensive close-in weapons system on the frigates that provides a final layer of protection against in-bound missile and fast inshore attack craft threats;

90.2 A Platform Systems Upgrade, focused on the replacement of propulsion diesel engines, upgraded cooling systems, and new platform management and integrated bridge systems;

90.3 The acquisition of the SH-2G(I) Seasprite maritime helicopter, to provide an embarked helicopter for the vessels that can provide rotary wing surveillance, warfare and airlift; and

90.4 The Frigate Systems Upgrade, currently being delivered, which will maintain the surveillance, combat and self-defence capabilities of the frigates. This includes replacement of the combat management systems and a number of sensor and weapon systems.

91. A further upgrade to the ships' communications system will ensure continued interoperability with our key Defence partners. These upgrades will be completed in the early 2020s, at which point the ANZAC frigates will provide a greater capability to the New Zealand Defence Force than at any time since their introduction in the 1990s.

92. To realise the full value of these upgrades, the frigates' expected service life will be extended past 2030. This decision has been supported by independent analysis of the vessels, which has demonstrated that they are supportable for a greater period of time than previously anticipated."

[1] https://tinyurl.com/4e4cajzc

Taken together, this shows a willingness to invest over $1.1B in total since 2018 or just over $90m each year, to sustain the NCF capability in service. Effectively the government has purchased the option to extend the operational life of the ANZAC frigate force out to 2035. Expressed as a present value over ten years, $90m p.a. amounts to a mid-point value of $0.7B at the Treasury recommended 5% discount rate (as well as at 4%) and $0.8B at a 3% social rate of time preference.

2.4 Adding up revealed preferences over the life of the NCF

The present value of the historic cost of the ANZACs acquisition over 20 years (expressed in $2019) and discounted at the Treasury recommended discount rate (5%) is $NZ6.1B. To this can be added recent decisions, such as the Frigate Systems Upgrade and the frigate's five-year life extension, which yields a present value of $0.7B. These cost data suggest from a whole-of-life perspective that Ministers have valued the NCF at **$6.8B** over 30 years.

This approach relies on a degree of continuity and consistency in the defence policies of the two major parties that have largely made up successive governments. It is important to note that this only reveals a floor value that successive governments have been willing to invest in supporting and sustaining the NCF but not the full WTP. It is a lower bound estimate as it is based on value equals cost. It doesn't test the unknown increased amount that Ministers would have been prepared to pay for the NCF capability or its use. [2]

[2] Economist will recognise that willingness to pay about costs is referred to as consumer surplus. In principle, so long as the relevant elasticities are known it is possible to estimate consumer surplus. In practice in the case of defence forces the relevant elasticities are not known so no such estimation is possible.

3 Experts' perspectives using scenarios

In our original analysis in 2019, we were focused on determining values for the NCF related to our original understanding that the total value for the NCF was the sum of capability value and delivered value (V = C + D).

In the analysis, then, we developed a method for determining a non-precise value for capability value, using the NCF's ability to deter attacks on maritime trade – in other words, to find one military non-use (or capability) activity to which we could assign a value. In addition to deterrence, the other military non-use values include existence and option values. This method would, therefore, only generate a partial value that sets a lower bound to the value of the NCF in capability terms rather than a mid-point estimate. At that stage, we left the problem of determining a delivered or use value (D) for further thought and analysis. Appendix B contains a more detailed discussion of Capability (C) and Delivered (D) values.

Developments since the pilot study

In the period since that report, we have refined our understanding of the relationship between capability and delivered value to the extent that we do not now consider them to be individually necessary within the scenarios approach to determine a figure for total value, and we do not now consider them to be additive, but rather as components that stand alongside each other as we develop an understanding of total value.

Instead, we now realise that if we can determine a value for any one class of NCF activity, we can use that to determine an overall value based on the relationship in terms of a probability weighting between that value and the total value. Therefore, determining deterrence value and its relationship to other value areas of the NCF will allow us to develop the scenarios as a perspective that gives insights into the overall value proposition for the NCF.

Canvassing experts' views

The approach still rests on a number of assumptions linked to hard data and based on an assumed probability of attacks on shipping in a range of scenarios, the detail of which is shown in the summaries of the scenarios and the analysis of deterrence value below. The approach, including the assessment of probabilities, was validated in 2019 through one-on-one and one-on-group interviews with academic experts and tested using decision-support software provided by ThinkTank, a specialist decision-support application. This group was used to assign probabilities to a range of scenarios shown in Figures 1–5 and discussed in more detail below. This group was chosen from people with a range of expertise, knowledge and experience in the issues.

This approach using decision-support software in 2019 was treated as a pilot, with the intention of refining the method if necessary. The pilot was successful, but rather than refining the method and re-running it, we have decided to accept the results determined then. There are two reasons for this. The first and most relevant is, as noted, that since then, we have developed our understanding of the relationship between capabilities and their delivery. Rather than the components of C and D (discussed in Appendix B) being additive, we realised that they are complementary. The scenarios approach amalgamates C and D to determine an overall or total value that integrates the two factors. Deterrence by

itself thus becomes a less significant component of the overall equation. When that factor is added to the logistical and administrative problems of re-establishing the decision support team, we concluded that errors in this component of the equation are not so significant that they seriously compromise the final answer, which is within a range in any case.

3.1 Logic and assumptions

The logic chain used for the scenarios analysis is:

- In any circumstance, there is (1) a probability (sometimes very small, sometimes larger) that merchant shipping could be disrupted by naval or pirate activity if there is no fear of being caught. The probability will be small in peacetime and larger in other circumstances.
- That probability will change (2) if the disrupting entity believes it will be caught and punished if it attempts to disrupt merchant shipping.
- Naval Combat Forces provide that deterrence. In this analysis, we have used the number of like-minded naval surface escort forces in different regions as the deterring element.
- Naval Combat Forces are just one method of ensuring deterrence. Other forms of deterrence (maritime air, diplomatic sanctions) would add to the deterrence value of Naval Combat Forces, but this study only examines the deterrence provided by Naval Combat Forces acting alone. We are not attempting to value the relative merits of different forms of maritime deterrence or their cumulative effect.
- The critical assumption is that 2 will be less than 1 because 'friendly' warships provide an element of deterrence. (This is a non-use value, so the general existence of friendly warships is important rather than their immediate presence during an attack. The analysis relates to preventing or deterring attacks rather than defeating them.)
- An additional assumption is that New Zealand's physical contribution to the 'friendly warship' force is proportional to that force's deterrence in dollar terms. This means that if a 'friendly' grouping of warships provides a certain level of deterrence (which can be valued), New Zealand's contribution to the grouping provides that proportion of the overall deterrence and thus generates that proportion of the value of the deterrence.
- The focus is on the economic value to New Zealand of deterrence from the disruption in international trade rather than the wider contribution to New Zealanders' wellbeing from deterrence of conflict.

3.2 Method

The method involves determining the following:

1. the value of New Zealand's maritime trade, both globally and within specific regions
2. the likelihood (or probability) that trade might be disrupted by naval action or by piracy if there is no deterrent available (point 1 above)
3. the cost of that disruption

4. the total naval escort force that might be available to act as a deterrent
5. the likelihood that disruption will occur given the deterrence factor (point 2 above)
6. the cost of that disruption, given the deterrence
7. New Zealand's contribution to deterrence as a percentage of the available Naval Combat Force; and, therefore;
8. the value of the NCF as a deterrent in terms of the protection of maritime trade
9. the total value of the NCF using the deterrence value (step 8) as the starting point.

3.3 Scenarios

The circumstances in which merchant shipping might be disrupted can be shown in five scenarios. (Although additional scenarios may be conceived, they are either subsumed within the five or are trivial.) For each scenario, the value of New Zealand's maritime trade, the number of 'friendly' warships to provide deterrence and New Zealand's contribution to that force are known. We used decision-support software to converge defence experts' views on the relative likelihood of the different scenarios. The five scenarios are described below.

Scenario 1: A benign international environment

In this scenario, there is no international conflict, no significant international tensions and very little likelihood of significant disruption to trade from state or non-state use of force. Other events, such as natural disasters or political events in a specific country or region, could affect maritime trade, but these are not events susceptible to naval deterrence.

Scenario 2: Regional trade disruption (e.g. South China Sea)

In this scenario, disruption arises through the activities of a regional power attempting to control access to and through international waters. Although trade is not specifically targeted, the activities of a regional maritime power in claiming widely recognised international waters as territory causes uncertainty to shipping schedules. There could also be incidents in which merchant shipping is attacked specifically.

Scenario 3: Piracy disrupts regional trade (e.g. Indian Ocean, Southeast Asian waters)

In this scenario, no inter-state conflict or tension will likely disrupt trade. In some parts of the world, however, piracy on trade routes is rife, and the extent of shipping losses has the potential to partially disrupt maritime trade.

Scenario 4: Regional trade disruption through conventional conflict (e.g. Arabian Gulf, South China Sea)

In this scenario, states in conflict with each other conduct their conflict at sea, attempt to disrupt the trade of their opponent and force considerable disruption to maritime trade, even where that is not directed to or from one of the parties to the conflict.

Scenario 5: Major international conflict

In this scenario, there is a general conflict between groups of states and across regions. Maritime trade could be targeted in any part of the world.

3.4 Data

Given these scenarios, we were able to determine the value of New Zealand's trade affected within each scenario (from published data), the size of like-minded or 'friendly' NCFs available for deterrence in the different scenarios (from published data and using assumptions about the meaning of 'friendly) and New Zealand's percentage contribution to that deterrence (making assumptions about frigate availability in each case). Probabilities were assigned to the various scenarios using decision-support software and trialled with a small group to assess the method's validity.

These are the facts we worked from (all figures are approximate and indicative. They may change significantly in relatively short order):

- total maritime trade for New Zealand imports and exports (2021): $102.0b ($106B when local trade is added)
- Northeast Asia is about 35% of New Zealand's two-way trade by value: $35.0B
- Southeast Asia is about 8% of New Zealand's two-way trade by value: $8.0B
- the Indian Ocean (Arabian Gulf/Horn of Africa/Suez Canal) carries about 10% of New Zealand's two-way trade by value: $10.0B
- total of global like-minded (not China, Russia, some others) destroyers and frigates (that is, warships with an escort role): 400
- total of like-minded escorts in the Pacific: 80
- total of combined maritime force escorts in the Indian Ocean: 30.
- therefore: New Zealand provides 0.5% of total 'like-minded' naval escort capability (two frigates), 1.25% of Pacific capability (one frigate) and 3.0% of Indian Ocean capability (one frigate).

3.5 The process

The process involved several steps, including determining:

- the circumstances in which maritime trade might be disrupted in each of the five scenarios
- the value of New Zealand's maritime trade that could be disrupted in the scenarios
- the probability that trade will be disrupted with deterrence relevant to the scenario
- the cost in terms of disrupted trade in each case using the formula cost = probability times the total value affected
- the New Zealand contribution to deterrence using the formula percentage contribution of New Zealand's frigates to the total force times the overall marginal value as already determined
- the relative likelihood of each scenario eventuating (based on a Delphi-type process with defence experts)
- Once the deterrence effect has been determined, we can place that against the total of the functions for the naval combat force and determine through simple arithmetic an overall value.

We see the deterrence effect of the NCF in each of the scenarios in the following blue boxes.

Scenario 1: A benign international environment

In this scenario, there is no international conflict, no significant international tensions and no likely or significant disruption to trade from state or non-state use of force. Trade is most at risk through disruption to global supply chains caused by natural disasters, failure at some point in the system or deliberate political decisions by a state actor or actors.

In summary:

- No overt danger to trade
- Value of New Zealand maritime trade: $102B p.a.
- Probability of disruption 0.01% p.a.
- Risk to maritime trade: $10m p.a.
- Effect of frigates: 0.5%

Value of NCF: negligible

Scenario 2: Regional trade disruption

In this scenario, although trade is not specifically targeted, the activities of a regional maritime power in claiming widely recognised international waters as territorial causes uncertainty to shipping schedules. There are fears that maritime trade could become a specific target.

In summary:

- Fear of significant potential danger to trade in E Asia
- Value of local New Zealand maritime trade: $ 43B p.a.
- Probability of disruption: 2%
- Risk to regional trade: $860m p.a.
- Effect of frigates: 1.25%

Value of NCF: E Asia $10.7m p.a.

Scenario 3: Piracy disrupts regional trade

In this scenario, there is no inter-state conflict or tension that could disrupt trade. In some parts of the world, however, piracy on trade routes is rife and shipping losses have the potential to be severe. Losses are normally covered by insurance, but they also lead to an overall disruption to supply chains.

In summary:

- Limited danger for overall trade (potential for piracy at any time)
- Value of local New Zealand maritime trade: E Asia $43.0B p.a.; Indian Ocean $10.0B p.a.
- Probability of disruption: 2%
- Risk to regional trade: E Asia: $860m p.a.; Indian Ocean $200m p.a.
- Effect of frigates: East Asia 1.25%; Indian Ocean 3.0%
- Value of frigates: East Asia $11m p.a.; Indian Ocean: $6m p.a.

Value of NCF: $17m p.a.

Scenario 4: Regional trade disruption through conventional conflict (e.g. Arabian Gulf; South China Sea)

In this scenario, states in conflict with each other conduct their conflict at sea, attempt to disrupt the trade of their opponent and force considerable disruption to maritime trade, even where that is not directed to or from one of the parties to the conflict.

In summary:

- Localised significant danger to trade in the relationship of 60:40 between East Asia and the Indian Ocean
- Value of local New Zealand maritime trade: E Asia $43.0B p.a.; Indian Ocean $10.0B p.a.
- Probability of disruption 10%
- Risk to regional trade: East Asia $4.3B; Indian Ocean $1.0B
- Effect of frigates: E Asia 1.25%; Indian Ocean 3.0%
- Value of frigates: E Asia: $32m p.a.; Indian Ocean: $12m p.a.

Value of NCF: $44m p.a.

Scenario 5: Major international conflict

In this scenario, there is a general conflict between groups of states. Maritime trade could be targeted in any part of the world.

In summary

- Considerable danger to trade
- Value of NZ maritime trade: $102B p.a.
- Probability of disruption: 10%
- Risk to trade: $10B p.a.
- Effect of frigates: 0.5%

Value of NCF: $50m p.a.

3.6 Adding the values

The values derived for each scenario cannot simply be added across the range. To do that would be to assume that each of the scenarios was equally likely across the lifetime of the warships. That is clearly not the case. Instead, we used an expert group to determine a probability over time for each scenario as a weighting within the total value proposition. Although this was a different group from that used to determine the probabilities of disruption within the scenarios, it was also small. We were not attempting to get a representative sample of society for polling purposes (unlike in the willingness to pay approach), so we were content that, as the mean of expert understanding, the numbers are sufficiently robust given the assumptions within this method to be used to gain the insights we were seeking.

The weightings, therefore, represent a best estimate of the kind of international environment that the NCF will face over the next 30 years. They allow us to determine the likely deterrence value for each environment.

The scenarios cover a range of potential states of the world, different weightings and derived deterrence values:

- Scenario 1 benign international environment: 15%. The deterrence effect is negligible in terms of value
- Scenario 2 regional tension: 36%. The deterrence effect is worth $3.9m p.a.
- Scenario 3 piracy: 12%. The deterrence effect is worth $2.1m p.a.
- Scenario 4 regional conflict: 22%. The deterrence effect is $9.7m p.a.
- Scenario 5 international conflict: 15%. The deterrence effect is worth 7m p.a.

