



Social Return Accounting

Using social science to calculate rates of return for government expenditures

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Executive Summary

Governments make expenditure decisions on items ranging from roads and rail lines to hospitals and schools to welfare benefits and social insurance schemes. Yet there is no common "language" for evaluating the social return of these different expenditures. The lack of such a language makes it impossible to prioritise these expenditures in a principled manner. Furthermore, physical infrastructure which is more amenable to traditional financial analysis is often privileged over social infrastructure. This report provides a method—Social Return Accounting—for evaluating all government expenditures on a level playing field.

Many government expenditures or investments have returns that are not easily put into monetary terms. What is the value of a hospital? A school? Public housing? Even the benefits of physical infrastructure cannot be determined from market prices when there are spillovers/externalities from use. In short, it's not easy to determine the social benefits of many government expenditures.

Social Return Accounting provides a method of doing so using rigorous, modern social scientific techniques. It provides a bridge from social science to social benefits.

This report outlines the Social Return Accounting approach and illustrates it through two detailed examples of large Australian government expenditures: the National Broadband Network and the National Disability Insurance Scheme.

There has been significant debate about which of the two competing approaches to the NBN—Fibre-To-The-Premises (FTTP) or Fibre-To-The-Node (FTTN)—is preferable.

This report shows how to calculate the Social Internal Rate of Return of both technologies. We estimate the SIRR of FTTN at 15.2% and the SIRR of FTTP at 21.1%.

The NDIS illustrates another dimension of Social Return Accounting. The report shows that the economic value of the life-saving benefits of carer stress are significant and go some way to offsetting the additional cost of the NDIS over existing schemes. The remaining difference between costs and benefits can be quantified, putting a dollar figure on the value of ex ante insurance against disability, and ex post dignity for those living with disability. That figure amounts to less than 1.1% of income for the average working Australian.

Social Return Accounting does not do away with the need to make assumptions. What it does do is deliver a principled way to measure the return on social investments of all kinds—ranging from physical infrastructure to social insurance schemes. By putting all government investments on a level playing field it permits a clearer assessment of how to prioritise government investments.



"Social Return Accounting does not do away with the need to make assumptions. What it does do is deliver a principled way to measure the return on social investments of all kinds—ranging from physical infrastructure to social insurance schemes."

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Overview

The Social Return Accounting Approach

Any private-sector enterprise considering an investment opportunity estimates the future cash flows over time and compares them to the cost of the investment. So-called "discounted cashflow" (DCF) analysis provides a percentage return that can be compared to the cost of capital—or "hurdle rate"—to determine whether the investment should be made.

Calculating the Internal Rate of Return (IRR) of a project involves making various assumptions about the future, such as future prices and market share for a business, and these assumptions are consequential for the result. But the process has two important virtues. First, it clarifies the assumptions required to reach a certain, threshold rate of return. Second, it provides a common unit of measure to compare all projects, even if they are of a very different nature, in different businesses, or in different geographies.

Government budgeting, by contrast, involves none of this discipline. Projects are often selected based on political considerations—both inside and outside the government in question. Powerful cabinet members or those representing certain segments of the population may be very successful in getting their preferred projects funded, regardless of the social and economic merit of those projects.

This report provides a framework for bringing the private-sector approach to capital allocation to public-sector capital budgeting.

The costs of a public-sector project are typically no harder to estimate than for private-sector projects. On the benefit side, however, matters are more complicated. In the private sector revenues and profits are the appropriate measure of benefit. But many government expenditures or investments have returns that are not easily put into monetary terms. Yet this doesn't mean that there aren't ways of estimating the equivalent monetary value. The social benefit of hospital, schools, or public housing are not so easy to quantify. Even the benefits of physical infrastructure cannot be determined from market prices when there are spillovers/externalities from use.

Social Return Accounting provides a method of quantifying the benefits of government investments and expenditures by using rigorous, modern social scientific techniques. It provides a bridge from social science to social benefits.

An example

Consider a policy proposal to extend the school day for primary school students by, say, 2 hours for all government schools in a given state. Calculating the costs of such a policy would be relatively straightforward. There would need to be extra funding for teachers, additional teaching supplies and utilities, funding for the transition costs to the new system, and so on.

The benefits are not so easy to measure, but SRA provides an approach—using the bridge from social science to social benefit.

"Social Return Accounting provides a method of quantifying the benefits of government investments and expenditures by using rigorous, modern social scientific techniques. It provides a bridge from social science to social benefits." The starting point would be determining the causal effect of a longer school day on standardised test scores. This would best be understood through a randomised controlled trial (RCT) with perhaps 50 schools in a treatment group and 50 (or more) in the control group. Each school, of course, would have several hundred students in it. With the treatment schools randomly selected essentially all one has to do to understand the causal effect of the longer school day on test scores is look at the differences in the average scores in treatment and control schools.

Such an RCT might have been run in a similar enough jurisdiction that those results could be used. Ideally, if time permitted, a new trial in the target schools would be performed.

The next step in the bridge is to use the best available evidence to map standardised test scores into later-life outcomes of interest. This could involve estimates of how primary-school scores map into secondary-school scores, and then how secondary-school scores map into a range of laterlife outcomes such as income, employment, health, incarceration, and others. The social value of these concrete later-life outcomes—income being the best example—are easy to value.

With the flow of costs and benefits understood, determining the Internal Rate of Return of the policy proposal is a simple financial analysis exercise—exactly akin to valuing any private-sector investment.

Two Applications

This report considers two Australian applications of the Social Return Accounting (SRA) approach: the National Broadband Network (NBN) and the National Disability Insurance Scheme (NDIS).

These are two large, recent public expenditure programs and they illustrate two different types of programs. Both enjoy bipartisan support from the Coalition and Labour party, although there is disagreement about the level of investment. The NBN is a clearly defined piece of national infrastructure whose benefits are relatively easily formulated in economic terms. That said, not all of those benefits can be determined simply by looking at what individuals are willing to pay for service plans on the NBN. There are *positive externalities* that are not captured by market prices, arising for two principle reasons.

The first is that the NBN is a classic example of a *network good*—the benefits that accrue to any individual depend on how many (and which) other individuals are also connected to the NBN. There is little point to have fast internet connectivity if those one is connecting to have slow connectivity. The second is that individuals may not internalise the full benefits of additional speed.

The NBN is a useful example for another reason: there have been two competing approaches to its development. The first involves connecting all premises in Australia directly to the network, so-called "Fibre-To-The-Premises" (FTTP) and so-called "Fibre-To-The-Node" (FTTN). FTTP offers faster speeds but is more costly to build. FTTN is cheaper to build but delivers slower speeds. Which approach is preferable depends on their Internal Rate of Return (IRR). We calculate the IRR for both FTTP (21%) and FTTN (15.1%).

The benefits of the NDIS, by contrast, are harder to measure in economic terms. This report considers issues such as reducing family and carer stress, and the value of independence. Yet it is still possible to put a range of economic values on these issues. This range is larger than for more readily economically-measured investments (like the NBN).

At the higher end of the range of benefits, the cost of the NDIS can be justified purely on the grounds of issues like reducing carer stress and valuing independence. At the lower end of the range, those benefits do not, on their own, justify the cost of the NDIS. But since we can calculate by how much, we can determine what value of *ex ante* insurance against disability would be required to justify the cost of the NDIS. Even in this case that amounts to 1% of the average income of working Australians.

SRA does not do away with the need to make assumptions. What it does do is deliver a principled way to measure the return on social investments of all kinds ranging from physical infrastructure to social insurance schemes. It provides a way of putting all government investments on a level playing field, permitting a clearer assessment of prioritising government investments.

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Social Return Accounting in Context



Brief Introduction and Framework

Public authorities, academics and financiers have long recognized that market economies cannot provide citizens with all the goods they need, or which would be socially optimal. Economics is clear that certain "public" goods will be underprovided or provided suboptimally absent public intervention in the market. Politics and public budgeting is thus an extension of this debate about the appropriate limits of such interventions. Political debates, particularly in Australia, often focus on the principles underlying a particular intervention or set of interventions which one party or another may propose. However, there is rarely a common language, much less an empirical or research-based one, which political participants use to evaluate interventions and determine them worthy or unworthy of public funding. Social return accounting is that common language which takes market-based principles of return on investment and applies them to the unique circumstances of public investments to determine their social value.