(As an aside, it is worth noting that security experts' views appear less pessimistic than those of ordinary New Zealanders. The National Security Long-term Insights Briefing, (October 2022) reports that 29% of the New Zealanders surveyed thought that "*NZ would be involved in an armed conflict with another country in the next 12 months*", while for the next ten years, the corresponding figure was 42%.)

Adding the values derived from the weighting of the individual scenarios, we can conclude that the deterrence effect of the NCF is worth approximately $23m p.a. in terms of the value of maritime trade not disrupted as a consequence of the existence of the NCF.

3.7 From deterrence to total value

To allow us to move from a deterrence value to a total value, we need to know what proportion of time for the NCF will be spent on deterrence as a component of total activities. We used a Delphi-type process with twelve New Zealand defence experts outside the New Zealand Government to assign probabilities to the different environments. Ten respondents are associated with New Zealand Universities, while the other two are recently retired senior public officials with relevant subject matter expertise. We asked our expert group to rate each of the six operating areas in terms of their likelihood over the next 30 years. The areas were:

- National protection. This was explained as a war-fighting requirement in cases where New Zealand or the country's interests were threatened.
- Deterrence. This was the effect of the warships in preventing any activity against maritime trade in the different environments described. We understand that there are other forms of deterrence (deterring attacks on New Zealand, for example), but we accepted that limitation and note that this means any deterrence effect will be understated to some extent.
- International presence and signalling. These are the routine naval activities around naval diplomacy intended to show New Zealand's commitment in principle to friends and allies and mutual interests.
- Support to international order. These are the cases where a warship might be involved in, for example, counter-piracy patrols in the Horn of Africa with allied Naval Combat Forces.
- Benefits to the economy. Benefits such as the employment given by the naval dockyard, the presence of ships' crews in the local economy and derived capabilities within the New Zealand economy to support the ships.
- Support to all-of-government activities. Often the NCF is tasked with supporting other sectors of the government. Examples include fisheries protection (a responsibility of the Ministry of Fisheries) or maritime search and rescue (managed by the national maritime coordination centre, a New Zealand Customs responsibility).

These six areas track closely with a recent RAND Corporation study (Huxtable et al. 2021) that examined the contribution of the British Defence system in contributing to the prosperity of the United Kingdom. They are not identical, partly because of differences in terminology and partly because the studies examine differing value propositions.

The only weightings needed to determine an overall value are deterrence and the relative weight compared to other tasks. Our expert group determined that deterrence would be some 13% of the total NCF value. This means that the total value of the naval combat force (a mid-point number) is $176m p.a. or $3.7B as a lifetime value. These figures are broken down further in section 5 of this report.

For interest, we can deconstruct the total value (derived from deterrence value alone) to get an annual value for each of the individual components of the naval combat force activity areas:

- National protection: 12.5%, value $22m p.a.
- Deterrence: 13%, value $23m p.a.
- International presence and signalling: 29%, value $51m p.a.
- Support to international order: 24%, value $42m p.a.
- Benefits to the economy: 9.5%, value $17m p.a.
- Support to all-of-government activities: 12%, $21m p.a.

(Note: to repeat, only deterrence value was used to derive the total value of the NCF. And the focus is on the economic value of deterrence from the disruption in international trade and not the wider social value of deterrence of conflict.)

3.8 Conclusion

This is a robustly logical approach to determining deterrence value, but one with some limitations.

The estimated deterrence value is only as good as the probabilities of disruption assigned to each scenario. Most importantly, any error in the derived deterrence value ($23m p.a.) would be compounded in estimating total value. Moreover, the derived valuation is very sensitive to the base level of maritime trade – the fall in New Zealand's maritime trade from 2017 to the base year used (2021) reduced the value by some 30%. For these reasons, values should be treated as indicative, as being within a range (perhaps a mid-point) rather than a precise figure.

An additional potential limitation is that we used only a small group of experts to assess probabilities. With hindsight, a larger group would have been preferable to avoid the problems of the mean answer altering perhaps significantly as new estimates were added. In practice, there was considerable agreement across the group of experts.

This previous point becomes especially important when we are attempting to determine the overall value of the naval combat force because that calculation also relies on assumptions and the group's 'best understanding' of different probabilities. As we show in section 5, a range of values is probably more useful than any attempt at giving a fixed point value.

4 New Zealanders' stated preference – 1000minds DCE surveys

The third perspective was to assess ordinary New Zealanders' WTP for the NCF. The project design revolves around using different research approaches to value the NCF from a range of perspectives. These different valuation techniques are complementary as they address the valuation from different perspectives and measure subtly different constructs.

4.1 Discrete Choice Experiments stated preference as an approach

The point of difference for the stated preference approach is that it uses a carefully designed survey to explore the general public's WTP for NCF's suite of capabilities and direct use of delivered outputs. This technique involves a discrete choice experiment (DCE) (McFadden 1973) in which respondents are asked through a survey to express their preferences by choosing between two or more multi-attribute alternatives (Johnston et al. 2017). DCEs are based on Lancaster's theory of consumer demand, where the value of a good is derived from the fundamental attributes of the good (Lancaster 1966). The advantage of this approach is the ability to measure the citizens' stated WTP for the NCF.

The literature scan (in Appendix C) found no jurisdiction where such a survey has been applied to valuing defence forces, but the Rand Corporation's 2011 pilot study for the UK MoD concluded DCE was a practical approach (Huxtable et al. 2021). See RAND (Lu and Rohr 2020) for an excellent summary of the advantages and potential drawbacks of applying a DCE approach to defence. The pilot survey we developed and tested in 2019 was pathbreaking because these techniques have not been applied to defence analysis before.

4.2 Method

4.2.1 Set-up

We used the 1000minds online DCE survey platform. DCE surveys were used to elicit the public's preferences by having them repeatedly choose between two hypothetical scenarios with respect to the NCF's capabilities, where the scenarios were described according to two defence-related attributes at a time and involving a trade-off. (Figures 2 and 3 include screenshots to illustrate the nature of the choices made, and Table 5 and Table 6 contain a full list of attributes). From each participant's answers to such questions (~30 per person), the software determines weights on the attributes, representing their relative importance to the person. The software can be thought of as converting each participant's survey responses into their individual utility function. Also, from the mean weights across all participants, willingness to pay estimates can be derived.

4.2.2 The surveys' design

Two parallel DCE surveys were administered simultaneously to explore people's stated WTP for the NCF's capability (N = 1032 valid responses) and for direct use of delivered outputs (N = 1002 valid responses) in August 2022. We used a research company with a large base of clients who are rewarded for computer-based surveys. We also developed a three-minute video which described the functions of the frigate force, which had to be viewed before the survey could be attempted. The research company sent the surveys out (along with a video link) to a mixture of respondents to ensure that the samples were broadly representative of New Zealand's socio-economic characteristics by age, gender and region (age and gender

breakdown is shown in Table 7 below). Each survey involves ~30 pairwise comparisons plus some demographic information. The survey has an internal consistency test involving two repeated questions. We excluded those whose responses were contradictory (possibly because they carelessly or randomly answered the questions) and re-sampled. The programme estimates a cardinal utility function (i.e. a measurable function) for each person that is consistent with their responses to the questions. Each level for each factor is given a weight: the bottom level for each factor has a weight of zero, and the sum of weights across the attributes = 1 (100%).

4.2.3 Survey questions

This DCE was designed to examine trade-offs participants are willing to make across various levels of five possible NCF attributes. The non-tax attributes reflect the range of functions and tasks of the NCF, ranging from the defence of New Zealand through supporting our Australian allies, our friends in the South Pacific and the wider region to contributing to global security through anti-piracy operations, for example. A tax attribute – i.e. "Additional tax each year per person for frigates" – was also included in the DCE to enable monetary values of the other NCF attributes, in terms of willingness to pay or accept, to be estimated.

As shown in Table 5, all but one of the NCF attributes were defined on four levels, ranging from lowest ranked ('worst' possible) to highest ranked ('best' possible). The capability DCE survey consisted of five NCF capability attributes:

- ability to defend ourselves
- support our formal allies
- support our friends
- contribute to a safer world
- give future governments the option to use the Navy.

These attributes, while slightly different from those used in the scenario analysis above, match well with the dimensions used in the Defence Mid-Point Rebalancing Review (DMRR). While the details of the DMRR are not in the public domain, what is clear is that the review developed a range of scalable military capability options and used expert judgment to rank the relative value for money of the various options. Expert judgement, "*including the service Chiefs and senior officials from outside the defence community*," (Catalyze Consulting 2014), was used to rank capabilities from highest to lowest. Then cost information was added to rank the relative value for money.

The capability survey questions were tested using a three-track approach with cognitive testing followed by piloting the survey with a selection of security experts and a small sample of New Zealanders as part of Phase 2B2. The delivered output survey underwent cognitive testing.

Table 5 Attributes and levels used in the capability survey

Attribute	Level
Looking after ourselves by defending New Zealand's sovereign territory	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Supporting our formal allies (e.g. Australia) by responding as requested	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Supporting our friends (e.g. Fiji, Indonesia) to maintain stability and order	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Contributing to a safer world, e.g. anti-piracy operations	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Giving future governments the option to use our Navy for another 20 to 30 years	No
	Yes
Additional tax each year per person for frigates	$50 more
	$25 more
	Nothing more
	$50 less

Source: NZIER

Table 6 Attributes and levels used in the delivered outputs survey (*with a matching attribute in the capability survey)*

Attribute	Level
Protecting our people through search and rescue and disaster relief *(Looking after ourselves by defending New Zealand's sovereign territory)*	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Protecting our resources through oceans surveillance and fisheries protection	Nil (no frigates)
	No change
	Marginally increased

Attribute	Level
(Looking after ourselves by defending New Zealand's sovereign territory)	Significantly increased
Showing our commitment to our relationship with regional partners, e.g. ship visits to the South Pacific *(Supporting our friends (e.g. Fiji, Indonesia) to maintain stability and order)* *(Supporting our formal allies (e.g. Australia) by responding as requested)*	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Promoting the free movement of trade, including carrying out anti-piracy operations *(Contributing to a safer world, e.g. anti-piracy operations)*	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Supporting global security by patrolling in an active war zone *(Contributing to a safer world)*	Nil (no frigates)
	No change
	Marginally increased
	Significantly increased
Additional tax each year per person for frigates	$15 more
	$7 more
	Nothing more
	$7 less

Source: NZIER

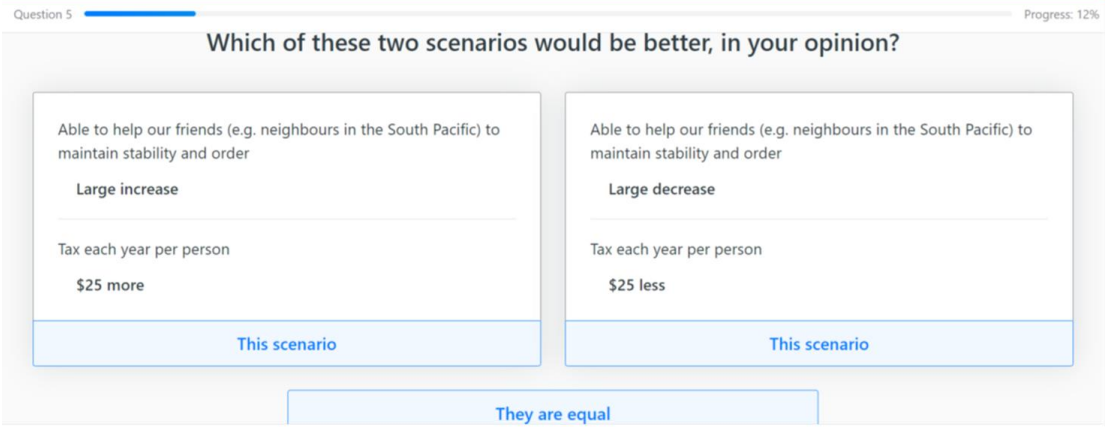
4.2.4 Respondents' choices using 1000minds

The survey was implemented using online 1000minds software,[3] which implements the PAPRIKA method.[4] Respondents are presented with a series of discrete choices and asked to express a preference. Screenshots showing examples of the survey questions are shown in Figures 2 and 3.

[3] https://www.1000minds.com/

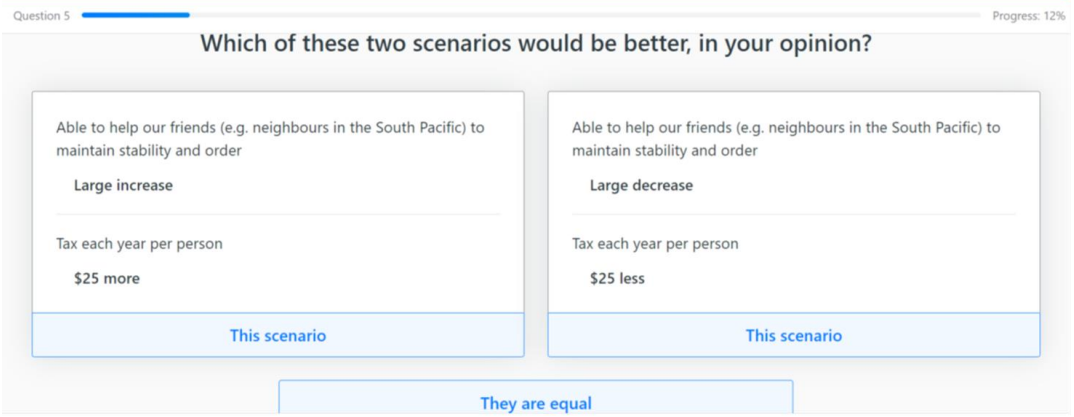
[4] PAPRIKA is an acronym for Potentially All Pairwise RanKings of all possible Alternatives. PAPRIKA was developed by 1000minds to make decisions as cognitively easy as possible while remaining scientifically robust. For more information visit: https://www.1000minds.com/paprika

Figure 2 Trade-off between two NCF capability attributes



Source: 1000minds

Figure 3 The trade-off between an NCF delivery attribute and tax payment



Source: 1000minds

Each choice requires the respondent to confront a trade-off between the two attributes contained in the question (assuming the other NCF attributes are the same). Comparing only two NCF attributes at a time keeps this exercise as simple as possible. The wording of the attributes and levels was intended to be as accessible and understandable as possible.

Central to the efficiency of the PAPRIKA method is the use of the logical property of transitivity.[5] Each time a respondent answers a question (i.e. ranks a pair of options using New Zealand's NCF – see Figure 2 and 3 above), all other options that can be pairwise ranked are identified and eliminated. Then a new question is chosen for the participants. In other words, the software adapts as the person answers their questions, such that this type of DCE is known as adaptive DCE. This procedure ensures that the number of trade-off questions the respondent is asked is minimised – here 29, on average – but all possible options are pairwise ranked, either explicitly or implicitly (by transitivity). Consistency tests were applied to selected questions as a quality check. Finally, from the respondent's explicit

[5] Transitivity is easily illustrated as follows. For example, if option X is ranked ahead of option Y and also Y is ranked ahead of option Z, then, by transitivity, X must be ranked ahead of Z – and so the PAPRIKA method eliminates this third pair of options and any other pairs implied by transitivity, thereby saving the respondent from being asked any such (redundant) questions pertaining to these implied rankings.

pairwise rankings, the software uses linear programming techniques to derive weights (known as 'part-worth utilities' in the DCE literature) for each attribute, representing their relative importance to the respondent. As well as weights for each individual, the weights are averaged across all respondents.

A major strength of the PAPRIKA method is that a set of weights is generated for each individual respondent, in contrast to most other DCE methods, which produce aggregated data only. This individual-level data permits a cluster analysis (Späth 1980) to be performed, enabling any 'clusters' of respondents with similar patterns of weights to be identified. It also means that it is possible to infer intermediate points between, say, "marginally increased" and "significantly increased" using interpolation techniques.

A representative sample enables valid and reliable results

The stratified sample shown in Table 7 was representative of New Zealand's population mix by age, region and gender. Plausible consistent rankings of the attributes emerged within and between the surveys and based on consistency testing, we are satisfied with the validity and reliability of the results.

Table 7 Survey respondents by gender and age group

	2018 Census	Survey C	Survey D
Total		1032	1002
Gender			
Males	49%	57%	56%
Females	51%	43%	44%
Age groups			
15-34	35%	28%	25%
35-44	15%	26%	21%
45-54	17%	21%	18%
55-64	15%	11%	14%
65+	19%	13%	21%

Source: 1000minds

Reliability

For each survey, we wanted at least 1000 valid responses. To get that many, 732 responses were excluded from the delivered outputs survey and 852 responses for the capability survey. Ninety percent (delivered outputs) and 86% (capability) of those excluded responses failed consistency testing. This involves two questions being repeated at the end of the DCE to test the consistency of each respondent's answers as a check of their 'quality'. The more consistent that respondents' trade-offs are to the choice pairs, the more confidence we can have in the reliability (repeatability) of their decisions and hence of the survey. We also tracked the median time taken for respondents to make a decision resulting in most of the rest of the exclusions from the survey sample.

As a result, all remaining survey respondents answered consistently (i.e. answered the two repeated questions identically to their first answers). This implies the respondents in both

groups understood what they were doing as they could repeat their choices consistently. Additionally, the median time for each question for respondents in both groups does not suggest that any respondent did the survey maliciously or in an excessive hurry.

Validity

We looked at the criterion rankings of the six attributes for both surveys as they covered the functions of the NCF using different survey questions. The results are discussed in the next section, which, with one exception, shows highly consistent rankings of the respective attributes between the two surveys. Based on this analysis, we can be confident about the external validity of the survey.

4.3 Survey analysis

We used the following steps and statistical techniques to categorise the diversity of peoples' preferences:

- we calculate the mean preference weights
- we can then calculate the diversity of preference weights using non-parametric regressions
- we can compare mean weights for different socioeconomic groups
- we can then find clusters of similarly-minded people
- we can use Fractional Multinomial Logistic Regression analysis to estimate if preferences are systematically related to different socio-demographic responses.

The two surveys bring out complementary overlapping perspectives and provide evidence to answer three questions: 1) what attributes of the NCF do Kiwis most value? 2) which Kiwis value the NCF? and 3) how much do Kiwis value the NCF?

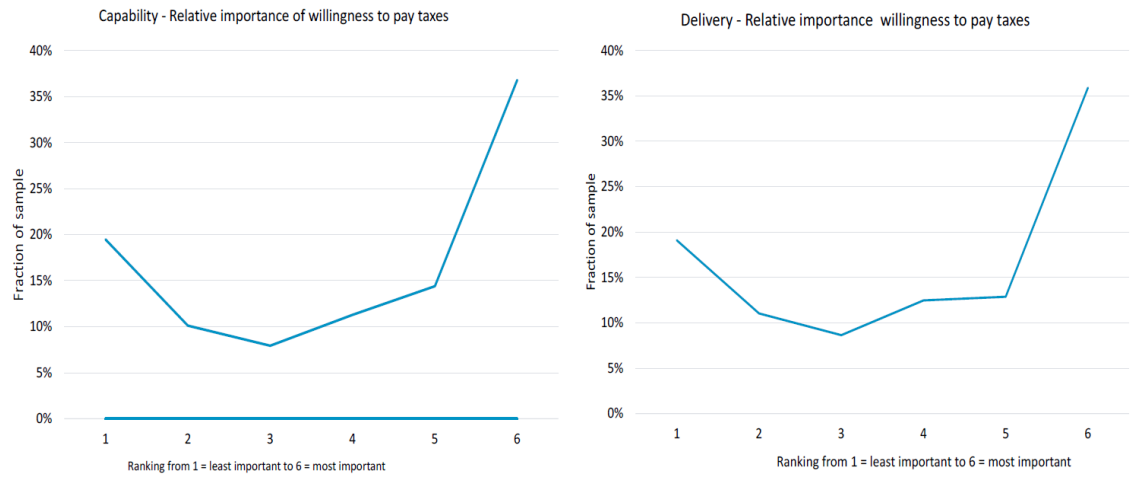
4.4 What attributes of the NCF do New Zealanders most value?

In the following graphs, we look at the variation in the preference for each attribute for ordinary New Zealanders by showing the relative importance of the attribute (where 1 is the least important and 6 is the most important) and the number of respondents with that ranking. The preferences of each respondent are converted into a rank number, with a rank of 1 indicating the least important attribute and a rank of 6 indicating the most important attribute. Each point on the graph indicates the fraction of respondents giving a particular rank to each attribute.

Consider, for example, Figure 4, the level of taxes people are prepared to pay to fund the NCF in both the capability and delivery surveys. (Note that the highest level of the attribute means people pay less taxes.) The graphs are 'U-shaped', meaning that 35% of respondents think it is very important to consider the cost of delivering naval services, while 20% of respondents think that cost is an unimportant attribute.

The tax attribute was highly important overall as it was ranked 1st in capability and 2nd in the delivered outputs survey. Though highly ranked overall, people were sharply divided on willingness to pay higher taxes for the NCF. Figure 5 shows there are 'hawks' for whom tax was relatively unimportant, 'stoic Kiwis' for whom tax was a middling priority and 'doves' for whom tax was the most important attribute.

Figure 4 New Zealanders divided on willingness to pay taxes for the NCF



Source: 1000minds

Young people and females are overrepresented in the group of respondents in the capability survey for whom paying less tax for the NCF is the most important of the six attributes. A further 15% say it is the second most important issue. Conversely, 20% of respondents say that paying less tax for the NCG is the least important attribute, suggesting they are prepared to raise taxes to fund the NCF, providing this enhanced ability to achieve its tasks and functions. The split on this issue suggests that New Zealanders' views are quite sharply divided on the need to fund the NCF. However, the existence of a group of 'stoic Kiwis' in the middle as well as 'hawks' suggests there is a significant WTP for the NCF.

While the two surveys' questions have used different attributes, the two surveys' results had very consistent patterns:

1) Defending New Zealand is the most important attribute of the NCF in both surveys
2) "Keeping our options open so the country can use our Navy 20 to 30 years into the future" also ranked highly in the capability survey
3) Supporting friends and allies is middle ranking for the NCF in both surveys
4) The NCF's role in global security is the least important attribute in both surveys.

Table 8 Comparing the rankings of non-tax attributes in the two surveys

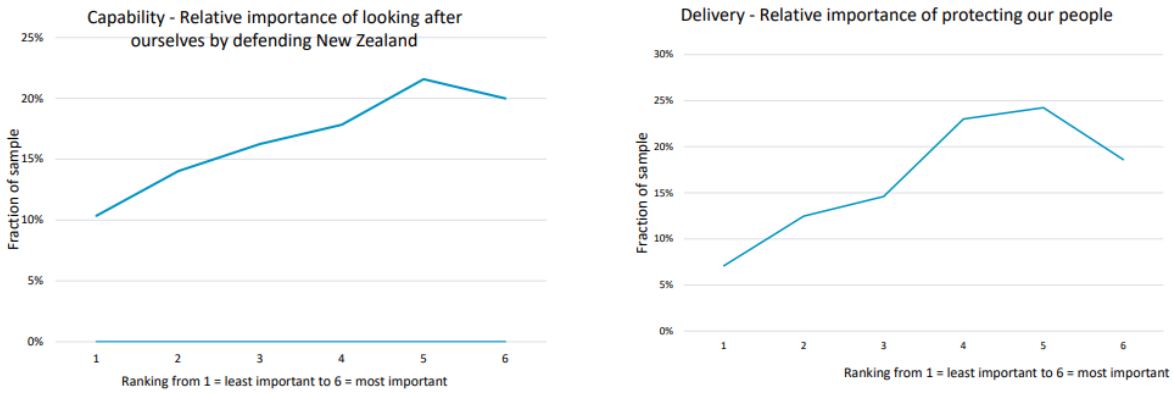
Delivery Survey Attributes	Capability Survey Attributes
Protecting our people = 1	Defending New Zealand = 1
Protecting our resource= 2	Keeping options open = 2
Promoting free movement of trade = 3	Supporting our friends in the South Pacific = 3
Supporting our regional partners = 4	Supporting Australian allies = 4
Supporting global security = 5	Supporting a safer world = 5

Source: NZIER

It is important to contrast the views of defence experts discussed in section 3 with those of ordinary New Zealanders shown in Table 8. The ' defence of New Zealand' was ranked highest by New Zealanders but for Defence experts, the equivalent attribute (national protection) was only a middling priority. Similarly, defence experts placed the highest weighting on 'international presence and signaling' (29%) and 'support to international order' (24%); the equivalence attributes were those that the public ranked lowest.

In the following graphs, we look at the variation in the preference for each attribute for ordinary New Zealanders by showing the proportion of respondents and the relative importance of the attribute (where 1 is the least important and 6 is the most important). Looking at Figure 5, the attributes relating to the defence of New Zealand were not only ranked highest amongst the functional attributes but also generally positive sloping. This positive slope indicates that this attribute is very important to a large number of people and unimportant to a few people. Some 45% of the respondents said "looking after ourselves" was the most important or the second most important attribute.

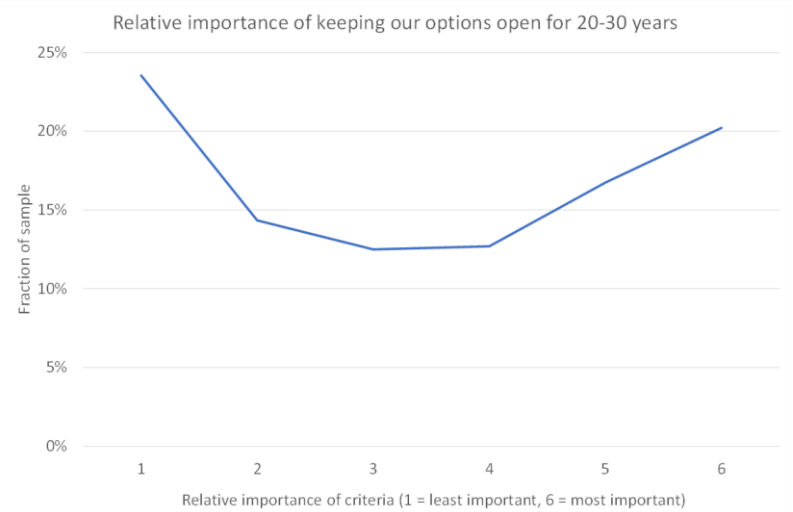
Figure 5 Priority is for defending New Zealand



Source: 1000minds

Figure 6 shows that New Zealanders were also sharply divided over the options value attribute – "Giving future governments the option to use our Navy for another 20 to 30 years.'' While highly ranked overall, this was the lowest priority for 23.5% of people and the highest for 20.2%, with a lower ranking (12–16%) for the rest of the respondents.

Figure 6 New Zealanders are sharply divided on keeping NCF capability options open



Source: 1000minds

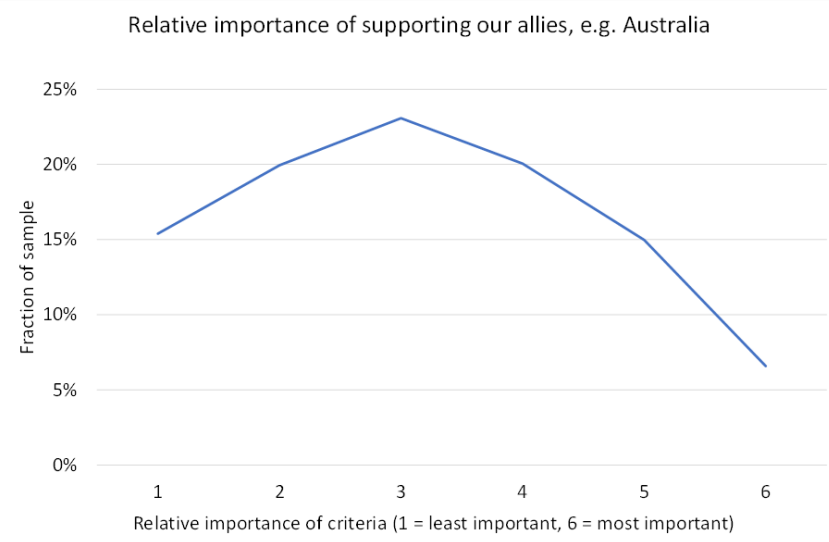
Two of the functions, 'supporting friends' and 'regional partners' shown in Figure 7, had inverted U shapes, indicating they were moderately important to a large number of respondents but neither highly important nor highly unimportant to many people. For example, in the capability survey, 'support for friends' was the lowest priority for 12.5% and highest for only 8% but middling (15% to 22%) for the rest of the people

Figure 7 Middling support for using the NCF to help our friends in the South Pacific

Source: 1000minds

Similarly, Figure 8 'support for our allies' was highest ranked for 6%, lowest for 15% and in the range 19% to 23% in the middle.

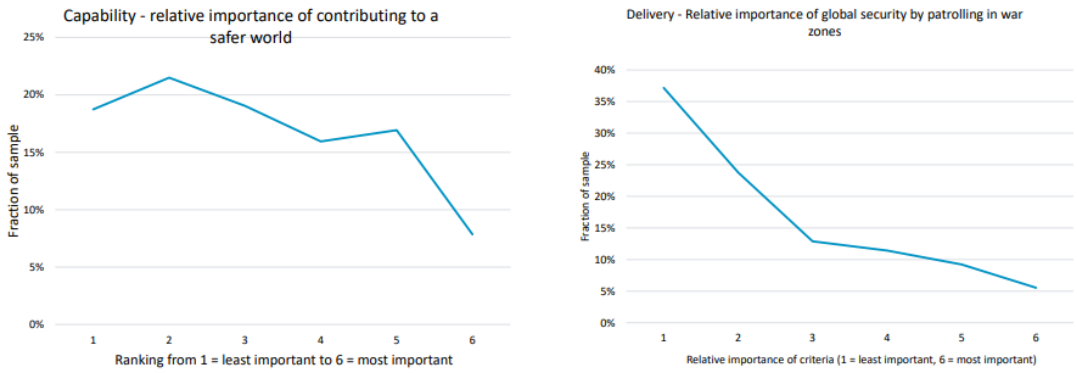
Figure 8 Even less support in the capability survey for our Australian allies



Source: 1000minds

The least important attribute criteria, 'contributing to a safer world', was downward sloping in Figure 9, indicating that it was important to few people and unimportant to many. It was the lowest priority for 19% of capability survey respondents and ranked highest by only 8%.