Below we discuss some of the history and applications of attempts to measure social return on non-market investments. This is closely related to the increasingly popular concept of "social impact investing". We chronicle social return investing's introduction and application in the few cases where it appears in the public budgeting debates in the UK. We then compare and contrast it to Cost-Benefit Analysis (CBA) which is the more dominant approach in the field of public expenditure evaluation. Following that analysis, we focus on social return investing's more widespread application and its various techniques as it has been applied in the non-profit sector. Finally, we discuss how our modelling procedures are different both from the way social return investing has been applied in both the public and non-profit sectors.

Government Investing Models

Most government budgeting and program evaluation focuses on realised costs and benefits. Programs are proposed by members of the legislature and the relevant budgeting office tallies the direct cost and revenue effects of the plan. The methods for calculating costs and revenues are prescribed by rules particular to the institution, and they tend to be conservative (in the forecasting sense), focusing on the amount of money required to be drawn from the Treasury to complete purchase orders, pay staff, lease office space, etc. The revenue sides are similarly conservative and usually concern how the program will offset other existing expenditures. Rarely do they project second or third-order effects (sometimes called secondor third-"round" effects), except to the extent that the budget office is instructed to do so or the program is expected to have a large impact on economic growth or unemployment. Even then, budget office projections are concerned with macro-economy level effects.

Social Return Investing in Government Policy

In the mid-2000's the UK government began exploring the feasibility of delivering public services through the non-profit or "third" sector.1 Through this review a committee of the UK government explored the advantages and disadvantages of commissioning public services through nonprofits.² The committee noted that non-profits may have advantages through specialized community knowledge, the ability to solicit greater take-up of services than may have been achieved through government programs, building trust with the community, and the ability to innovate service delivery more nimbly than government.³ However, there was a concern among those in government that if the public were to commission services through an intermediary it also needed a way to evaluate the progress and effectiveness of the public funds expended.4

In 2008, the UK committed itself to a project aimed at settling how it would measure the effectiveness of funds distributed through its Office of the Third Sector. At that time, it considered three different methodologies (SROI, Social Accounting, and LM3), eventually settling on the Social Return on Investment (SROI) strategy. SROI is a methodology that had existed since the late 1990's, originally pioneered by the Roberts Enterprise Development Fund (REDF) in the US and later by the New Economics Foundation in the UK.5 SROI methodology has been refined and distilled into seven key principles: involving stakeholders, understanding what changes, valuing the things which matter, including only material changes, not over-claiming, transparency, and result verification.6 SROI was chosen because it provided the government a quantifiable metric, in the form of a benefit ratio, which could be uniformly applied and compared across projects to measure the effectiveness of public funds spent on thirdsector organizations.7 SROI evaluations follow a specific chain of logic to evaluate impact, which helps assure funders that projects are being compared on a level playing field.

Further, in 2012 the UK government passed the Public Social Value Act. This act requires commissioners of public services to consider what social value their projects would create when contracting public services in amounts of €750,000 (\$1.2 million) and above. Several reviews of the Act have found both positive and negative impacts of requiring public services to consider social value. A 2015 Cabinet Office review of the Act views it as having a positive impact so far, but issues remain in take up and acceptance among the different public commissioners within the government. The Cabinet review also stated, crucially, the Act's impact has been strongly affected by a lack of clear definition about what constitutes social value and how to measure it. Many businesses are not properly informed, according to the Cabinet Office's review, of how to measure social value. The review mentions SROI methodology and recommends socialising it further when soliciting bids for public projects in order to enhance the effectiveness of the Act. Below we discuss SROI, and aim to answer the question of social value measurement more concretely.

"SROI is a methodology that had existed since the late 1990's, originally pioneered by the Roberts Enterprise Development Fund (REDF) in the US and later by the New Economics Foundation in the UK." "In 2009, the Varua and Stenberg published an SROI-based evaluation of a hot-breakfast-forkids program which had been operating in Sydney through the Daystar Foundation. The authors' evaluation estimated that Daystar's impact through the breakfast program was between \$2 and \$9 for each \$1 invested."

More Traditional Cost-Benefit Accounting Methodology

Methods for analysing the costs and benefits of a project (CBA) already exist and are widely documented. Officially authorized CBA methodologies follow a precise set of rules and prescriptions, and there are limits to what the analyst can consider and how those benefits and costs are to be allocated. For example, in the United States the Office of Management and Budget (OMB) has a manual which describes how benefit transfers are to be estimated.8 Specific rules determine how social science studies which estimate the potential benefits of a policy that has been tried on a smaller scale or in a different location can be used and extrapolated to different target populations.

CBA differs from SROI in that the latter considers costs and benefits more expansively. In particular, SROI encourages the identification of valid, new, social science research within the particular domain of the new policy. It also allows the evaluator more flexibility than traditional CBA in mapping impacts back to the investor (state or federal). Additionally, CBA methodologies often require the construction of a model of consumer preference, which is used to estimate their response through a utility function and/or willingness to pay model to a new policy.9

Non-Profit and Civil Society Investing Models

Social Return on Investment (SROI) has been used extensively in the non-profit field. We discuss its application in a variety of contexts as well as compare some of the evaluation methodologies maintained by several SROI standard-setting organizations.

Non-Profit Program and Results of Various SROI Evaluations

Social Return on Investment: A Case Study of a Community NGO in Sydney

In 2009, Varua and Stenberg published an SROI-based evaluation of a hot-breakfast-forkids program which had been operating in Sydney through the Daystar Foundation. The authors' evaluation estimated that Daystar's impact through the breakfast program was between \$2 and \$9 for each \$1 invested. The authors conduct a brief literature review of the SROI methodology and then described their specific program of focus.

They define the Daystar breakfast program across three measurable areas of impact on children's time at school: reduced school absenteeism, improved learning, reduced obesity, improved healthy lifestyle, behavioural changes, and students who return as volunteers for the program. To estimate value of reduced obesity they used a measure of public health costs associated with treatment of Type II diabetes. The behavioural effects were counted through the value of reduced crime and the associated costs of crime calculated by an Australian agency. Crimes were limited to those types of vandalism, theft, and destruction of property youths are most likely to find themselves in. The authors did not estimate the effects of better learning and reduced absenteeism because it would have required assumptions of test scores, graduation rates, and employment outcomes that were deemed to be too far into the future.

This program was focused on primary school-aged children. Using these inputs and outputs they then assigned them a value and calculated a present discounted value over 5 years. This produced a dollar figure which was netted against present costs and expressed as a benefit ratio. The authors also took care to present a range of estimates based upon plausible fluctuations of their input parameters.

Measuring Social Enterprise Value Creation: The Case of Furniture Bank

Mook, Chan and Kershaw, 2015 use an example SROI evaluation as a way to explain the method and how it could be used to justify program expenditure by a funder. In their example, the authors chronicle the work of Furniture Bank, a nonprofit located in Toronto, Canada which provides furniture to newly housed, lowincome individuals through furniture donations and refurbishment.

The Furniture Bank is a single program enterprise which takes donations of gently used furniture and gives it for free to those trying to escape homelessness. This helps the homeless because furniture is a large fixed expense in setting up a new home. The authors identified two broad streams of benefits for the enterprise. The first was for the furniture recipients, but a second parallel stream was for the volunteers who worked for the bank, who may themselves also have been homeless. The volunteers gained marketable skills and employment experience which the authors counted as useful for them escaping homelessness and poverty. The authors were careful not to count the labour of the volunteers as being free, even though in a strict accounting sense it was, from an opportunity cost perspective it was not.

Further, since many of the Bank's volunteers came from corporations and other groups on teambuilding exercises, the authors captured a small social benefit from this line time item as well.