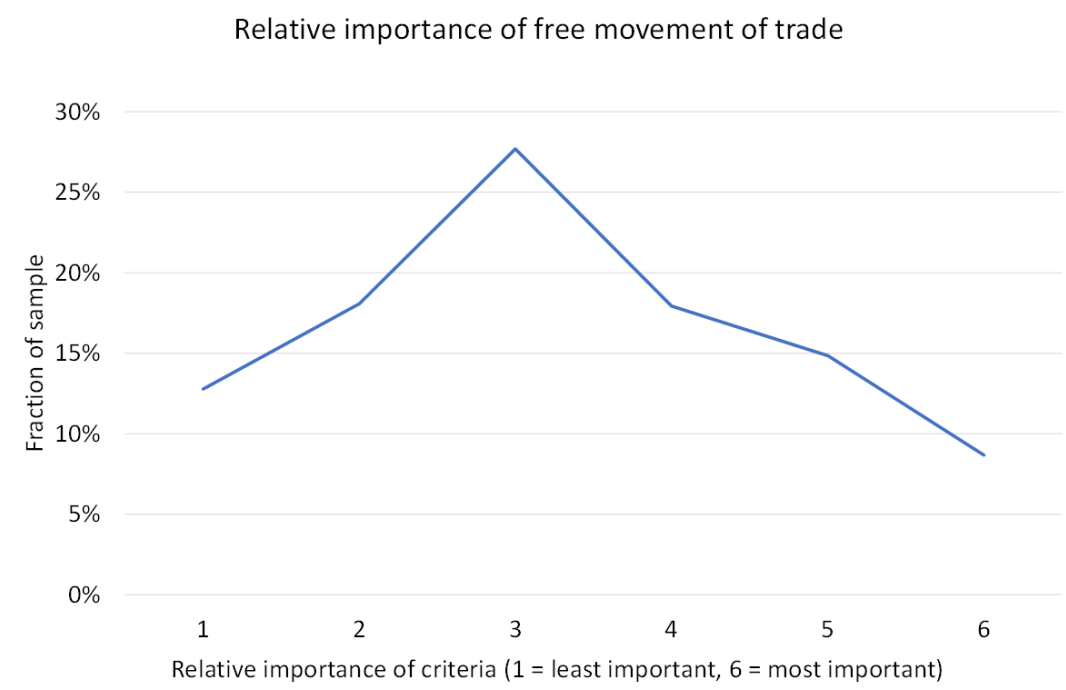
Figure 9 Least support for NCF in global security



Source: 1000minds

The one attribute which is hard to explain from the ranking shown in Table 8 and appears an outlier is the response to the question in the delivery survey "Promoting the free movement of trade including carrying out anti-piracy operations" (Figure 10). Although few ranked this as a high priority (7%), this attracted more support as a medium-ranked attribute (19.9%, 23.1%, 20.1%) than the corresponding question in the capability survey. For 'contributing to a safer world', e.g. anti-piracy operations, the corresponding % shares for middle-ranked priorities are 15.4%, 15.0% and 6.6%).

Figure 10 But support in the delivery survey for promoting free movement of goods, e.g. anti-piracy operations



Source: 1000minds

4.5 Which New Zealanders value the NCF?

What the above graphs bring out is the significant variation in how different people value NCF capability and delivered attributes. For example, the WTP tax and options value were the most important attribute for some and least important for others. We have undertaken Fractional Multinomial Logistic Regression analysis of both surveys to determine what variables explain the differences in people's views on the NCF attributes.[6]

4.5.1 Significant variability in New Zealanders' preferences: little is explained by objective variables

The main finding from the regression analysis is that most of the variation in people's preferences, as discussed above, is independent of their basic objective socio-demographic characteristics – age, gender and regional location. Although some variation is presented by the demographic variables used in the survey, we may have an omitted variables problem – including more variables may help explain some variation. For example, including ethnicity would allow questions such as: Do the Pasifika rank "support for our friends in the South Pacific" higher than other people in the sample? Another variable we could include is income groups to better understand if tax is more (or less) important than other attributes across a wide range of income groups in New Zealand.

[6] Fractional multinomial logistic regression is applied for decision-making data analysis of data that are in fraction form and all the alternatives add up to 1. The data produced by the 1000minds algorithm is in the form of preference weights between all alternative choices that add up to 1. To assess the significant of differences between socio-demographic groups, a Fractional Multinomial Logistic Regression (FMLR) is applied. The FMLR model applied uses the quasi-maximum likelihood estimator which is standard for multinomial models (Papke and Wooldridge 1996).

Some statistically significant differences did emerge in each survey, e.g. some socio-demographic variables (e.g. gender, region, age) had a significant effect for some but not all of the attributes. There were no consistent effects across both surveys, as different groups have statistically significant effects. For example, those aged 75–84 statistically differ from those aged 18–24 for some attributes in the capability survey, but for the delivery survey, this only applies to those aged 35–44. So, while there is significant variation in people's preferences, most of this variation is independent of their basic socio-demographic characteristics.

4.5.2 Three distinct clusters: hawks, stoic Kiwis and doves

Survey data suggest that New Zealanders generally have mixed views on the value of defence spending. For example, Grimwood's (2017) analysis of the 2016 Social Attitudes Survey reports that 20% of people supported increased spending on defence, 54% supported the status quo, and 26% wanted less military spending.

Based on public opinion surveys, we hypothesised that there would be three reasonably distinct groups: hawks (strongly pro-spending on the NCF), doves (anti-spending) and stoic Kiwis who favour the status quo. Cluster analysis confirmed the hypotheses. Both surveys had three distinct groupings: hawks, stoic Kiwis and doves. No cluster had strong discernible socio-demographic characteristics that are statistically significant. For example, although older people are more willing to fund the NCF, they are not the dominant members of cluster 1 (Hawks), and the age effect was not statistically significant.

Table 9 Three distinct clusters in the capability survey

Capability	Cluster 1 - Hawks	Cluster 2 - Stoic Kiwis	Cluster 3 - Doves
Number of people	178	464	390
Tightness (average distance)	6	12	10
Taxes	0.112	0.143	0.334
Look after ourselves	0.322	0.160	0.158
Support friends	0.154	0.177	0.133
Contribute to a safer world	0.099	0.185	0.128
Support allies	0.180	0.154	0.135
Future governments	0.132	0.180	0.113

Source: 1000minds

Note highlighting shows the most important attribute as well as tax.

The scores in Tables 9 and 10 reflect the weighting of the level for each attribute (where the lowest level is 0). The intuition behind the table can be deduced by comparing Cluster 1 and 3. For Cluster 3 (doves), the most important attitude WTP taxes, while none of the other attributes are highly valued. By contrast, for Cluster 1 (hawks), WTP taxes for the NCF is relatively unimportant, but defending New Zealand (look after ourselves) is very important.

Table 10 Three clusters also in the delivery survey

Delivery	Cluster 1 - Hawks	Cluster 2 - Stoic Kiwis	Cluster 3 - Doves
Number of people	71	509	422
Tightness (average distance)	0.6	16.6	11.8
Taxes	0.028	0.133	0.316
Fishing	0.252	0.221	0.148
Disaster response	0.136	0.214	0.165
Regional partners	0.475	0.151	0.122
Safety	0.068	0.166	0.133
Active operational tours	0.040	0.188	0.114

Source: 1000minds

4.5.3 Different clusters support different attributes

The table shows the different weights on the various attributes in the two surveys:

- Cluster 1 – hawks – the smallest and tightest cluster, the most willing to fund the NCF and to support attributes directly related to defending New Zealand.
- Cluster 2 – stoic Kiwis – the largest group with a moderate WTP and very diverse in the NCF capabilities and delivered activities they support.
- Cluster 3 – doves – the lowest WTP and low average weights on all NCF capabilities and activities.

4.6 How much do New Zealanders value the NCF?

WTP is assessed by comparing a WTP tax attribute with each NCF attribute. The strength of the approach is that it is based on choices between attributes (1000minds 2022). The main weakness is that these are hypothetical, not real, choices, as it is a stated preference, not a revealed preference technique. There is a risk of status quo bias as a WTP for more and a willingness to accept (WTA) less are not symmetrical. Derived valuations using these techniques risk overestimating willingness to pay.

Assessed WTP is calculated by comparing the weights from the WTP tax attribute with the weights for the other NCF attributes. We looked at the relative weights placed on all levels of all the attributes in Tables 5 and 6. The relative weights on the levels of the 'additional tax each year' per person for the frigates attribute to determine the monetary values assigned to the levels of the other remaining attributes. This WTA estimate is interpretable as the amount that someone would need to be paid as compensation to forgo the function (represented by the attribute) concerned. In other words, it represents the value that the person puts on the current NCF capability represented by the attribute (that they would lose if it were removed).

To determine the current value of the NCF, we deduct the 'no change' level (i.e. status quo) of the other attributes to calculate the WTA forgoing each function.[7] The 1000minds output gives the weights for each level of each attribute for each respondent, and the sample mean and median weights for each attribute. We determined a range of values of the WTA forgoing each NCF attribute using the weights determined by all respondents.

By discovering the trade-offs, New Zealanders are willing to make across various levels of the five NCF attributes, as a secondary objective, we could also measure their willingness to pay for enhanced NCF capability – i.e. the opposite of WTA as compensation for forgoing the capability.

The primary objective of determining the current value of the NCF is achieved by summing the monetary values assigned to the willingness to accept forgoing each function in Tables 5 and 6 above. It is possible to infer intermediate points between, say, marginally increased' and 'significantly increased' using interpolation techniques. The secondary objective of determining the value of enhanced NCF capability could be achieved by summing the monetary values assigned to either the 'marginally increased' or 'significantly increased' levels of the attributes above.

The strength of this approach is that it is based on people's choices between the attributes, as revealed by the DCE surveys. This characteristic is also the approach's main weakness as these are hypothetical, not actual, choices, i.e. derived from a stated preference rather than a revealed preference technique. There is also a risk of status quo bias as a WTP for more and a WTA for less are not symmetrical. Derived valuations using these techniques risk overestimating WTP.[8] Hence caution is required in interpreting estimates as they are upper-bound valuations.

4.6.1 New Zealanders' stated preferences show a significant willingness to pay for the NCF

To calculate stated preferences of WTP for the NCF capability, we looked at the average per person WTA forgoing each of the four NCF capabilities, added these up and scaled that up by the adult tax-paying population. The resulting valuation of the amount people are WTA to forgo the NCF capability was *$570m p.a.*

We followed a similar procedure for the delivery survey using the five delivered functions. Unsurprising, the willingness to pay for outputs was significantly lower than for capability *$221m p.a.* However, this amount is a significant premium above the direct operating costs (in NZ$ 2019) of the two ANZAC frigates (excluding depreciation and capital charge) of $37m in 2017 and $32m in 2018.

Where possible, we took a conservative approach to derive the values. For example, we have used an assumed 30-year life for generating a present value. The expected life of the ANZAC frigates will be closer to 40 years, partly as a result of investment in deep refits for

[7] For the delivered outputs survey we used all five attributes for the functions delivered. For the capability survey we only used 4 of the five attributes. The fifth – options value – proved more intractable to value. The options value attribute is fundamentally different to the other attributes. It is binary ("no" and "yes") whereas the other attributes are incremental (no change, small or large increase, small or large decrease). So it is not possible to simply include an options value in the valuation calculations. Moreover, to do so risks being misleading as its effect is already captured by the other attributes.

[8] Because there are no comparable studies it is not possible to assess the significance of the risk of overestimation. The one related empirical study (Frey, Luechinger, and Stutzer 2004) found very high willingness to pay to avoid the risk of terrorism.

frigate life extension. Using a 40-year expected life would increase the estimated values from the DCE approach in this research report between 10% and 15%.

In addition, we have used the adult population (4.0 million) to scale the individual estimates rather than the total population (5.1 million): using the latter would increase the total valuations by over 27%. We chose the lower value on a strict interpretation of the survey, which was that people with dependents, willingness to pay taxes included payments on their dependent's behalf.

4.6.2 The whole-of-life value depends on the discount rate

The present value over the whole-of-life of the platform (assumed to be 30 years) depends crucially upon the discount rate selected. Discounting the annual WTP for NCF capability ($570m) at the current Treasury recommended discount rate (5%) yields a present value of **$8.7B**. Using the lower social time preference rate, say 3%, yields **$11B**. The mid-point between the two (4%) yields **$9.8B**.

Looking at willingness to pay $221m p.a. for delivered outputs yields a mid-point of **$3.9B** with a range of **$3.4B** *(*at 5%) to **$4.3B** (at 3.0%) over 30 years.

4.6.3 With offsetting possible sources of bias

There are two offsetting sources of bias.

First – in principle, the two survey results are independent, and the framework developed for this project suggests we could add together the valuations arising from the capability ($9.8B) and delivery ($3.9B) surveys. In practice, however, the two surveys overlap in terms of their content, and it is implausible that survey respondents distinguish between capabilities and direct use of delivered outputs. Box 2 below sets out using set theory why with a high degree of overlap, we concluded that the joint score (or, in this case, valuation) is close to the higher of the two scores.

Second, there is a risk of overestimating the total value of the NCF by simply adding up the WTP for all the attributes. WTP estimates are intended to capture the value of (marginal) changes to the levels of one attribute at a time while all the other attributes are constant. Simply summing WTPs across the attributes ignores that cumulative changes to the NCF are likely to yield diminishing returns. The whole may be less than the sum of the parts, as what people are willing to pay for all attributes together may be less than the increased WTP from each improvement in one attribute. For example, dropping the lowest-ranked capability attribute values altogether would drop the estimated capability value by 23%. In addition, of course, as discussed earlier, DCE surveys are based on hypothetical, not real, choices, and therefore valuations need to be interpreted with caution, and the derived valuations need to be interpreted as an upper limit.

Box 2: Diminishing returns – the adding up problem

Simply summing WTPs across the attributes ignores the fact that cumulative changes to the NCF are likely to yield diminishing returns. If there is good reason why two attributes are not orthogonal (i.e. at right angles) then in a sense they 'overlap' to a degree. This suggests using set theory as they share common elements. So, if the attributes are seen as two sets A and B with elements {A} and {B}:

$\{A \cup B\} = \{A\} + \{B\} - \{A \cap B\}$

In other words, the elements in the sum are the total of the 2 separate sets of elements less those which are common where there is an overlap (or double up). The elements can be thought of as the scores produced by the system.

So, what can say when we believe there is some overlap, but we do not know how much? One way to think about this is to look at the extremes: if the two scores are s1 and s2.

No overlap would have the two attributes together being worth:

No overlap Sum = s1 + s2

But if there is a high degree of overlap, we might consider the joint score to be close to the higher of the two scores:

High overlap Sum = s1 (if s1 > s2.)

For lower degrees of overlap

Intermediate overlap Sum = s1+ s2/ k where k > 1 (with an example being k = 1.5.)

In this formulation k is a parameter that reflects the estimated amount of overlap. The higher the overlap the higher is k.

5 Summary: Putting it all together – What economic valuations have emerged?

The preceding sections of this report have described three different perspectives on deriving an economic value for the NCF. The different perspectives are complementary but not additive – Cabinet Ministers' revealed preferences overlap with citizens' stated preferences – so the resulting estimates can't be added together. The perspectives of Cabinet Ministers, experts and ordinary citizens are quite different in their approaches, and they draw slightly different conclusions, in dollar terms, regarding the overall value of the NCF. Strikingly, however, they are all within the same order of magnitude.

In summary, the perspectives:

- Canvassed our understanding of a national historical and political WTP as expressed by funding towards frigate purchases and upgrades over the years.
- Gave us an understanding of the value of the frigates in deterring attacks on maritime trade in a variety of circumstances leading to another value for the NCF derived from that deterrence value.
- Showed us the current WTP as expressed through two DCE surveys of representative public opinion using conventional selection techniques to ensure the validity of the results.

Because of the different perspectives, it is not surprising that there are different understandings of overall value. Indeed we found during the pilot survey that ordinary people and experts had quite different preferences.[9] We expected different stakeholders' valuations would differ. As well there are problems with relying on any one perspective:

- Historical WTP is just that: historical. As circumstances change, whether related to international security, the state of the national finances or changing political ideologies, there is no certainty that history will be replicated.
- Similarly, the value according to scenario analysis relies on assumptions about trade, threat and participation. If the assumptions alter, the answers could be quite different. For example, the scenario analysis would be immediately invalidated if New Zealand chose to free-ride on this issue. No doubt, if that were to occur, different scenarios could be devised to measure a different form of value.
- When we examined the WTP using DCE, we realised it is based on a hypothetical WTP tax and, because of the anchoring effect, could see different answers in response to different prompts.

Although the three perspectives each have problems, when we bring them together, we see a value range within which we are confident a plausible value will lie.

The values derived from these methods may be expressed as an annual flow of value or a stock valuation over the assumed life of the frigate platform, which we have taken to be 30 years. We have determined annual and assumed lifetime values for the NCF where we can. In the calculations, we note that the 30-year present value is sensitive to the discount rate

[9] See Figures 5 and 6 and associated commentary on p16–17 NZIER (2019).

chosen. The discount rate could be set at the Treasury's social opportunity cost (currently 5%) or the social rate of time preference (3-4%). Where appropriate, we note both rates.

5.1 Cabinet Ministers' willingness to pay

We conclude that the mid-point lifetime value is **$5.1B**.

When we utilise different discount rates, the lifetime values may be expressed as **$4B** at 3% or **$6.1B** at 5%.

To this can be added recent decisions such as the Frigate Systems Upgrade, which is just being completed and the proposed frigate's five-year life extension (2027), which reveal a WTP of around $90m p.a. to retain the NCF capability. The present value of $90m ($0.7B using a 4% discount rate) for 10 years of fleet life extension costs can be added to the historic cost of $5.1B for 20 years to yield a whole-of-life value of **$6.8B** on a revealed preference basis.

5.2 Scenarios analysis using experts' judgement

The lifetime value is derived from an annual value of $176m p.a. increasing to $237m with 1.0% p.a. trade growth over three decades, or $380m (with a 2.6% increase in trade growth), or $760m (5.0% growth).

Using the discount rates shown above, based on 2.6% growth in maritime trade p.a., the mid-point estimate for the lifetime value of the NCF is **$3.7B**.

The ranges for the present value are (at 4% over a 30-year life span) **$3.0B** (with no growth) and **$4.5B** (at 5.0%).

5.3 New Zealanders' stated preferences of willingness to pay

There are two components for WTP. For the willingness to accept the removal of the capabilities (C) provided by the NCF ($570m p.a.), the mid-point is **$9.8B** for the whole-of-life valuation.

- The ranges for the present value are **$8.7B** *(*at the Treasury's 5% discount over a 30-year life span) and **$11.0B** (at a social rate of time preference of 3%).

The stated preference WTP for delivered outputs (D) (that is, for using the warships) is $221m p.a., for which the mid-point lifetime valuation is **$3.9B**.

- The ranges for the present value are **$3.4B** (at a 5% discount rate) to **$4.3B** (at a 3%).

In principle, the two DCE survey results are additive (C + D). In practice, however, the contents of the attributes in the two surveys overlap, and it is implausible that survey respondents distinguished between capabilities and direct use of delivered output. Given the high degree of overlap, we concluded that the joint valuation would be close to the higher of the two values.

5.4 Remarkably consistent valuations

Lu and Rohr (2020, 21) observed, *"Value is subjective, and any value proposition must therefore be inherently customer- or user-centric*." Although we had no expectations about how the three perspectives would relate to each other, we can see in Table 11 that they do

lead to reasonably consistent valuations, despite different stakeholders valuing various attributes quite differently. This consistency could be an artefact of some objective reality, or it could be coincidental. We do not know.

The numbers themselves, while mid-points represent a lower bound (as for political WTP), while others (New Zealanders' WTP, for example) are an upper bound. Moreover, while expressed in dollar values, the three approaches measure slightly different things – the scenario analyses focused on dollar values of maritime trade in imports and exports, revealed preferences are about expenditure on real resources, and the DCE stated preference survey measures WTP hypothetical taxes. We discuss this further in Appendix E when we explore the link from this research to The Treasury's Living Standards Framework.

Table 11 Valuations from the different perspectives and approaches

Perspective	Annual value	Present value (and range)
Cabinet Ministers	NA	**$5.8B** ($4.9 to $6.7B)
Scenarios using experts	$176m p.a.	**$3.7B** ($3B to $4.5B)
Public's WTP Delivery	$221m p.a.	**$3.9B** ($3.4B to $4.3B)
Public's WTP Capability	$570m p.a.	**$9.8B** ($8.7B to $11B)

Source: NZIER

There is, therefore, no objectively right answer for the valuations shown in Table 11. While the results from three perspectives using three different approaches yield reasonably consistent valuations, it would be misleading to simply rank them in lifetime values:

- New Zealanders' willingness to pay for capability: **$9.8B**
- Political willingness to pay: **$5.8B**
- New Zealanders' willingness to pay for delivery: **$3.9B**
- Experts' scenario analysis: **$3.7B**

Taken together, these values suggest that different stakeholders all place a significant economic value on the NCF in the range of **$3.5B** to **$10B** over 30 years.

6 Conclusions and next steps

Attempting to place an economic value on defence forces has been discussed in the literature but never attempted before. Although we were initially sceptical, we have grown increasingly confident about applying this task to the NCF as we proceeded from a scoping phase to a pilot and then a proof of concept.

This is leading edge, if not bleeding edge work. Nothing of this kind has been attempted anywhere else in the world, although the UK has undertaken a very comprehensive scoping study. When interpreting the research findings, it is important to remember that these results can't be benchmarked or compared.

6.1 Caveats and cautions

Like any leading-edge experimental research, this is subject to caveats and cautions:

- while robust ballpark estimates have emerged, they are not precise valuations but should be viewed as approximations
- for the DCE willingness-to-pay surveys, the valuations are very sensitive to the population scalar
- for the scenarios approach, key assumptions are the base year, the weights and assumed growth in maritime trade
- there are other technical caveats to be borne in mind with each approach
- for the DCE stated preference surveys, more confidence can be placed in the relative values placed on different NCF functions than the absolute values derived
- with all approaches, the present value is very sensitive to the discount rate adopted.

6.2 Confidence in the research approaches

Different degrees of confidence can be attached to the alternative approaches. Though the revealed preference of willingness to pay is the most reliable approach, as it is based on actual decisions, it has the lowest validity because it implicitly equates value equal to cost. Scenario analysis is the least reliable because of reliance on assumptions (base year, scenario and deterrence weights). The DCE surveys approach has the highest validity as it derives valuations from diverse preference functions but has only middling reliability because of anchoring effects and the reliance on hypothetical choices.

Nonetheless, the results from applying these techniques in combination are promising and likely to apply to other capabilities, such as maritime surveillance. The DCE stated preference surveys of New Zealanders' attitudes also yield a wealth of information about the NCF functions that citizens value most and least highly.

This research was technically very challenging and has significantly benefited from the peer review by Dr John Yeabsley of NZIER and the external reviewers: Rear Admiral (retired) John Martin, Professor Paul Hansen from Otago University (on the DCE survey) and Professor Keith Hartley of the University of York. Professor Keith Hartley's comment on this draft report was:

"This is an impressive and pioneering contribution to our knowledge in this important field. The authors are to be congratulated on their novel approach to a completely new and important part of defence economics. Scholars have recognised the challenge of defining and measuring defence output; but this is the first attempt at empirical measurement. Extremely well done is my judgement on the Report. "

6.3 Next steps

We would welcome the opportunity to discuss this report with you and to explore how it can contribute to a more informed dialogue about the NCF and the applicability of these techniques more broadly, e.g. how it be applied to other defence capabilities.

We look forward to the opportunity to continue working with you to explore the implications of this exciting project.

7 References cited

1000minds. 2022. “What Is Conjoint Analysis.” 2022. https://www.1000minds.com/conjoint-analysis/what-is-conjoint-analysis.

Catalyze Consulting. 2014. “New Zealand Defence Force Develops a Balanced and Sustainable Defence Plan.” http://www.catalyzeconsulting.com/wp-content/uploads/2014/07/Catalyze-NZDF-DMRR-Case-Study-July-2014-v1.0.pdf.

Creedy, John, and Hemant Passi. 2017. “Public Sector Discount Rates: A Comparison of Alternative Approaches (WP 17/02).” Treasury Working Paper 17/02. Wellington: The Treasury.

Frey, Bruno S., Simon Luechinger, and Alois Stutzer. 2004. “Valuing Public Goods: The Life Satisfaction Approach.” SSRN Scholarly Paper 528182. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.528182.

Gill, Derek, Andrew Coleman and Jelita Noviarini 2022 ‘Valuing of New Zealand Naval Combat Force – Interpreting the 1000minds survey results’ NZIER Background Technical Paper (unpublished)

Grimwood, R. 2017. "The Role of the Government: Analysing Results from the 2016 Social Attitudes Survey" COMPASS Research Centre, The University of Auckland

Huxtable, Luke, Kate Cox, James Black, Keith Hartley, Ronald E. Smith, Matthew Uttley, Benedict Wilkinson, Charlene Rohr, and Hui Lu. 2021. “Understanding the Ministry of Defence’s Wider Contribution to UK Prosperity: Measuring Defence Output.” RAND Corporation. https://www.rand.org/pubs/research_reports/RRA638-1.html.

Johnston, Robert J., Kevin J. Boyle, Wiktor Adamowicz, Jeff Bennett, Roy Brouwer, Trudy Ann Cameron, W. Michael Hanemann, Nick Hanley, Mandy Ryan, and Riccardo Scarpa. 2017. “Contemporary Guidance for Stated Preference Studies.” *Journal of the Association of Environmental and Resource Economists* 4 (2): 319–405.

Lancaster, Kelvin J. 1966. “A New Approach to Consumer Theory.” *Journal of Political Economy* 74 (2): 132–57.

Lu, Hui, Rohr, C. 2020. "Understanding MOD’s Wider Contribution to UK Prosperity: Measuring Defence Output LOE5 Summary Paper Discrete Choice Modelling Experiment" RAND Corporation.

McFadden, Daniel. 1974. “Conditional Logit Analysis of Qualitative Choice Behavior.” In *Frontiers in Econometrics*, 105–42. New York: Academic Press.

Oxford Economics. 2020. “Chart of the Week: Our Forecast for World Trade Growth.” 2020. https://blog.oxfordeconomics.com/chart-of-the-week-our-forecast-for-world-trade-growth.

Papke, L. E., & Wooldridge, J. M. (1996). Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. Journal of applied econometrics, 11(6), 619-632.

Späth, Helmuth. 1980. *Cluster Analysis Algorithms for Data Reduction and Classification of Objects*. Vol. 4. Chichester, UK: Ellis Horqwood.

The Treasury. 2021. “Living Standards Framework.” https://www.treasury.govt.nz/sites/default/files/2021-10/tp-living-standards-framework-2021.pdf.

———. n.d. “Our Living Standards Framework.” Accessed December 13, 2022. https://www.treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework.

Appendix A The phases of the project

Assessing the value proposition of the NCF from an economic perspective is a challenging problem with limited overseas parallels in defence studies to draw on. A value proposition is a general term that identifies the benefits that an organisation delivers to its stakeholders. Economic value is a narrower, more technical term discussed in Appendix B that assesses the sum of all economic benefits obtained from a resource or capability.

To assess the economic value of defence capabilities, we have explored a range of approaches. We have adapted techniques developed in other fields, such as non-market valuation techniques and applied them to defence. The project design includes a variety of techniques so the valuations from one approach can be compared with others.

The original organising value framework for the project is V = C + D, and this is discussed in Appendix B in more detail. To value capability (C), our research design is based on using different perspectives and approaches. We wanted to use at least three techniques to assess the NCF's economic value. These techniques are complementary as the valuation is based on different perspectives.

We adopted a phased approach with specific checkpoints. In brief, using the framework in Figures 1 and 2 above, we developed a project design with multiple phases, all of which have now been completed:

Phase 1: Feasibility study – literature scan and project design.

Phase 2A: Prototyping, which developed a framework for valuing separate NCF components and identified techniques to value the different framework components.

Phase 2B1: Pilot, which piloted the feasibility of techniques for valuing the components in a limited number of situations.

Phase 2B2: Focused on determining the feasibility of triangulating the value of NCF capability.

Phase 3: Full-scale application of the methods developed so far to the NCF with the aim of producing valuations for the NCF from three different perspectives.

A.1 Phase 1: Feasibility study based on a literature scan

In the feasibility phase, Phase 1, we explored the available literature in order to undertake the detailed project design. The literature scan was designed to give an appreciation of the issues relating to defence value as they are understood in the international community. The literature scan also gave insights into methodological issues related to valuing defence capabilities. We did not want to replicate work that had already been done nor fall into traps that might have ensnared previous researchers.

We found that the literature on valuing defence assets is sparse, and practical applications of the possible techniques are rarer still. The traditional approach to valuation in defence economics is to assume that defence output equalled inputs by value – which is not helpful in identifying defence output. However, non-market valuation techniques developed in other domains are applicable to the problem at hand.

We were not surprised by our findings in this area because most applied economic literature (e.g. economics of immigration, tourism) is made up of descriptive material surrounding a small core of theoretical concepts devised by just a few creative people who do not change much over time and who tend to reference each other. We, therefore, looked to other fields grappling with valuation problems. The most productive are techniques initially developed in environmental economics that are increasingly being applied to health and transport economics. More recently, the focus has been on defence capabilities, but again, no values are placed on capabilities.

The findings from the literature scan were covered by our report in April 2018, and the details are included in Appendix C for ease of access. In summary, our previous report concluded:

- *There is a considerable literature on defence economics in general, mainly focused on the choices states make in developing their defence systems and on the cost of the systems. The literature on valuing as opposed to costing defence assets is much sparser…….:*
- *The task of valuing defence has been attempted periodically over the years, but almost solely by focused 'defence economists' as opposed to more general 'policy economists'*
- *Some of the literature asserts the conventional assumption that 'cost equals value' on the grounds that because governments have chosen to spend a certain amount they must value the asset to that extent*
- *That literature then generally goes on to describe the defence system and gives a breakdown of its costs*
- *Some of the literature lays out conceptual approaches to determining the value of defence assets. Almost none of these apply the concepts in the development of empirical estimates or detailed case studies.*

In this phase, we worked with Professor Keith Hartley, an international defence expert from the University of York in the UK, who was subsequently used as an external reviewer for the later phases of the project. He emphasised the most recent theoretical literature on defence capabilities. The capability approach suggests that capabilities can be valued as the expected present value of (contingent) military and civil operations (Markowski, Chand, and Wylie 2017). However, in the absence of an independent measure of the value of outputs, the practical problem of operationalising these concepts remains to be addressed.

A.2 Phase 2A: First pass prototype study of the NCF

Phase 2A was a prototyping stage focused on operationalising the concepts shown in Figures 1 and 2. We undertook a 'first pass' to test the practicality and validity of estimating the value of the NCF using different components in the V = C + D equation.

This phase involved the following:

- developing an understanding of all NCF deployments
- developing a method for capturing the value of D (the direct use of the NCF) based on historical patterns of how the NCF has been tasked, focusing particularly on deployments (national economic sovereignty protection, disaster recovery, participation in combined naval deployments)

- developing a separate method for the approach to value C (non-use) values (e.g. option value of capability, existence value, deterrence effects). We determined that a range of economic concepts would be necessary to develop the approaches. These would include existence value (willingness to pay), deterrence value (costs not incurred), opportunity costs (what we forgo by not having the capability and the cost of substituting for it if necessary) and potentially club value (the value we gain by being able to contribute to collective security endeavours such as naval operations in the Gulf).