On the benefits side, they projected health benefits from the new furniture users getting better sleep. They used additional scientific literature to extrapolate this to a reduction of doctors' visits and reduced work absenteeism due to improved sleep. The authors also accounted for the environmental effects of reduced reliance on furniture going to landfill. Finally, the authors disclose how their assumptions made a big difference to their reported impact ratios of 46% and 134%, and they calculated the ratio over 2 different financial years of the program.

Evaluation Methodologies, Reviews, and Interpretations of SROI by Academic and SROI Standards Organizations

Social Value UK Guide to SROI, 2016

Since SROI became the preferred method of evaluation of the UK's Office of Civil Society (a.k.a Office of the Third Sector), the Cabinet Ministry published a standards document which contains clear principles that underpin the SROI method. This document details the method, along with examples about how to evaluate programs.¹⁰ The Third Sector Office has standards embedded for what qualifies as a "material" benefit, what kinds of double counting is not allowed, and how to establish the appropriate time horizons for an evaluation.

The Office recommends establishing an "impact map" at the beginning of any evaluation process. This means defining how the evaluator expects to quantify value to the funder and determine what primary and knock-on effects will be counted and which will not. Using a hypothetical example similar to a "meals on wheels" program the Office explains each of its counting principles. These include valuing all inputs appropriately and ascribing near market values, or proxy values to them. For example, an evaluator should count volunteer labour as input and value it according to some standard wage level. The Office does not stipulate the precise method for valuing all inputs through proxy means, some suggestions include using revealed preference methods, contingent valuation, hedonic pricing, and time-use values.

The Office is also careful to warn evaluators about overstating the effects of their program or intervention. In many cases there is reason to believe that some level of a measured activity would have occurred in the target population absent any intervention. The evaluator should make an effort to estimate such a baseline or counterfactual, and only claim credit for the level of activity generated above the baseline. The Office's guide also advises that the evaluator conduct sensitivity analyses around its key parameter assumptions as well as for the persistence and durability of the measured effect.



Measuring Value: A Guide to Social Return on Investment (SROI) – New Economics Foundation, 2008

The New Economics Foundation (NEF) was one of the pioneers of the SROI method in the UK around the time that the Office of Civil Society was preparing to deem SROI its preferred methodology. NEF's statement on its SROI methods are substantially similar to the Office of Civil Society's guidance document, discussed above.11 However, NEF's guidance document is aimed at a broader audience than the UK Office of Civil Society. NEF states that many different bodies can use SROI to their benefit to establish social impact, not just non-profits. They also distinguish between prospective and retrospective analyses, where the latter is focused on a program which was already implemented, and the former is focused on a program which has yet to launch.

Social Accounting for Nonprofits: Two Models – Richmond, Mook and Quarter, 2003

The authors use the paper to present several models of social return accounting. They discuss an upcoming book of theirs which describes the models in detail. In general, they recognize that traditional accounting systems such as those promulgated under GAAP or FASB lack any reference to the resources used or the impacts generated outside of market valuation. They go on to discuss two alternative methods, the community social return on investment (CSRI) model and the Expanded Value-Added statement. The CSRI method is roughly similar to SROI, but it specifies a particular community stakeholder as the principal and reorganizes any program or nonprofits income and expenditure around the resources used and put back into the community through an intervention or program.

In their explanation of the CSRI concept they profile an employment training program in Canada which helps burdened job-seekers (alcohol or substance abuse, older laid off, physical or mental disabilities, etc.). The CSRI model creates an income statement, from the perspective of the community or some other public stakeholder, with inputs and outputs on either side of a ledger. The inputs are valued, including any volunteer labour resources or other non-market transacted items, on an opportunity cost basis. The outputs are then valued based upon their primary, secondary, and tertiary effects. In the case of the employment training program, the authors valued the primary effects as the wage income those who completed the program received if they obtained a job. They added secondary effects and tertiary effects as the income support savings the state government could expect to recoup now that some of the job-seekers are no longer on unemployment benefits.

In their explanation of the expanded value statement they discuss a different non-profit's program dealing with housingassistance. The expanded value statement is primarily a different way of organizing a value-added statement, with a few innovative valuation techniques mixed in. The statement is a table with columns, one each for financial, social, and combined flows of value. The first three rows are similar to the CSRI method, wherein the primary, secondary, and tertiary effects of the program or intervention are stated. Below that is a subtotal of the direct costs of the program, and the subtotal of the benefits and costs is then netted to produce a value-added figure on the bottom line. This calculation is presented for financial, social and combined effects. In the case of the housing assistance program the authors calculated the benefits of housing directly to certain poor persons. For secondary they added in the value of learning certain skills for those who were housed, and the value of skills gained by their volunteers.

Social Ventures Australia – SVA, 2017

SVA is an organization which has followed in the tradition of the UK Office of Civil Society and set up a consulting business around helping non-profits evaluate and publicize their social contributions.12 The website is an introduction to the SROI methodology, the description of which follows closely to the UK model described in the Civil Society Office brief above. SVA's take on SROI is a bit different than the UK Office's in that it places a lot of emphasis on an organization conducting interviews with its stakeholders, customers, suppliers, and community members. SVA envisions SROI as a way of taking stock of a non-profit program's qualitative impacts on its community, not just those things which can be directly or indirectly measured through economics. Additionally, SVA encourages organizations to embrace a more expansive understanding of social value than some other descriptions of the SROI methodology have. In particular, they present an example where an evaluator accounts for "increased self-confidence and an increased sense of belonging in the community" in their impact measurement. SVA does not elaborate on its methodology for such accounting in this source material.

SVA notes that the Australian government already has a handbook on CBA and requires Departments to prepare an RIS (regulation impact statement).¹³ They also noted that the Australian government published a report about the non-profit sector in 2010 and encouraged more uniformity in the way SROI was reported.



The impact maps and the way an organization wants to state its social benefits have a larger impact on the final result than parameter assumptions, such as a discount rate.

Social Capital Protocol – World Business Council for Sustainable Development, 2017

The Social Capital Protocol (SCP) is a guidance document published by the World Business Council for Sustainable Development (WBCSD) which establishes its principles for member companies to consider when choosing investment projects. The main thrust of the SCP is that businesses should consider various forms of capital return when making investment decisions, and that they should seek to optimize all forms of capital return, rather than prioritizing financial capital returns as is the custom in most market economies. Specifically, SCP is focused on providing a standard framework for collaboration on social impact investing. In particular, SCP considers social capital as made up of societal capital and human capital. The former is mainly interpersonal, comprising relationships between people, institutions, and shared values. The latter is capital possessed by individuals such as skills, knowledge, and personal wellbeing.

The SCP then outlines steps in its framework for how participants should make capital decisions, while considering all of these forms of capital. The steps of SCP are to frame decision, scope the evaluation, measure and evaluate, and then apply and integrate what has been learned.

Each step is covered in detail with relevant real-world examples. Although SROI allows a lot of discretion. SCP leaves even more up to the evaluator in terms of method and application of counting rules. However, SCP is clearer about time horizon for capital investing than SROI, specifying that the organization should consider the entire life cycle of the inputs it uses and the outputs it creates. SCP is also clearer than SROI about taking the final step to remedy any facets of its program or change its business processes to accord with what was found in the other steps of the evaluation.

Turning Social Return on Investment on Its Head – Mook, Maiorano, Ryan, Armstrong, Quarter, 2015

The authors begin by describing efforts currently underway at the **US-based Financial Accounting** Standards Board (FASB) to take a fresh look at non-profit accounting. FASB has wanted to revise the accounting standards that apply to non-profits for a while. Under current accounting rules, many non-profits currently exclude the value of volunteer labour from their total contributions, since they don't pay for it and therefore have not met the fair-value tests of traditional accounting. FASB and the non-profits believe it is too difficult to establish the value of each person's time, without the wage-market mechanism. The authors also review some case studies of several organizations which have put their programs through SROI analyses. They raise both positives and negatives, including that SROI often doesn't capture the full environment of the organizations, or the full overhead costs necessary to keep the organization running and retain talented staff. Given the limitations of SROI as a methodology, the author argues for an "interpretivist" approach to SROI impact ratios (e.g, 4:1), rather than viewing the numbers as an objective indication of quality.

The main point seems to be that SROI numbers should be presented in reports along with other context, and that the presenters should be clear about the assumptions put into the calculations.

How Our Model is Different

Our model differs from the aovernment investing and nonprofit investing methodologies, particularly SROI, in several key respects. In general, our approach is more expansive in its consideration of costs and benefits compared to government investing models. A key distinguishing feature is our use of social science-ranging from randomized controlled trials to observational studies-to appraise streams of benefits. We employ a wider view of societal capital development, by including human and social capital, whereas traditional public finance focuses on financial/ physical capital expenditure. Thus, although we have a more expansive conception of the benefits of social investment, we also have a more rigorous method of determining those benefits.

We visualise the process as unfolding as shown in the figure below. We begin with a policy problem a government or public financing authority wants to solve. In the case of NBN it was Australia's slow internet relative to its OECD peers. The analysis will only follow when government agrees to solve the policy problem through a break in the status quo. We then set about analysing which of society's capital accounts-broadly conceived and discussed below ---will be impacted and in which direction. Then, using carefully collected and vetted academic literature we create verified links between the policy change and increases or decreases in physical, human and social capital. We then relate these economically to dollardenominated value streams and to the economic costs of the project. Following that, we parameterize a model using Discounted Cash Flow analysis, like one would for a private investment project, and apply it to the streams of value and costs enumerated in the prior step.

Using the DCF we can impute a social internal rate of return (SIRR) to the project and conduct sensitivity analyses to see how robust the finding is. In some cases, as we discuss in the NDIS case below, there will be cost gaps which may have to be justified according to other principles of social justice and conceptions of fairness.

Government investing models typically focus on direct expenditures and receipts into the Treasury. Several of our evaluated programs, including the NBN and NDIS, are government programs and thus hew closely to government estimates of costs. However, on the benefit side our considerations are far wider. For example, the NBN project's annual reports tally only the benefits the NBN Co. itself will generate and return to government. Although the project's sponsors paid some attention to the increased potential for economic growth and employment possibilities faster broadband could enable, there was no direct measurement of these benefits. It was assumed that if the NBN Co. supplied faster internet that Australians would subscribe up to the point that their private valuations of the service dictated (i.e. individuals would do their

Our Model



own private cost-benefit analysis and purchase if the private value exceeded the private (subscription) cost). Our evaluation of the NBN moves beyond that to bring other streams of value, grounded in estimates from the social science literature, and estimates total public willingness to pay.

We explore the potential the NBN has to improve human capital through upskilling potential for workers, gains in ICT knowledge, and the effect that would eventually have on wage growth. NBN also has the power to increase human capital through savings which will accrue through the health system due to increased usage of telemedicine techniques. We then explore social capital by valuing the emotional connections documented through a peer-reviewed medical study of the effect on elders from videoconferencing with loved ones.

Non-profit investing models, particularly the SROI method, are useful for their own contexts and adaptable to different methods of non-profit service delivery and evaluation. However, our model follows somewhat more conservative assumptions when it comes to benefit estimation. For example, several SROI evaluations attempt to value such benefit streams as social connection to others and feelings of belonging.14 While SROI encourages organisations using its evaluation tools to find financial proxies to incorporate these benefits, the benefits may not correlate strongly with the financial proxy.

For example, in an evaluation of a craft program for aged persons in Scotland the program claimed that participating in arts and crafts lowers stress and anxiety for aged persons. While many studies do document this effect, the Craft Café program chose as its financial proxy the cost for an aged person to undergo weekly stress counselling sessions. TThe craft program's sponsors use of this proxy implies that they believe their program has 100% of this cost reduction effect and thus saved the UK NHS the cost of the counselling sessions. Of course, loneliness and depression are serious issues and it is difficult to measure these effects scientifically. However, our approach is to carefully choose which social science estimates we use, not only in establishing that there is an effect, which the Craft Café evaluation does, but to also estimate the magnitude of the effect in our estimate. We go beyond establishing that there is an effect in our use of social science research to attempt to confirm the magnitudes of such effects, also using high quality social science research. We also present a range of estimates for our work.

Finally, our work differs from the non-profit context in that we present it in the form of a rate of return on investment. While mathematically an internal rate of return and net present value calculation is equivalent, presenting it as a rate of return allows one to compare multiple options together and also relates it to the cost of public funds. This is different than the SROI benefit ratio because it relates the costs and benefits to a specific return rate over a specific time window. Two non-profit projects might have the same benefit ratio, say 4:1, but presenting that figure is not useful to a policymaker if the time horizon and rate of return are not included. A project which is expected to return 4% over 5 years might be financed differently than if it is expected to return 4% over 30 years. Policymakers need to know the rate of return and time horizon in order to choose the most appropriate financing mechanism. For shorter timeframes it is possible to use tax (equity) financing if the government believes the rate of public return will be higher than the distortionary effects of the tax. For longer timeframes it may be wiser to use debt financing, assuming that the rate of public return significantly exceeds the interest rate on government debt.

"A project which is expected to return 4% over 5 years might be financed differently than if it is expected to return 4% over 30 years. Policymakers need to know the rate of return and time horizon in order to choose the most appropriate financing mechanism."





Case Study

The National Broadband Network



Background and History

The National Broadband Network (NBN) is a project the Australian Federal Government has undertaken through a quasipublic organization to extend broadband and enhance internet speed around the country.

Australia had for years suffered from lower internet speeds than many of its OECD peers. In 2009, the Rudd government announced a plan to build high-speed internet infrastructure through a wholly owned corporation, NBN Co.15 In 2010 the government proposed a plan to extend broadband around the country, promising speeds as high as 1 Gigabit per second.¹⁶ NBN was charged with building a modern fibre-optic cable network, which would connect every Australian. Additionally, the government proposed a method for delivering the fibre-optic network directly to the premises of each subscriber's home.17 Original cost estimates for this kind of fibre-extension were quite costly, and some initial estimates put the figure as high as \$94b.18 The fibre-optic network would require significant construction costs due to the complexity of digging and replacing the existing copper telephony wires installed in most homes. This option was branded, "Fibre to the Premises", or FTTP.

"NBN service has the power to bring high speed, video quality internet connection speed to millions of Australians who do not have it. With strong video and audio quality connections videoconferencing as part of the consultation process in healthcare is possible." Following the 2013 election in which the Abbott government assumed control of Parliament the figures for NBN were revised substantially downward. Instead of constructing fibre cables to each premises the government's plan was now to construct fibre to predesignated "nodes". From these nodes the NBN signal would then flow along existing copper telephony wires into people's homes.¹⁹ Although less expensive to build, the "Fibre to the Node" (FTTN), was not promised to be as fast. The new government now only promised speeds as high as 25 megabitsper-second in internet speed.20

The Coalition government has followed through on its promise to build the fibre network to reach, through some modality, every Australian. However, the costs have not been contained to the level originally projected with FTTN. Significant cost overruns have come about through construction of nodes in new home developments²¹, existing rural areas, as well as connecting the satellite uplinks and backload for very remote areas.²² Furthermore, while there has been steady subscriber growth to NBN service, problems, delays, and download speed issues have also arisen.23

In addition, there have been issues with financing and profitability. The government took on public financing of the project with specific revenue conditions attached. In particular, because the government wanted to safeguard its investment, it demanded the NBN Company seek a 7% rate of return on its investment.24 NBN Co. is not a traditional telecommunications company. The company was formed with combinations of public and private capital for the purpose of building the NBN network only. Retail distribution and maintenance of NBN service at the customer level is the responsibility of the retail service provider (RSP). The RSPs buy wholesale access to NBN network coverage and bandwidth from NBN at controlled prices.²⁵ These RSPs then market NBN service to customers who pay for tiered broadband packages.