A.3 Phase 2B: Pilot study of the NCF

Phase 2B was concerned with exploring the feasibility of different valuation techniques. It was broken into two stages. In Phase 2B1, the main focus was on piloting the feasibility of assessing the value of NCF capability (C) through:

- stated preference, i.e. non-market valuation using survey methods
- revealed preference – the value of the NCF based on historical costs and the actual decisions made
- specific values determined by the potential use in a variety of scenarios, ranging from a benign international environment to general conflict between states.

The secondary focus was on assessing the ease of valuing NCF direct use of delivered outputs (for both military and other uses) through the classification of historical patterns of use and willingness to pay for the NCF. The findings from this line of inquiry are in Appendix D below.

In Phase 2B2, the main focus was on determining the feasibility of valuing NCF capability. This included:

- refining the stated preference survey and conducting a 'throw away' pilot with a small group of security experts and citizens
- drafting a full set of scenarios and testing this in a pilot workshop
- refining the historical cost data so we can triangulate the values from the different approaches.

In addition, we developed and piloted an interview with non-military government users.

These different valuation techniques are complementary as they address the valuation from different perspectives. Looking at capability (C), stated preference assesses the value placed by the general public as well as security experts, and the scenarios draw on expert opinion on deterrence value (a subset of C). Historic cost analysis will generate a single value of the revealed preference of the willingness to pay by political decision makers for C and D combined, but predominantly for C. Historic cost is expected to provide a lower bound on the total value of the NCF as it measures WTP rather than value generated.

The stated preference survey was expected to generate a range of values that New Zealanders are prepared to pay for the NCF and compare with the value that security experts provide. This means we can generate a range of valuations based on the average willingness to pay as well as upper and lower bounds (based on 20% and 80% of New Zealanders). The scenarios are designed to yield a cross-check on the other two valuations.

Similarly, delivered outputs (D) for non-military uses, in particular, can be valued using a mix of techniques, including a direct measure of value, direct costs or the cost of an alternative. Where no independent measure of value is available, then WTP based on variable cost can be used. Applied together, the set of techniques reduces the risk of reliance on one approach and ensures that the resulting valuation is not the artefact of a particular measurement technique.

This phase used the concepts in the framework to illustrate our findings from the first three phases. It discussed three different approaches focused on estimating C, including the reliability and validity of stated preference based on a survey, exploring revealed preference (based on historical cost) and projected value (based on scenarios).

To estimate D, we explored the historical patterns of use, and this is consistent with the view that to understand where we are going, we need to understand where we have been. The analysis of historical patterns of willingness to use and to pay looked at the historical pattern of deployments and decision-making on defence acquisitions.

A.4 Phase 2B2 – Pilot

The project design drew on the techniques initially developed in environmental economics and applied these to naval capabilities. To value defence force *capabilities*, we developed an approach drawing upon three perspectives:

- Cabinet Ministers' willingness to pay based on historical cost
- Experts' judgement using scenario analysis to develop a deterrence value
- Citizens' stated preferences using survey techniques.

Over the prototyping, piloting and proof of concept phases, we refined and developed the application of these approaches to the Defence Forces, focusing initially on the NCF.

Willingness to pay based on historical cost

The easiest approach was using historical cost data to express the whole-of-life cost of the current ANZAC frigates. This sets a lower bound on the value of the naval combat force. The historic costs approach provides an estimate of the willingness to pay by political decision-makers for direct use of delivered outputs (D) and capability (C) combined, but it is not possible to precisely attribute the total value to each component. The key weakness of this approach is that it is based on decisions at a point in historical time, and the strategic context has altered significantly in the 30 years since the initial acquisition decisions were taken.

Scenario analysis to develop a deterrence value based on expert judgement

An alternative approach to determining the value of the NCF is based on its ability to deter future attacks on maritime trade. The potential disruption to merchant shipping was illustrated by five scenarios ranging from a relatively benign environment to generalised warfare between groups of states.

We piloted this approach with a handful of defence experts using decision-support software. An electronic workshop was used to assign probabilities to the different scenarios and to undertake a dialogue to reduce the range of probabilities reported. Based on this pilot, we were satisfied that this approach, though subject to caveats, would yield a credible value for the NCF based on the deterrence of attacks on maritime trade.

Surveying stated preferences

The central approach we have explored used the 1000minds survey platform to assess people's stated willingness to pay for the NCF. We have designed, tested and piloted a survey with eight selected defence experts and a selection of 18 ordinary New Zealanders.

This was a 'throw-away' pilot as, given the small sample size, the results would not be robust. Based on our analysis of their responses, we are satisfied that this survey approach was likely to produce valid and reliable information about the willingness to pay for military capabilities such as the NCF.

Valuation of delivered outputs (D) based on mixed methods

Valuation of direct use values from delivered outputs was explored using a mix of techniques, including direct measure of value and, where these are not available, a mix of direct costs or the cost of using an alternative force element (such as offshore patrol vessels for frigates).

Historical willingness to use and pay for the NCF

There has been a clear willingness to use the NCF reflected in there have been at least one naval operational tour each decade (Korea, Malaya, Borneo, Indian Ocean, Southeast Asia, Gulf region, South Pacific) since 1950.

Willingness to use must be combined with a willingness to pay. Successive governments have acknowledged the cost of the vessels and searched for alternatives but have always accepted that the utility of the NCF outweighs its costs.

Full application to the NCF

We proposed valuing the NCF by taking three perspectives and adopting three different approaches:

- rolling out the stated preference survey with a target of 1,000 responses, including a subset of respondents who receive supplementary information, together with a control group of defence experts
- inviting the participation of a wider group of defence and security analysts to take part in the scenario analysis using decision-support software.
- refining the willingness to pay information based on historical cost and recent decisions.

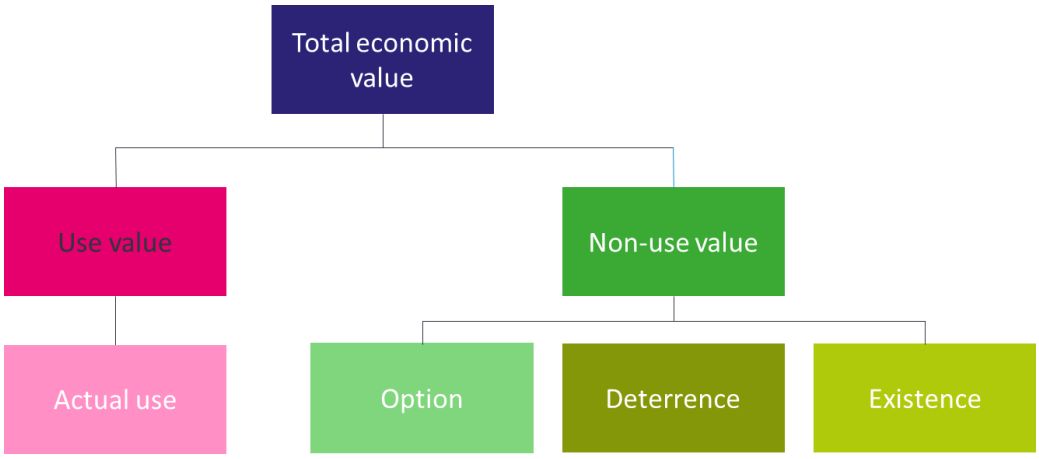
Valuing the NCF is a worthy quest rather than a holy grail

Based on the work up to the end of Phase 2B2, we were confident that techniques are available that can be used to place a value on the NCF capability for military purposes, and we are more than 80% confident that they will generate results that are plausible, reliable and valid. These techniques are likely to also be applicable to other capabilities, such as maritime surveillance support.

Appendix B Our initial framework

At the start of the project, we developed a framework for showing total economic value, as shown in Figure 11, and for valuing the NCF, as shown in Figure 12.

Figure 11 Total economic value framework



Source: NZIER

The economic value framework in Figure 11 suggests the total value for any asset as being the sum of its Use value and its Non-use value. (All the terms mentioned here are defined in more detail below.) In turn, for defence assets specifically, there is both a military value (M) and other value (O) for non-military activities. As well (although it does not specifically affect overall value), military use has direct, indirect and potentially future components.

This all suggests that the organising value framework for the project is V = C + D, where:

- V is the total economic value to New Zealand
- C is the non-use value capability or 'could' use value that accrues through possession (rather than use) of the asset's capabilities
- D is the delivered or 'do' use value generated from the delivered outputs obtained by physically using the asset.

Additionally:

- C = Mnu + Onu
- D = Mu + Ou.

Therefore:

- V may also be expressed as V = M(u + nu) + O(u + nu).

The values are collectively exhaustive but not mutually exclusive, as NCF activities are multi-attribute.

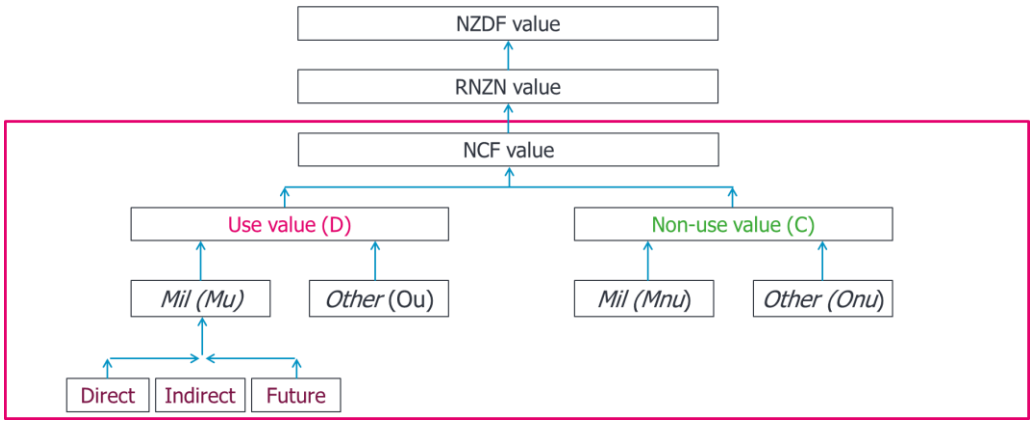
Box 3: Definition of our terms

- **Use value**: (*Delivered* or 'direct' use) The value generated from the delivered outputs obtained by physically using the asset or having it available for immediate use
- **Non-use value**: (*Capability* or 'could' use) Value accrued through possession (rather than use) of the asset's capabilities
- **Military use**: (*Mu*) An activity related directly or indirectly to specifically military objectives:
- **Direct**: military-focused activity to directly achieve New Zealand's national security ends
- **Indirect**: activity that supports New Zealand's friends and allies
- **Future use**: availability for use in the immediate or distant future
- **Other use**: (*Ou*) An activity with no immediate military utility
- **Military non-use**: (*Mnu*) The military or strategic value obtained through possession of the capability rather than through its actual use
- **Other non-use**: (*Onu*) Any non-military value accrued through possession of the capability including spin-off values

The term 'non-use' or 'C' value is potentially subject to misinterpretation. An insurance policy provides valuable services (protection) even when there are no claims. Similarly, the NCF provides valuable services such as deterrence and ensuring the option exists to deploy the frigates in the future, even if it is not actually used.

Not all of these can be readily quantified. The project design was based on an 80/20 solution. As long as the valuation addresses the major elements in the framework, the approach will generate a conservative value. For the minor omitted values (such as Onu: non-use for non-military purposes), the sign is known to be positive, and interviews were used to test the likely magnitude.

Figure 12 Economic values of defence capabilities



Source: NZIER

Figure 12 and Table 12 also distinguish direct use (i.e. military-focused activity to directly achieve New Zealand's national security ends) and contrast that with indirect use, which refers to activity that supports New Zealand's friends and allies. Practical examples of direct and indirect military and other use and non-use are shown in Table 12.

Table 12 Military and non-military value

Use	Military value	Non-military value
Direct use	Achieving NZDF outputs (prepared, protect, project), e.g. Gulf Operations (2015)	No particular military utility: • Aid to civil power • DOC; MDCDEM; Customs; Fisheries • Diplomacy • Constabulary
Indirect use	NCF activities that achieve other government objectives as well: Protection of SLOCs sustains economic prosperity Gulf and Horn of Africa operations strengthen the international order	Workforce and industrial development. Development of transferable skills in the workforce.
Non-use	Accrued value through possession: Deterrence Option Existence	Accrued value through existence: Reserve national response capacity

Source: NZIER

This framework draws on the distinction between capability and delivered outputs used in the New Zealand Defence Force's own financial management system. It was elaborated, drawing on insights from environmental economics on use and non-use values.

Appendix C Key findings from the literature scan

The literature scan undertaken in 2018 at the start of the project identified there is considerable literature on defence economics in general, mainly focused on the choices states make in developing their defence systems and on the cost of the systems. The literature on valuing as opposed to costing defence assets is much sparser. In addition, there is a large literature on non-market valuation, which we are familiar with but is not summarised here. This includes environmental economics, health and roading (Jones-Lee 1990; Viscusi 1992).

When the project was restarted in 2022 after a pause, we undertook a quick scan of the literature to see if there were any new developments or contributions to the stock of knowledge on valuing defence forces. We identified a major study undertaken by the RAND Corporation that was commissioned by the UK Ministry of Defence (Huxtable et al. 2021). We will discuss that study in the next section. Thereafter we discuss the most prominent examples identified by the initial scan. The sources examined are discussed in more detail at the end of this Appendix.

C.1 The RAND study

The UK Ministry of Defence commissioned RAND (Huxtable et al. 2021), in conjunction with academic partners, to undertake an exploratory study to assess different methodological approaches to assessing UK Defence's value proposition. It identified five main lines of enquiry: 1) Defence analogue to QALYs; 2) Value of life methodologies; 3) Defence as Insurance; 4) Proxy indicators for the impact of defence outputs and outcomes; 5) Application of discrete choice modelling experiments to defence.

Each study addressed five questions: "1) How transferrable is the methodology to the defence context? 2) What are the barriers to, and opportunities from, applying the approach in the defence context? 3) What could a defence-related equivalent entail and how would this methodology work in practice? 4) What are possible applications in decision-making and areas for refinement or further research?" (RAND 2020 p6).

Several lines of enquiry, including discrete choice modelling experiments (which is the same as the 1000minds approach) and Defence QALYs, looked very promising but no decision has been taken to date (December 2022) to pursue this line of research further.

C.2 Key references and their findings from the initial scan

In this appendix, we detail the range of references used to guide our own thinking and to support the conclusions detailed in this report. Not all references were of equal value. Most references used some variation of the formulation from Smith (2007):

> *while budgets and forces can be measured, and military capabilities can be estimated, the final security outputs are inherently intangible. It is this intangibility that makes the valuation of defence so difficult.*

The most important insights (which can not necessarily be applied directly but which will inform our own approach) were gained from the following:

‘Measuring Defence’, Economic & Labour Market Review (Angboso and Spence, 2009)

It is not sufficient to use the convention in defence accounting that ‘cost of inputs equals value of outputs’. The key conceptual issue is ‘how to define a unit of output’. There are two possibilities: activities which measure specific things the Armed Forces do, and capabilities of the Armed Forces (the ability of the forces to pursue a particular course of action, such as precision strike of military targets).

‘Structuring Value Attributes’, Interfaces (Buede and Downey, 1986)

There are two systematic methods for structuring value systems, described as top-down and bottom-up. The top-down method is objective driven; that is, the analyst begins by ascertaining the global objectives of the decision maker and proceeds to a value structure by subdividing the objectives, sub-objectives, and so forth until a final set of attributes is obtained. The bottom-up approach, in contrast, is alternative-driven. In this case, the analyst begins by questioning the decision maker for a reasonable set of alternatives, each of which might solve the problem. Once the alternatives are defined, the analyst generates a value structure by probing the decision-maker for the major differences between the identified alternatives.