Due to NBN's tightly controlled and high wholesale data prices, RSPs must charge higher package fees to customers. Therein lies a tension. Although NBN is safeguarding the taxpayers' investment, those same taxpayers are potential NBN users. The users may not see their tax dollars lost, but they are still paying a high price for NBN service.

The Case for NBN

NBN service has the potential to improve the lives of Australians socially and economically through the expansion of human, social, and physical capital. When we think of capital, traditionally physical capital is what comes to mind. These are tangible, infrastructure projects such as bridges, roads, and buildings, which enhance the capacity of an organized economy to produce more goods and services. However, social and human capital are also important. Human capital is the next most familiar, comprising those skills and traits which make humans important parts of the social production function. Traditionally, this type of capital encompasses scientific or technical knowledge which allows people to perform complicated tasks and enhance the production of goods and services. Standard theory predicts that education is strongly and positively related to the enhancement of human capital. Finally, social capital is the strength of connections between people which helps them organize their familiar, personal, and professional lives, and gives them a sense of meaning and satisfaction. This type of capital is least-well understood and often the hardest to measure, but very important. Declines in social capital are associated with increases in social ills.26

We show that building the NBN was a worthwhile project and that expenditures even at the levels contemplated by the Rudd government, using FTTP, would have been justified in returns to the country though aggregates of human and social capital. We review and estimate economic returns from the literature to human and social capital, assuming the FTTP were built the way it was envisioned originally and compare those same benefits to what we assume the FTTN will provide by way of download speed.

Human Capital Expansion through ICT Skills

The first stream of benefits we focus on that would have been enhanced through the extension of the NBN using FTTP are internet-computer-technology (ICT) skills. Falck, Hiemisch, and Wiederhold 2016 present an example of broadband network extension in West Germany which shows that network extension leads to skill increases and higher wages. In the 1990's Germany attempted to expand its broadband internet capability. However, due to technological limitations introduced through voice telephony networks created in the 1960's, the Germans were only able to provide such faster internet service for those within 4.2 km of a main distributed frame (MDF). This peculiarity created a "natural experiment", where those within the arbitrary cutoff of the MDF experienced higher speed internet than those just outside of this range, despite being culturally, socially, and economically similar to their neighbouring communities. This permits estimates of the treatment effect of higher internet speeds, rather than simply measuring a correlation.

The authors were able to measure wages, ICT skills, and other covariates to a very fine level of detail and at a rich sample depth for communities both within and without the 4.2 km cutoff. They found those within the higher speed range communities had substantially higher ICT skills and experienced a wage return from those skills, relative to the communities outside the cutoff. We have taken the German experience and extrapolated it to the Australian context. Using a 30-year time window, we have forecasted a hypothetical wage return to the introduction of higher speed broadband internet. Although the Falck et al paper describes many different conditional returns to ICT skills, some as high as 17%, we use one of their lower estimates, 8%, in our calculations in order to be conservative. Using data on average weekly earnings across various information-technology relatable industries from the ABS, we generate a present value of \$205 billion in wage returns to Australia over a 30-year period. Additional details of this calculation are in the appendix.

Method of Benefit Transfer

While we find increases in ICT skills rise with expansions of broadband service it is important to discuss how those benefits transfer. In the German case, the authors believed the effect of broadband was largest on those who worked in jobs that required problem solving and complex communication tasks, rather than routine tasks.²⁷ While it is possible that introduction and training on computers could happen in the work place, another avenue of transfer is through schools.

There is an extensive literature examining the impact of expanded broadband access to schools. A 2012 article from McCoy, Quail and Smyth found that broadband expansion in Ireland, which led to some students having access to faster internet in their homes than others, improved mathematics and reading proficiency on standardized tests.28 This measurement was done longitudinally, at the student level, and controlled for a variety of covariates.²⁹ Additional evidence for positive test-score effects has been found, but there is some doubt regarding the impact. Silva et al. 2016 found that broadband access to children in Brazil correlated with small increases to their standardised Portuguese language test scores.³⁰ Falck et al 2017 found near net zero effect on test scores, but when they decomposed the effect they found positive results in some test scores and negative effects on others.31

Falck et al controlled for the student taking the test across time and subject, and were thus able to isolate a more specific effect than many others. Other better identified studies using a randomized controlled trial intervention have found positive test score effects from computer aided instruction (CAI)³², an overall improvement in math test scores in China³³, and the effect can also extend to remedial education programs in India.³⁴

There has been some dispute in the literature regarding the effectiveness of broadband in raising test scores. Belo, Ferreira, and Telang in 2014 found negative correlation with broadband use and 9th grade test scores in Portugal.³⁵ However, that is not the conclusion of most economic studies and we have serious reservations about the methodologies used in that paper.³⁶

While the discussion of test scores is important to achieve educational benefits, we do not specifically relate it to an economic benefit here. We believe this effect is already captured by the relationship between broadband expansion, ICT skills, and wage effects in the section above regarding human capital. While ICT skill build-up can occur in the workplace, exposure in an educational environment can prime graduates to be ready to take up such skills for pay in the context of formal employment or higher education.³⁷ Higher test scores may also lead to better rates of graduation, educational opportunities and skill building. However, these effects are ultimately expressed in an economically measurable fashion through a wage. Because we have already measured this effect once through the German example, we do not count them twice.

Health Benefits from Telemedicine

One component of human capital is the skills that workers bring to the labour market, but another is their wellness and abilities to do the tasks asked of them. Therefore, health is an important component of human capital. NBN service has the power to bring high speed, video quality internet connection speed to millions of Australians who do not have it. With strong video and audio quality connections videoconferencing as part of the consultation process in healthcare is possible.

There is evidence that the application of telemedicine through videoconferencing or improving the speeds at which health professionals can exchange large quantities of information about patients can improve service and reduce costs. A study of Hong Kong emergency hospital transfers showed that the introduction of tele-radiology (study of radiological images taken of patients) reduced the transfers of patients to intensive care by 21%.³⁸ Already in Australia examples of cost savings are evidence from pilot studies in Queensland which showed that the tele-paediatrics program saved Queensland's Department of Health 33% on a paediatric program over 3 years due to fewer patient transfers being required.39 Generally, these savings come from elimination of costs not directly associated with medical care, but which the health system would be required to absorb. These include travel for medical purposes or special modes of transfer for patients with difficulty moving. They can also include reduced overhead for lease and maintenance of physical buildings and offices required to see patients if videoconferencing substitutes for face-to-face consultations.40

If we applied these principles on a larger scale, we can estimate the savings for the overall Australian health system with certain parameters. Nearly every Australian State or Territory runs some version of a patient transfer scheme program that will reimburse or pay up front to transfer patients from one part of their territory to another part within it or interstate to obtain the care they need. Each state's program is slightly different in its benefit generosity, how much it pays for meals, accommodation, and what benefits a traveling partner is entitled to. Nonetheless, the states and territories spend a combined \$188 million per year on patient transfer assistance programs.41 While it is unreasonable to expect that NBN service would eliminate the need for all patient transfers, we estimate that the states and territories could cut half of their patient travel assistance budgets were videoconferencing and other benefits of broadband available. We estimate that the 50% cost savings in public funds for these programs over a 30year window and discounted to the present would provide \$1.8 billion in benefits.

Social and Emotional Connection for Aging Persons

One of the primary benefits of NBN is bringing to Australia is the ability to more easily videoconference across large distances. We tend to think about this benefit only in the context of improved physical capital and how videoconferencing will reduce travel and meeting costs for businesses or improve file transfer speeds. Yet, videoconferencing for personal use is a huge potential benefit. In this section we describe how personal use of videoconferencing can improve contact between elders and their loved ones.