‘Estimating Output Mix Effectiveness: a scenario approach’, Memorandum No 14/2016, Department of Economics, University of Oslo (Hanson, 2016)

In studies of effectiveness in the military, the same general problems apply that the New Zealand Productivity Commission found in a review of productivity in the health and education sectors. There is a possibly significant time lag between the production of military outputs and the realisation of outcomes. There is no clear connection between inputs and outcomes in the sense that a marginal change in defence budgets is unlikely to have an immediate impact on the status of outcomes such as peace or overall sovereignty.

The paper suggests a new framework for measuring outcome mapping functions and measuring effectiveness in the public sector. The framework exploits the development of military scenarios as continuous outcome indicators to overcome the problems related to stochastic environmental variables and to lags between the transformation processes.

‘Measuring and improving state sector productivity: Draft Report’ (New Zealand Productivity Commission, 2017)

After a decision has been made that the state sector should produce certain outputs, productivity measures show how efficiently those outputs are produced. Typically, numerous activities will be involved in the production of an output. These all need to be measured.

‘The Case for Defence’, Defence and Peace Economics, (Hartley, 2010)

The benefits of defence spending are both economic and non-economic, and it might be that the non-economic benefits are valued more highly than the economic benefits.

‘Defence Output Measures: An Economics perspective’, Defence R&D Canada, Centre for Operational Research and Analysis, DRDC CORA CR 2011-78 (Hartley, 2011)

There are major problems with the standard military production function where defence output is assumed to be a function of technology, capital and labour inputs. Defence output is asserted without recognising the problems of identifying and valuing defence outputs.

‘Conflict and Defence Output: An Economic Perspective’, Revue d’économie politique (Hartley, 2012)

There are at least three approaches to determining the economic value of defence:

First: estimating a nation’s per capita defence spend and then asking whether its citizens are willing to pay at least such a sum of the annual protection offered by its armed forces. Comparisons can be made with other similar types of public spending programmes.

Second: value of life studies can be used to estimate the valuation of lives saved and injuries avoided resulting from the provision of armed forces - protection adjusted life years. A similar approach might be used for property.

Third: Regard defence as insurance in response to various current and future known and unknown threats and contingencies.

‘Measuring Defence Output: An Economics Perspective’ in Military Cost-Benefit Analysis (Hartley and Solomon, 2015)

Defence provides economic benefits that can be reflected in cost savings from avoiding conflict or minimising its duration and contributing to post-conflict recovery and restoration of market activity.

A starting point in answering the central research questions is to apply cost-benefit analysis: to identify the costs of defence and then ask whether defence provides at least a comparable level of benefits in the outputs produced. It is also important to capture non-economic benefits in addition to measurable economic benefits in measuring the overall benefits of defence spending.

‘Conducting Comparative Research into Defence Capability Formation’, Applied Economics and Finance (Markowski, Chand and Wylie, 2017)

The value of a quantum of military capability can be expressed as the expected present value of (contingent) military and civil operations, which this capability element is called upon to prosecute when required, weighted by the corresponding probabilities of these operations occurring.

References identified

In addition to those articles discussed above, a number of other references were reviewed but found to be of more limited utility for the project. The full list of references used in the project is as follows:

Anagboso, Mavis, and Alison Spense. 2009. 'Measuring Defence'. Economic & Labour Market Review 3 (1): 44–52. https://doi.org/10.1057/elmr.2009.8.

Bateman, Sam. 2016. 'Maritime Security Governance in the Indian Ocean Region'. Journal of the Indian Ocean Region 12 (1): 5–23.

Belin, Jean, Josselin Droff, and Julien Malizard. 2017. 'The Economics of European Defence: Some Additional Insights'. #15. Armament Industry European Research Group.

Brands, Hal, and Peter D. Feaver. 2017. 'What Are America's Alliances Good For? Parameters 47 (2): 15–30.

Buede, Dennis M. 1986. 'Structuring Value Attributes'. Interfaces 16 (2): 52–62. https://doi.org/10.1287/inte.16.2.52.

Catasús, Bino, and Anders Grönlund. 2005. 'More Peace for Less Money: Measurement and Accountability in the Swedish Armed Forces'. Financial Accountability & Management 21 (4): 467–84. https://doi.org/10.1111/j.0267-4424.2005.00229.x.

Dahlman, Carl Johan. 2007. The Cost of a Military Person-Year: A Method for Computing Savings from Force Reductions. Santa Monica, CA: RAND Corporation. https://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG598.pdf.

Dunne, J. Paul, and Nan Tian. 2015. 'Military Expenditure, Economic Growth and Heterogeneity'. Defence and Peace Economics 26 (1): 15–31. https://doi.org/10.1080/10242694.2013.848575.

Hanson, Torbjorn. 2016. 'Estimating Output Mix Effectiveness: A Scenario Approach'. Department of Economics, University of Oslo. https://www.econstor.eu/handle/10419/165957.

Hartley, Keith. 2010. 'The Case for Defence'. Defence and Peace Economics 21 (5–6): 409–426.

———. 2011. 'Defence Output Measures: An Economics Perspective'. DRDC-CORA-CR-2011-178. York University, United Kingdom. http://www.dtic.mil/docs/citations/ADA555592.

———. 2012. 'Conflict and Defence Output: An Economic Perspective'. Revue d'économie Politique 122 (2): 171–195.

Hartley, Keith, and Binyan Solomon. 2015. 'Measuring Defence Output'. In Military Cost Benefit Analysis: Theory and Practice, edited by F. Melese, A. Richter, and Binyan Solomon. London: Routledge.

Hildebrandt, Gregory G. 1999. 'The Military Production Function'. Defence and Peace Economics 10 (3): 247–72. https://doi.org/10.1080/10430719908404926.

Hove, Kjetil Hatlebakk, and Tobias Lillekvelland. 2017. 'On Growing Operating Costs in the Armed Forces'. Defence and Peace Economics 0 (0): 1–16. https://doi.org/10.1080/10242694.2017.1413621.

Hove, Kjetil, and Tobias Lillekvelland. 2016. 'Investment Cost Escalation – an Overview of the Literature and Revised Estimates'. Defence and Peace Economics 27 (2): 208–30. https://doi.org/10.1080/10242694.2015.1093754.

Jones-Lee M, Jammerton M, and Philips P (2004) The Value of Safety: Results of a National Sample Survey. In Viscusi and Gayer (Eds) Classics in Risk Management Volume 1 pp371-394. Elgar Reference Collection.

Katoch, Rajan. 2006. 'Defence Economics'. Strategic Analysis 30 (2): 280–309.

Kavanagh, Jennifer. 2005. 'Determinants of Productivity for Military Personnel: A Review of Findings on the Contribution of Experience, Training, and Aptitude to Military Performance'. Rand Corporation. https://www.rand.org/content/dam/rand/pubs/technical_reports/2005/RAND_TR193.pdf.

Markowski, Stefan, Satish Chand, and Robert Wylie. 2017a. 'Conducting Comparative Research into Defence Capability Formation'. Applied Economics and Finance 4 (6): 91–106.

———. 2017b. 'Economic Growth and Demand for Military Expenditure in the Indo-Pacific Asia Region'. Defence and Peace Economics 28 (4): 473–490.

Markowski, Stefan, Peter Hall, and Robert Wylie. 2010. Defence Procurement and Industry Policy: A Small Country Perspective. Taylor & Francis.

Melese, F., A. Richter, and Binyan Solomon, eds. 2015. 'Introduction'. In Military Cost–Benefit Analysis: Theory and Practice. London: Routledge. https://www.taylorfrancis.com/books/e/9781317531722/chapters/10.4324%2F9781315724690-11.

Melese, Francois. 2009. 'The Economic Evaluation of Alternatives (EEoA): Rethinking the Application of Cost-Effectiveness Analysis, Multi-Criteria Decision-Making (MCDM) and the Analysis of Alternatives (AoA) in Defense Procurement'. NPS-AM-09-012. Naval Postgraduate School Monterey CA, Graduate School of Business and Public Policy. http://www.dtic.mil/docs/citations/ADA527988.

New Zealand Productivity Commission. 2017. 'Improving State Sector Productivity'. Draft report. Wellington: New Zealand Productivity Commission.

Nordlund, Peter. 2016. 'Defence-Specific Inflation – the Swedish Perspective'. Defence and Peace Economics 27 (2): 258–79. https://doi.org/10.1080/10242694.2015.1096571.

Penney, Christopher E., and Allan Weldon. 2016. 'An Overview of the Defence and Peace Economics Special Issue on Defence Inflation'. http://cradpdf.drdc-rddc.gc.ca/PDFS/unc247/p804601_A1b.pdf.

Phillips, Mark. 2012. The Future of the UK's Reserve Forces. Royal United Services Institute. https://rusi.org/sites/default/files/201204_op_future_of_the_uks_reserve_forces.pdf.

Pieroni, Luca. 2009. 'Military Expenditure and Economic Growth'. Defence and Peace Economics 20 (4): 327–339.

Robbins, Mark. 2015. 'Towards a Political Economy of Military Spending'. PhD Thesis, Carleton University Ottawa.

Shio, ANDO. 2012. 'The Impact of Defense Expenditure on Economic Growth: Panel Data Analysis Based on the Feder Model'. The International Journal of Economic Policy Studies Volume 4 article 8. https://rusi.org/sites/default/files/201204_op_future_of_the_uks_reserve_forces.pdf.

Smith, Ron. 2007. 'Valuing Defense'. Public Finance and Management Vol 7 (Issue 3): 242–59.

Viscusi, W. K. 1992. 'Improving the analytical basis for regulatory decision-making'. OECD.

Wall, Kent D., and Cameron A. MacKenzie. 2015. 'Multiple Objective Decision Making'. In Military Cost–Benefit Analysis: Theory and Practice, edited by F. Melese, A. Richter, and Binyan Solomon. London: Routledge.

Yeabsley, John. 1995. 'Unchartered Seas: The Economics of New Zealand's Maritime Security'. NZIER working paper 95/35. Wellington: NZIER.

Appendix D Historical patterns showing a willingness to use and to pay

Willingness to use and willingness to pay are interdependent concepts. Willingness to use is a political matter, but there can be no use without payment. Equally, paying for a capability makes little sense if the capability will never be used. In the last seven decades, successive governments have shown a clear willingness to use the NCF and have been prepared (albeit often reluctantly) to pay for it.

Willingness to use

We undertook a review of the historical patterns of the use of the NCF based on annual reports, material supplied by the Navy and other historical documents. The key insights included:

- clear government intent across official documents since 1950 to pay for and maintain a blue-water navy
- clear government willingness to use the blue-water navy when necessary or appropriate
- a consistent willingness to pay for the frigate capability by successive governments
- general-purpose frigates chosen based on consideration and rejection of a range of other options, ranging from more capable vessels to removing the capability from the NZDF altogether
- policy commitment to blue-water navy lately reaffirmed in the 2016 Defence White Paper and the 2018 Strategic Defence Policy Statement.

The NCF has been employed extensively across the full range of military and other (non-military) uses identified. Details of NCF use between 1948 and 2015, showing 3 or 4 years per decade, are outlined in Appendix D. The use patterns clearly reveal that successive governments have been willing to use the NCF as required. Appendix C is summarised as:

- historical use patterns can be split into military and other use
- active warlike operational tours by the NCF at least once a decade
- extensive other use, often at short notice, for a range of government agencies.

Military use has included:

- every decade at least, naval operational tours that used the war fighting capability of the NCF (Korea, Malaya, Borneo, Indian Ocean, Southeast Asia, Gulf region)
- annual exercises with allied and friendly nations in support of strategic relationships, always combined with defence diplomacy
- routine support to Royal Navy, Royal Australian Navy, US Navy as requested.

Other uses have included:

- annual support to other government agencies in the Southern Ocean and Sub Antarctic area
- periodic support to royal and vice-regal travel in the Pacific

- periodic support to New Zealand diplomacy in the Pacific (independence celebrations, Bougainville peace talks)
- periodic support to New Zealand diplomacy through port calls in areas where ships are operating for military purposes
- search and rescue, disaster response and relief, national representation (e.g. Brisbane and Osaka expo).

An analysis of the actual use of the NCF shows the range and flexibility of the force. It allows military activities such as:

- naval support to allied and coalition military operations
- naval relationships with regional and Commonwealth powers in support of national strategic relationships
- naval support to Australian and allied fleet training
- naval support to foreign policy decisions.

As well, the NCF supports non-military activities such as:

- constabulary duties in the New Zealand maritime area of interest
- regional diplomacy
- vice-regal duties
- national events in New Zealand and internationally
- response to and recovery from natural disasters
- ancillary maritime operations as required.

Willingness to pay

Although there has been a clear willingness to use the NCF, that has to be combined with a willingness to pay. The summary below shows that successive governments have acknowledged the cost of the vessels and searched for alternatives but always accepted that the utility of the NCF has outweighed its costs.

Decision chain on naval and maritime constabulary capabilities

1978 Defence Review:

- cost of new frigates more than New Zealand can afford
- need a blue-water naval capability rather than just a constabulary force
- need to be able to carry out military tasks
- need to maintain strategic relationships.

1981: Government decision to buy second-hand frigates as a stop-gap measure.

1983 Defence Review: Financial issues alone require consideration of an alternative force structure – at that time, a four-frigate force carrying out both naval and constabulary duties.

1986 Defence Review Officials' Committee:

- Australia's and New Zealand's needs virtually identical

- strong logistical and operational advantages to working with Australia.

1987 Defence Review:

- commitment to maintaining a blue-water navy
- intention to work with Australia for a mutually acceptable and cost-effective ship
- need to be able to carry out military tasks
- need to maintain strategic relationships.

1987: MOU with Australia for two frigates with an option for two more.

1989: Government decision to accept the ANZAC frigates.

1990: Treasury analysis for the Minister of Finance: altering the blue-water navy policy would require expenditure in other areas.

1997: Coalition Government allowed the option for two new ANZAC frigates to lapse and declined offer from Australia for two used ANZAC frigates.

2002: Government accepted the need for offshore patrol vessels and commenced acquisition processes, thus reverting to the need for four platforms suitable for blue-water operations, but with two of those platforms optimised for constabulary rather than naval operations.

2010: the Royal New Zealand Navy (RNZN) commenced operating two offshore patrol vessels that have taken over most, if not all, of the support tasks previously undertaken by the frigate force.

Box 4: The role of the National Maritime Coordination Centre in tasking the NCF

New Zealand has had a history of non-military use of the frigate force because until 2010, other than for limited inshore work, the frigate force was the only group readily available for constabulary duties and for support to other government agencies within New Zealand's area of maritime responsibility. The support tasks involve patrolling New Zealand's exclusive economic zone and territorial waters to help protect and maintain the country's maritime interests. These interests include maritime sovereignty and security, marine resource management, law enforcement, environmental protection, maritime safety and external relations.

Coordination of activity within the maritime patrol area is the responsibility of the National Maritime Coordination Centre (NMCC). The NMCC is a whole-of-government agency (managed by the New Zealand Customs Service) with the main function (in terms of the use of the frigate force) of coordinating the tasking of available maritime patrol assets. A core group of six agencies make the most use of maritime patrols:

- New Zealand Customs Service
- Ministry of Fisheries
- Department of Conservation
- Ministry of Foreign Affairs and Trade
- New Zealand Police
- Maritime New Zealand

In summary, this section shows the clear willingness to use the NCF reflected in at least one naval operational tour each decade. On willingness to pay, successive governments have acknowledged the cost of the NCF and searched for alternatives but have always accepted that the utility of the frigate force outweighs its costs.