Social Connection and Depression in Aged Care Facilities

Being away from loved ones for extended periods can cause stress and depression. These conditions can also precipitate physical health problems. Residents of aged care facilities are particularly vulnerable to these effects due to their isolation from family, lack of independence, proximity to others of only their own age and frequent medical issues. Visitation and activities can alleviate some of these stressors, and videoconferencing can play a role in mitigating depression and stress. Tsai and Tsai (2011) studied a videoconferencing intervention in an aged care facility in Taiwan for this exact purpose.⁴² The authors selected 23 aged care facilities across Taiwan based on size and internet connectivity to participate in the study. Although only 16 eventually participated, those facilities which did randomly assigned residents into the treatment and control groups. The residents were pretested for cognitive capacity and symptoms of depression and loneliness. Those in the treatment group were asked to use the internet to communicate with family members at least once per week for 3 months to adapt to the technology and then could use it however much they desired after that. The study's results showed both loneliness and depression

decreased among the treatment group relative to the control group at 3, 6, and 12 months after the intervention.⁴³ These reductions were statistically significant on the order of 0.5 standard deviations for the loneliness metric and 1 standard deviation for the depression metric.

Decreases in loneliness and depression are valuable on their own, but they can also take on public health cost significance due to their relationship with other physical medical problems. Another study from Switzerland shows that those who have depressive symptoms upon hospital admission for an unrelated medical problem have a higher probability of re-admission and morbidity than those without such symptoms.⁴⁴ The Swiss study found that 22% of the patients studied had depressive symptoms which were high on the GDS measurement scale, and that those who had such symptoms were more likely to be readmitted and had 1.6 times higher morbidity than those without them.⁴⁵ Further, the study also found that those who had depressive symptoms cost 28% more in inpatient services to treat per day than those without.

We believe that videoconferencing for elders in aged care facilities is a measurable benefit which NBN can achieve and make more widespread. Therefore, NBN can forestall Australia having to bear the cost of increased elder depression and medical costs. To appreciate the full effect, we construct a cost estimate for this population.

According to the Australian Institute of Health and Welfare's (AIHW) GEN aged care database there were 155,295 adults age 75 or higher permanently in residence in aged care facilities in 2016.46 Another fact sheet from the AIHW indicates that 46% of aged care facility residents are suffering from depression.47 Using this figure implies 71,436 adults in aged care could be depressed. Another AIHW data set which tracks the complex health care needs of adults in residential care shows that 63% of those residents were rated as having high needs for complex care.48 Using this figure as a predictor for those who are likely to enter hospital we estimate that 45,004 depressed adults in aged care may enter the hospital at any time. These figures are reasonable given a study which was performed by AIHW in 2008 regarding transfers from hospital to residential aged care, which showed that roughly 52,000 hospital separations that year were for adults already in residential aged care.49



Among the depressed who stay in hospital for any condition, the Swiss study showed several things. First, it showed that those who are depressed tend to stay in the hospital longer and that the cost per day of their hospital stay was 28.3% higher than those who were not depressed. The AIHW study on transfers from hospital to residential aged care found that those returning to aged care had a 6-day median stay.50 In order to estimate the cost to the health system of repeated stays by depressed adults in aged care we must also construct an estimate of stay cost. A NATSEM study by Brown, Abello and Thurect in 2011 found that the cost per day of hospital for older Australians experiencing cardiac or pulmonary disease was \$2,009.⁵¹ However, this study was performed in 2004 and the cost must be inflated to present value. Using a medical cost index from the AIHW, we found the average annual increase in medical costs was 5.6% between 2014 and 2005.52 Using this figure and inflating to the present the cost per day would exceed \$4,075. We then multiply all of these figures through including the depressed population of adults in aged care who are likely to go to hospital, the median stay for such adults in days, the cost per day, and finally the Swiss study's increased likelihood that those with symptoms of depression are to be readmitted (1.57). Summing up these effects produces an annual estimate of \$1.73 billion in medical costs.

However, the Tsai study does not imply that videoconferencing entirely eliminated depression and it would go beyond the literature to make such an assumption. Instead, the study showed that compared to the control group the treatment group's depressive status indicators went slightly down initially and then was held steady after 12 months. The study showed that the control group's depressive status indicators increased by 50% over the course of the 12 months and experienced no reductions.⁵³ Applying a 50% decrease scaling to our \$1.73 billion estimate implies an \$864 million decrease in medical costs if depressive status is linearly linked to all other parts of the value chain. This estimate when spread over a 30-year window discounted to the present this would produce \$16.9 billion in economic value.

We posit that part of NBN's effect in expanding videoconferencing capability to all of Australia through higher bandwidths will be to reduce the prevalence of depression amongst those in aged care facilities. Given the linkages between depression in aged care facility residents, longer hospital stays, and higher medical costs we believe investment in this area could bear significant benefits. It is also worth considering that this estimate focused on a narrow group of individuals who could benefit from enhanced videoconferencing capability. While older persons, in general, have higher medical costs, if the link between videoconferencing with family and friends and reduced depressive symptoms holds for the general population as well as the other linkages between depression and hospital stay, this estimate could be a lower bound to what the health system in Australia could save.

Measurement of Costs and Benefits Together

So far, we have given a history of NBN, described the difference in the investment required to complete the project under the FTTP and FTTN scenarios, and articulated three streams of value that could be weighed against the costs of either broadband expansion scenario. Altogether, we have computed that Australia could net \$224 billion. This total flows from the sum of the three streams of value discussed above. including \$205.7 billion from human capital and productivity impacts on wages, \$1.8 billion from reduced patient transfer expenditures, and \$16.9 billion from reduced depression and medical costs for aged care residents. But, we have not conditioned the flows of value from these streams on which scenario the Australian government chooses, either FTTP or FTTN. In this section we discuss the costs and benefits and use a linear estimate of internet speed as a proxy for benefit flow from either project scenario.

NBN Cost Differentials Under FTTP or FTTN

One of the main drivers of switch from the Labour plan to extend fibre to the premises and the Liberal plan to pursue fibre to the node was cost. The Labour plan was estimated to cost \$44 billion but suffered from repeated setbacks and higher costs. A detailed financial summary in 2013 showed revised estimates of the rollout's cost as high as \$72.6 billion through the end of fiscal year 2024.54 In order to estimate the cost of the FTTN we have used actual NBN Co. expenditure reports from recent periods as well as their projections for the next several years to model costs.55 The FTTN is expected to cost \$44.5 billion, assuming the same revenue assumptions in the FTTP plan held.56

Underpinning the FTTP plan was the understanding that it would have boosted speeds for more NBN subscribers. This was an early part of the debate over the plan. The New Zealand rollout of NBN used the FTTP model, and it is generally acknowledged that they can achieve higher data speeds as a result of this.57 This can be confirmed through reports on the state of internet speed and connectivity which are published by Akamai, a web performance and media delivery company. In the first quarter of 2017 this report showed that Australia's average connection speed was 11.1 Mbps and New Zealand's was 14.7.

In order to compare the FTTN to the FTTP we must measure both the costs and benefits of both. Using the cost and revenue projections for the FTTP from 2013 we assumed all capital expenditures were incurred at the beginning of the project and calculated an internal rate of return of 21.1% for FTTP. For FTTP, we assumed that the net benefits accrued through sum of the sources of human and social capital we discussed above (\$224 billion) less the projected costs. We then used the FTTN cost projections, which were informed from more recent NBN corporate plans, and the sources of human and social capital to construct an internal rate of return. However, when calculating FTTN's rate of return we linearly diminished the \$224 billion from human and social capital by 50%. We diminish the benefits because FTTN is expected to be slower and impact bandwidth, and we assume that the medical, social, and skill building benefits Australians expect to enjoy are correlated to their connection speed. We do not include the NBN Co. revenue as an additional line item in either the cost or benefit portion of the calculation, because this is simply an accounting transfer from the users of NBN service to the creators of it. Estimates of Australian internet speed as well as proportions of various countries' population in the

Asia and Pacific region that have access at 4, 10 and 15 megabitsper-second (mbps) are available through Akamai reports. Although Australia is close to New Zealand in most of these metrics it is still far behind some of the most advanced countries in Asia and Europe. For example, Japan, Singapore, Hong Kong, and South Korea (the fast four) all had average speeds in excess of 20 mbps in Q1 of 2017, while Australia had 11.1. On average, this puts Australia at 50% of these countries speeds. Similar patterns held when comparing the proportion of Australia's population which had speeds greater than 4, 10, and 15 mbps. The fast four averaged over 93% for proportion with access to 4 mbps or more, compared to Australia's 81% and New Zealand's 91%. Australia only had 35% with access to 10 mbps or faster, compared to well over 70% for the fast four. Finally, Australia only had 19% with access to 15 mbps or faster, compared to an average of about 50% for the fast four.