The following section sets out in more detail the historical use patterns of the NCF.

We used annual reports, material supplied by the NZDF and other historical documents to undertake a review of the historical patterns of the use of the NCF, and the results are summarised in Table 13.

We classified the patterns of use using the organising value framework for the project (discussed further in Appendix B) V = C + D, where:

- C is the non-use value of the capability itself
- D is the sum of direct use values from delivered outputs, additional to the war-fighting capability of the asset.

Use value: (Delivered or 'do' use – D) The value generated from the delivered outputs obtained by physically using the asset.

Non-use value: (Capability or 'could' use – C) The value accrued through possession (rather than use) of the asset's capabilities.

Military use: (Mu) An activity related directly or indirectly to specific military objectives:

- Direct use: military-focused activity to directly achieve New Zealand's national security ends.
- Indirect use: an activity that supports New Zealand's friends and allies.

Other use: (Ou) An activity with no immediate military utility but of value to New Zealand society.

Military non-use: (Mnu) The military or strategic value obtained through possession of the capability rather than through its actual use.

Other non-use: (Onu) Any non-military value accrued through possession of the capability, including spin-off values.

Total value: The sum of use value and non-use value.

Table 13 Historical use patterns of the NCF

Date	Category	Location	Event / Comments
1948	Ou	Sub Antarctic Islands	Support Met Service
1949	Ou	Palliser Bay	NGS sinking coal hulk
1949	Ou	Sub Antarctic Islands	Support Met Service
1949	Ou	Raoul Island	Support other government agencies
1949	Ou	Pacific	Support vice-regal visit
1949	Mu (I)	Pacific	Assert British sovereignty Flint Island
1949	Ou	Raoul Island	Medevac

Date	Category	Location	Event / Comments
1949	Ou	Sub Antarctic Islands	Support Met Service
1949	Ou	Raoul Island	Support other government agencies
1950	Mu (I)	Mediterranean	Exchange with RN
1950	Ou	Pacific	Hydrographic survey
1950	Ou	NZ	SAR
1950	Mu	Korea	Operational deployment (generally two frigates 1951–54)
1952	Mu	Korea	Operational deployment (generally two frigates 1951–54)
1954	Mu	Korea	Operational deployment (generally two frigates 1951–54)
1954	Mu	Malaya	Operational deployments under command CinC FE
1954	Ou	Pacific	Support vice-regal visit
1954	Ou	Pacific	SAR
1954	Mu	China	Protect merchant shipping from Chinese nationalist activities
1954	Ou	Raoul Island	Support other government agencies
1954	Ou	Fiji	Salvage local coaster
1954	Ou	Sub Antarctic Islands	Support biological survey expedition
1954	Ou	Chatham Islands	Transport for Bishop of Christchurch
1957	Mu	Far East	Anti-piracy patrols
1957	Ou	Southern Ocean, Antarctica	Support for polar expedition
1957	Mu (I)	Pacific	Weather ships for nuclear tests, Visits to Pacific islands
1958	Ou	Raoul Island	Support other government agencies
1958	Mu (I)	Christmas Island	Multiple deployments as weather ships to support British nuclear testing
1958	Ou	NZ	Salvage tow of merchant ship
1958	Ou	Sub Antarctic Islands	Support Met Service
1958	Ou	Far East	Search for grave of Sir Ernest Shackleton
1960	Mu	Far East	Commonwealth Strategic Reserve
1963	Ou/Mu (I)	NZ	Escort Royal Yacht
1963	Ou	Antarctic	Support Operation Deep Freeze
1963	Ou	Raoul Island	Support other government agencies
1963	Ou	Pacific, Northern Cook Islands	SAR
1963	Ou	Raoul Island	Support other government agencies
1963	Mu	Far East	Operational deployment, confrontation

Date	Category	Location	Event / Comments
1963	Ou	Antarctic	Operation Deep Freeze
1966	Mu	Far East	Commonwealth Strategic Reserve
1966	Ou	NZ	Support Waitangi commemorations
1966	Ou	NZ, Far East	Salvage and SAR duties
1968	Mu	Far East	Commonwealth Strategic Reserve
1968	Ou	NZ	Aid to ship on fire
1970	Mu	Far East	Commonwealth Strategic Reserve
1970	Ou	NZ	Escort Royal Yacht
1970	Ou	Japan	Support to Expo 70
1970	Mu (I)	NZ	Exercises with RN warships
1973	Mu	Far East	Anzac Force component
1973	Mu (I)	NZ	Exercise with RAF/RNZAF
1973	Ou	Pacific	Mururoa watch and atmospheric sampling
1973	Ou	Raoul Island	Support other government agencies
1975	Mu	Southeast Asia	Attached NZFORSEA
1975	Mu (I)	US	Attached USN
1975	Ou	Raoul Islands	Support other government agencies
1978	Mu (I)	US, Canada	Deployed with USN/RCN
1978	Ou	Pacific	Support to Tokelau
1978	Mu	Far East	NZFORSEA component
1978	Ou	Tasman Sea	SAR yacht
1978	Ou	Raoul Island	Support other government agencies
1978	Ou	Pacific	Support for Tuvalu independence celebrations, including accommodation for Princess Margaret
1978	Ou	Sub Antarctic Islands	Support Met Service and DIA biological survey
1978	Ou	NZ waters	Medevac of Russian seaman
1980	Ou	Sub Antarctic Islands	Support Met Service
1980	Mu	Southeast Asia	Deployed to NZ Force SEA
1980	Mu (I)	North America	Deployed with USN/RCN
1980	Ou	Raoul Island	Support other government agencies
1980	Ou	Kermadec Islands	Support other government agencies
1983	Mu (I)	Indian Ocean	Armilla Patrol
1983	Ou	Australia	Support to Brisbane Commonwealth Games
1983	Ou	Sub Antarctic Islands	Support Dept of Lands and Survey
1983	Mu	Far East	NZFORSEA component

Date	Category	Location	Event / Comments
1986	Ou	Sub Antarctic Islands	Support Met Service
1986	Ou	NZ	Escort Royal Yacht
1986	Mu	Southeast Asia	Attached NZ Force SEA
1988	Ou	Sub Antarctic Islands	Support DoC
1988	Ou	Raoul Island	Support other government agencies
1988	Ou	Pacific	Support vice-regal visit
1988	Mu, Ou	Pacific	Joint exercise, ship visits
1988	Mu, Ou	Far East	NZFORSEA component, ship visits
1988	Mu (I)	Far East	Combined exercising, FPDA
1988	Ou	Australia	Support to Expo 88
1988	Mu (I)	Tasman	Exercises with Australia
1988	Ou, Mu (I)	Australia	Australian bicentennial support, Sydney naval review
1988	Ou	Pacific, PNG	Ship visit to Lae
1988	Mu (I)	Australia	Combined convoy exercise
1990	Ou	Pacific	Disaster relief, Cyclone Offa
1990	Ou	Sub Antarctic Islands	Support Met Service, DOC
1990	Ou	PNG	Support Bougainville peace talks
1990	Mu (I)	NZ	Fleet concentration with RAN/RCN
1990	Mu	Far East	Deployment
1993	Mu (I), Ou	UK	50th Battle of the Atlantic commemorations
1993	Ou	NZ	Support Police and MAF operation in Bluff
1993	Mu	Far East	NZFORSEA component
1993	Ou	Sub Antarctic Islands	Support DOC, Met Service
1996	Mu	Middle East	Support UN embargo of Iraq
1999	Ou	Southern Ocean	Fisheries, SAR
1999	Mu (I)	Australia	Exercises with RAN, RN
1999	Mu, Ou	Far East	Combined exercises, ship visits, challenged over free passage in Indonesian archipelago
1999	Mu, Ou	East Timor	Standby following violence and INTERFET RAN/USN/RNZN mission
2003	Mu	Gulf region	Coalition operations
2003	Mu (I), Ou	Australia, South Pacific	Exercising with Australia and France, port visits
2003	Ou	Raoul Island, Sub Antarctic Islands	DOC, Fisheries support
2003	Ou	NZ	Training with Police, Customs, Immigration

Date	Category	Location	Event / Comments
2003	Mu (I)	Lord Howe Island	Support and salvage RN warship
2003	Ou	NZ	Fisheries support
2003	Mu (I), Ou	Australia	Combined exercising, training
2003	Ou	South Pacific	Support vice-regal visit
2006	Mu (I), Ou	Australia	Multiple visits for exercises, training, defence diplomacy
2006	Mu (I), Ou	Southeast Asia, Northeast Asia	Multiple deployments, FPDA exercising, bilateral exercising, defence diplomacy
2006	Ou	NZ	EEZ patrolling
2008	Mu (I)	Australia	Combined training, exercising, both frigates, multiple visits
2008	Mu, Mu(I), Ou	East Asia	FPDA and other exercising, ship visits, support MFAT (several ships, several visits, many countries)
2008	Ou	NZ	EEZ, support DOC, Fisheries, Customs, multiple patrols
2008	Ou	Raoul Island	Support DOC
2008	Mu	Gulf region	Coalition naval operations
2011	Mu (I)	Australia	Fleet concentration, exercises
2011	Mu Ou	Southeast Asia	FPDA exercise, port visits, support MFAT
2011	Ou	NZ	EEZ patrols
2011	Mu (I), Ou	East Asia, US	Exercising, port visits, support MFAT
2013	Mu, Ou	East Asia	FPDA, other maritime exercises, ship visits, support MFAT
2013	Mu	Gulf region	Coalition operations
2013	Mu (I)	Australia	Joint/combined exercising, ex Talisman Sabre
2015	Mu	Gulf region	Coalition operations
2015	Mu (I)	Australia	Maritime exercising
2015	Mu (I), Ou	Southeast Asia, North Pacific	Maritime exercising, defence diplomacy

Source: NZIER/Jim Rolfe based on the review of annual reports and other historical documents

The table shows that it is possible to split historical use patterns into military and other uses. NCF has been employed extensively across the full range of military and other (non-military) uses identified. Successive governments have been willing to use the NCF as required in both:

- active warlike operational tours by the NCF at least once a decade
- extensive other use, often at short notice, for a range of government agencies.

Appendix E The links between external security, this research and the NZ Treasury's Living Standards Framework.

As part of commissioning Stage 3 of this project, we were asked to explore the links between this research brief and the NZ Treasury's Living Standards Framework (LSF) (The Treasury n.d.). In brief, at first pass, this is an easy problem as the valuations appear to fit under physical capital at the third level of the LSF – stocks of national wealth. But on deeper reflection based on an email exchange with the relevant Treasury officials (dated 1 to 5 May 2022), it is clear that while international connections, including external security, have been recognised as an important dimension, this has not yet been explored in any detail by the Treasury. As such, it is still an incomplete 'work in progress' in the current LSF. So while links can be made from the research to the LSF, this research can't be systematically integrated.

The context of this discussion is that external security has been added to the 2021 version of the LSF. The new version now has three levels – the domain level with twelve dimensions of wellbeing, a new institutions and governance level and the national wealth stocks level. Previously external security was essentially missing from earlier versions of the Treasury's LSF, and internal security was restricted to a focus on domestic crime.

The three perspectives in this research – Cabinet Ministers, New Zealanders and experts - based on the three approaches measure slightly different things. The scenario analysis focuses on dollar values of maritime trade, including both imports and exports. Revealed preferences are focused on real decisions to commit government expenditure on real resources. The 1000minds stated preference surveys measure hypothetical willingness to pay taxes.

There are three possible approaches to linking research like this on external security into the LSF:

- external security – like many things – can be squeezed into the LSF and is now clearly envisaged in the new institutions and governance level 2 in particular
- external security is used as an analytical question like resilience
- external security is a separate domain – an intermediate outcome – that provides a framework for the LSF to operate within.

Force fitting external security into the LSF levels

To elaborate on the first approach – external security is touched on briefly in the discussion of the new L2 of the LSF but can be read into the framework at each of the three levels:

Under the Wellbeing Level 1 – Defence contributes to a range of domains.

The obvious link is "Safety – Being safe from harm and the fear of harm and keeping oneself and others safe from harm" (The Treasury 2021). Although the discussion of the definition of safety is purely domestically focused, and the measures in the dashboard focus on internal security, the definition is broader than previously, and as Ukraine attests harm/fear from harm includes external security threats. By contrast, the LSF2018 defined this domain as ''safety from crime and from the fear of crime" was much narrower – unless external security was limited to war crimes!!

More tenuous links could also be drawn to other domains. The current Ukraine conflict stems from Putin's desire to interfere in Ukraine's "engagement and voice" outcomes.

Under Level 2

“International connections – Foreign governments, firms and other organisations with whom we trade and cooperate to achieve shared goals or compete when our interests are not aligned. International treaties and arrangements” (The Treasury 2021, 3). This new level in the framework allows for enabling assets such as diplomatic capital, and cultural capital which are not directly measurable but act to increase the value of the four aspects of our national wealth in level 3. Defence plays more directly into the framework at this level as it contributes to strengthening our institutions, particularly our international connections

The Treasury’s discussion of international connections mentions external security alongside external trade. “We have not explored these topics as part of this refresh process, but by adding international connections into the LSF we have now located these topics clearly in the framework, creating space to explore them in more depth in the future.” (Treasury 2021, p 50).

The scenario analysis – which highlighted the role of deterrence in promoting maritime trade – is a good example of the contribution that the NCF makes to the LSF level 2.

Under Level 3

Defence assets could be made to fit directly under physical capital. However, the way these assets are measured (historic cost less depreciation) does not capture investment in capability and the stocks of soft and hard power capital that have been built up or run down over time.

For example, ANZAC frigates would be measured on this approach at their depreciated book value in 1990s dollars. By contrast, we estimate Cabinet Ministers' willingness to pay for ANZAC frigates on an historic cost basis ($6B) is greater than the $5.2B valuation for all specialised military equipment on the NZDF’s balance sheet as at 30 June 2020.

Moreover, defence contributes to protecting the security of the various national capital stocks. For example, the role of defence in fisheries protection and hence in preserving and managing New Zealand's natural capital stock and counter cyber in protecting financial capital and intellectual property etc.

No doubt, with more intellectual gymnastics, more linkages could be drawn - defence regulars and territorials as part of Work and Volunteering etc.

As the Treasury observed in their email “simply identifying potential links narratively is kind of trivial – the more important step for agencies wanting to demonstrate their value is to rank, quantify and provide evidence for their impacts, so that the opportunity cost of investment in one kind of area can be compared with investment in another.”

Fitting external security into the LSF analytical prompts

The LSF includes four analytical prompts – including “Resilience Do individuals, collectives, institutions, organisations and the environment have the ability to adapt to or absorb stresses and shocks?” Some aspects of defence outputs contribute to resilience. But external security and resilience are not the same things – although there are elements of overlap.

Or is external security a separate domain?

New Zealand does not currently face a hostile threat environment – unlike, say, Ukraine, Israel, Taiwan etc. One of the rationales for New Zealand's Defence Forces is to maintain capabilities which have an option value in the face of an uncertain future environment. As such, they are a form of capital, but much of that value isn't recognised under accounting conventions.

An alternative view is that external security is a separate domain that is an intermediate outcome (the absence of or mitigation of threats but not a final outcome in and of itself). With the possible exception of safety from external threats (which is part of the safety domain), external security is an intermediate outcome that helps secure other valued final outcomes and a capital that protects other capital stocks and is a part of resilience. These can include current wellbeing domains (as with the Ukraine example above) but also international connections in L2 and protecting national capital stocks in L3 (e.g. the role of the defence forces play in fisheries protection).