Further justification for the 50% benefit diminishment for FTTN comes from text of one of the Akamai reports from Q3 of 2016. Regarding Australia and New Zealand, they write:

The third quarter saw significant progress for ultra-fast Internet in New Zealand. Chorus, Enable, Northpower Fibre, and Ultrafast Fibre — the four wholesale telecommunications providers working as part of the publicprivate partnership to build the New Zealand governmentowned Ultra-Fast Broadband (UFB) network — all announced that gigabit FFTH services would be available throughout the UFB network starting October 1. Once completed in 2022, the UFB is expected to service 80% of New Zealand's population, while the already complete Rural Broadband Initiative delivers speeds of 50 Mbps to the remainder of the population. Shortly following

this announcement, local ISP Bigpipe declared that all of its customers who were then on the fastest plan of 200 Mbps would receive free upgrades to gigabit speeds.

In neighboring Australia, the National Broadband Network (NBN) announced it was on track to roll out universal broadband access at minimum speeds of 25 Mbps, with 40% of the country having gigabitspeed access by 2020. The state-run NBN is a wholesale network that provides access to retail ISPs. It faced protests in the third quarter for its high fees, which include both a per-user access fee and a usage-based fee - the latter being priced at roughly \$12 (\$15.75 AUD) per Mbps. Local telecommunications executives have warned that the high fees would cause customers to avoid high-speed Internet plans and could also make the retail ISP business economically unviable.

Given that Australia is only projected to cover 40% of the country with access to 1 gigabyte connections by 2020 and that New Zealand is projected to have UFB service available to 80% of its population it seems reasonable to condition the benefits of FTTP by 50%.

This leads to an IRR for FTTN of 15.2%.



Case Study

The National Disability Insurance Scheme



Background and History

The National Disability Insurance Scheme (NDIS) is a new federal policy Australia has implemented to replace prior State and Territory-based programs for funding supports to those with developmental, intellectual, and physical disabilities. The program's main features are that it allows disabled individuals, or their representatives, to design their own package of care around a pre-determined block of funding and increases funding and workforce development in this space compared to earlier State and Territory-based programs (ST). The NDIS is administered nationally through the National Disability Insurance Agency (NDIA). NDIA's role is to solicit and review applications for NDIS-funded supports for those with disabilities in Australia. NDIA then makes a determination on an applicant's submission and through a Local Area Coordinator helps them to design an individual support plan. Overall, NDIS is expected to cost \$22 billion per annum if fully funded at current benefit levels.

"Many family members and carers felt that being in the NDIS had helped to reduce the financial strain that living with disability and caring for a person with disability entailed." In 2006, disabled interest group chairman Bruce Bonyhady began pushing for change in the way disability was supported in Australia. Bonyhady is the chair of Yooralla, one of Australia's biggest disability service providers in Victoria. He is also the father of two sons, both born with cerebral palsy. Bonyhady began circulating his concerns among others including Brian Howe, a cabinet minister, and slowly the project began to take shape. Bonyhady formed a group called the Disability Investment Group in 2008, which began advocating for change in the way disability was financed, particularly emphasizing that it be done on an insurance model rather than a welfare one.58 Building on the momentum of Australia's ratification in 2008 of the UN Convention on the Rights of Persons with Disabilities (CRPD), the Group's issue was taken up by the Australian Productivity Commission (PC).59 The PC issued a report in 2011 on the state of disability in Australia and made a strong case for change.60 This was further bolstered by work PriceWaterhouse Coopers (PWC) performed around the same time. PWC's analysis indicated that moving from the status quo ST system to an NDIS-like insurance model would eventually save Australia money, along with providing better supports. PWC's analysis was based on a pilot program started in New South Wales called Stronger Together 2 (ST2).

Following the PC and PWC reports the government began to take action. The Council of Australian Governments, a body linking the Federal with State and Territory governments, agreed in 2011 on the need to reform disability support and financing.61 In 2012, an agreement was reached to launch the NDIS system on a trial basis in three jurisdictions, SA, Tasmania, and ACT. Since then, all other States and Territories have agreed to rollout the NDIS in phases. In March of 2013 parliament passed the NDIS Act, which created the NDIA at the federal level and funded it through increased Medicare levy. Initially, NDIS was to be named, "DisabilityCare Australia", but it was changed to the NDIS in late 2013.

Despite the unified enactment, NDIS was not launched at the same time or in the same fashion in all Australian States and Territories. The NDIS launched in July 2013 for SA, Tasmania, and the Barwon area of Victoria. The ACT launch was in July 2014.62 Following its launch in these areas, NDIA commissioned an evaluation study with the National Institute of Labour Studies (NILS) of Flinders University in SA to conduct an evaluation of the NDIS in its early phases.63 This evaluation includes several survey instruments used to collect quantitative information as well as interviews to obtain qualitative responses. There are several surveys, one aimed at NDIS participants, to the extent they can respond to the questions in different formats, another for the families and carers of NDIS participants, and another specifically to gauge disability support providers (DSP) employees and firm owners' opinions.64 A key feature of the NDIS is improving the outcomes for persons with disabilities as well as the lives of their family and carers. Another key goal is to improve the competition and quality of service in the DSP workforce. To the extent that NDIS is successful, the NILS evaluation will be key. As of this writing only the initial and intermediate findings reports are currently available. However, NILS intends to release a final report soon.

The Case for the NDIS

Many parties have made the case for the NDIS over the previous system. The PC, PWC, COAG, and the Commonwealth government have all determined NDIS represents a crucial reform, despite its additional expected cost. NDIS is a different type of program than a discretionary expenditure on a particular infrastructure investment. This is because it funds supports for the most vulnerable in Australian society. It is difficult to measure a return to society from allocating the marginal dollar to NDIS using investment models. In contrast to the NBN, NDIS is one in which issues of morality and fairness play a central role.

In 2017, NDIA endorsed the PC's estimate of \$22 billion per year to properly fund the Scheme. In 2009, the Commission found then current expenditure on ST programs was \$6.5 billion. Inflating that to present amounts using the RBA's **Consumer Price Inflation series** would be \$7.73 billion.65 This leaves a real cost gap of approximately \$14.2 billion per year. While the rest of this section will focus on some of the quantifiable benefits we can estimate surrounding the policy shift to NDIS, we will invariably be left with some portion of that cost gap in place. At the end of this section we will discuss an approach in political philosophy that justifies using public funds for an insurance scheme which covers this gap and puts an implicit price on that insurance.

Reducing Family and Carer Stress

The PC report found clear evidence of stress amongst family members and carers of persons with disabilities. The report shows that over 50% of respondents to a 2009 SDAC survey of carers for persons who PC believed would qualify for NDIS felt 'weary' or 'lacked energy'; 47% felt worried or frequently depressed; 18% had been diagnosed with a stress-related disorder due to their caring role; 32% had sleep interruptions that affected daily functioning; and 47% felt like they were losing touch with friends since taking on a carer role.66

These results are compounded by the financial duress that families or carers were often under due to the limited financial resources provided to them. The initial report from the NILS at Flinders regarding the family and carer evaluation of the NDIS credited it with reducing their financial stress:

"Many family members and carers felt that being in the NDIS had helped to reduce the financial strain that living with disability and caring for a person with disability entailed. Increased access to supports including respite, support to assist with personal care and independent living and life skills, and supports around the house eased the burden for some family members and carers, and allowed them to be involved in other valued activities such as employment, social activities and quality time with other family members."67

In particular, the NILS evaluation reports have shown that among the trial NDIS populations of carers and families that the NDIS framework is reducing the stress of caring for a loved one with a disability. The Intermediate findings report, which contains a richer set of data about carers and families, shows that 44% of carers say they have some control over how they spend their time, with 25% reporting having 'a lot' of control.68 Additionally, 33% of carers reported having time to take weekly or daily breaks from their responsibilities, and Table 45 of the report shows that 65% of carers said NDIS has increased carers' ability to provide assistance.⁶⁹ Further, in Table 46, 51% of respondents said NDIS has decreased their anxiety about having supports in the future.

The value of this decrease in anxiety, stress, and fatigue among carers is likely correlated with increased benefits to the disabled for whom they care. In measuring the value of this decrease we look to an example from the medical profession when it put in limits to the hours that young resident doctors in hospitals had to work.

"In contrast to the NBN, NDIS is one in which issues of morality and fairness play a central role."

The medical profession in the United States has a wellestablished procedure for training new doctors around the time when they receive their board certification. To become a doctor in the U.S. a student must graduate from an accredited undergraduate university and successfully apply to an accredited medical school. Following graduation from a 4-year medical degree program graduates hold an M.D., but are not fully licensed to practice medicine until they complete a 'residency'. Whereas medical school teaches and evaluates broad knowledge about body systems, pathology, and research skills, medical residency is an apprenticeship in which the young doctors learn how to work in a clinical setting and treat patients. The length and intensity of these residences depends upon one's chosen field within medicine. These residencies are often very stressful, because of the rigour of the work as well as the long hours residents are required to work or stay 'on-call'. At times these shifts can reach or exceed 24 hours.

The governing board for graduate medical education in the U.S. the ACGME first restricted duty hours to 80 hours maximum per week, over a 4-week average in 1989.70 Following extensive study in 2003, the ACGME promulgated additional regulations which kept uniform standards, but allowed flexibility for certain specialties. The ACGME's report considered a great deal of evidence and concluded there were high risks to overworking residents in stressful conditions. Following the duty-hour restrictions several prestigious medical journals published evaluations of the dutyhour restrictions and whether there was a decrease in the medical error rate as a cause. Several evaluations which followed, one of which was published in the New England Journal of Medicine, found substantial decreases in the rate of medical errors and serious errors for those residents who followed the ACGME regulations, compared to those who did not.71

Furthermore, medical researchers who implemented hours regulations noticed residents made fewer mistakes, had improved sleep and that it helped reduce patient mortality rates. Fletcher et al. 2011 conducted a study of studies which had investigated the relationship between medical error and mortality rates from before and after the ACGME 2003 duty hour restrictions. Fletcher's literature review found most studies estimated a 2-percentage point decrease in patient mortality due to the duty hour restrictions.

"There are clear parallels between medical residents and Australian disability support carers and family members"

Disabled individuals face a similar, although not identical situation. Many disabled individuals funded by the NDIS have difficulty providing for themselves and are reliant on care-givers for mobility, meal preparation, and maintaining their living quarters. For such an individual, having a stressed or tired caregiver could be dangerous, particularly if the disabled individual is suffering from an unrelated medical problem, or accidentally injures him or herself. Researchers from the Department of Developmental Disability and Nueropsychiatry at UNSW (Trollor et al.) conducted an inquiry into the preventable deaths suffered by those with intellectual disabilities (ID).72 Matching records between 2005 and 2011 from the NSW disability services minimum data set and death records the researchers were able to track causes of death for persons with an ID and compare them to the general population using ABS data. They found that persons with ID suffered higher rates and more premature death from preventable causes than the population comparison group. This finding is significant particularly because the nature of the person's intellectual disability bears little on what the researchers found they died from. The authors found that 38% of the deaths of those with an ID were preventable. The causes of death included circulatory issues (12%), infections (9%), cancer (5%), injury or poison (5%), and respiratory (3%).73

Applying the lesson of resident duty hour restrictions to the NDIS provides us a way to estimate the value of the reforms. There are clear parallels between medical residents and Australian disability support carers and family members. Medical residents who did not get enough sleep were making preventable mistakes and causing injury or death which was preventable. NDIS has already been shown to be reducing the stress and anxiety levels of carers. We posit that this reduction will translate into better care for disabled individuals.

Taking the Trollor figures' rates of preventable deaths for persons with disability and the population of persons we expect to be in NDIS we can estimate a number of lives saved through reduced carer stress. There are 460,000 Australians who are eligible for NDIS. There is an overall 4% annual mortality rate for persons with intellectual disability in Australia.74 If we assume Trollor's full figure of 38% of deaths are preventable, we estimate that nearly 7,000 lives will be saved per year.

This estimate is reliant on several assumptions. First, it assumes that the rates of mortality and preventable deaths for the entire NDIS population would be equivalent to those who have been measured - those with intellectual disability. It is plausible that these rates are lower for persons with different disabilities. Second, using 38% to scale down the average mortality rate assumes that either all of these such deaths were preventable and that improved carer and family attention will reduce them to zero. Mistakes happen, and this is a difficult assumption to hold. Third, some of Trollor et al.'s causes of 'preventable death', such as "circulatory issues" or "cancer", would be difficult if not impossible for any fully alert carer to prevent as they likely concern other underlying medical issues beyond the carer's control. We remove those causes and focus on infections, respiratory, and injury and poison causes. These are more likely to result from carer stress or inattention and often present physical symptom warnings (smell, discolouration, coughing, etc.) that could be detected before they became an issue. If we use only those categories, they would sum to 17%, and our calculation would show 3,100 lives saved.

Valuing Human Life in Economic Terms

The main difference between estimates of NDIS benefit and those of the NBN is the terms of expression. We have measured the number of disabled persons in the NDIS program whose lives would likely be saved under different assumptions about carer attentiveness, but this is not an economic measurement. To compare these figures to the other measures and ultimately to cost, we must estimate the value of a life saved.

Estimating the value of life is particularly fraught because of its implications that people are commodities the same as buildings, cars, or other economic assets. We do not intend this section to assume people are economic assets. However, there are methods which have been used to calculate the value of 'statistical life', and those are based on evidence. We present several valuation methods below and then apply them to the context of the value of lives saved above.

One approach is to measure what juries have awarded in general cases of death or dismemberment when another party was found at fault. Smith measured plaintiff awards in jury trials involving wrongful death in the United States from 1994 to 2000. He compiled data about the types of injuries and manner of death as well as other demographic and economic conditions of deceased or injured. The jury awards ranged (in USD) from \$1.000 to \$23 million, with the mean around \$1 million.75 Converted to AUD and updated for inflation these values would be \$1.920. \$44.1 million, and \$1.9 million.76

Economists also estimate the value of a statistical life through measuring revealed preferences. Often, this involves measuring a person's marginal willingness to accept risk of death in an activity against their economic return. For example, if someone had the option of working as a sales assistant for \$70,000 per year with the mortality risk of 2%, or in the agriculture sector for the same hours for \$100,000 per year, but the mortality risk rises to 5%, one could conclude they are willing to accept an additional 3% risk of death for \$30,000 per year. This implies the individual values his or her life at \$1 million.77 Studies in the Australian context around dangerous jobs show valuations within the ranges of other estimates.

Data from Safe Work Australia (SWA) on the number of on the job fatalities by industry show that the Transportation, Construction, and Agriculture sectors are the most dangerous. The safest are the Information and Financial Services industries, with variation in between. Using the fatality data from SWA and average weekly earnings data from the ABS we can construct similar crude industry-level risk and reward tradeoffs. Such reasonable valuations range from \$1.1 million to \$6.7 million. These figures come from reasonable swaps between industries which someone skilled in a certain trade could make. Although it would be unreasonable to expect someone to transition from mining to financial services easily, a move from Transportation to Manufacturing is not, and such a reasonable transition would imply a valuation of life of \$1.1 million.

Another method is to directly ask people how they value their lives, or parts of them. This particular method is fraught. People tend to overestimate when asked directly what value they would place on their life because there is no context provided to how they would die or reasonable comparison values. Instead, researchers gave interview subjects hypothetical questions such as would you prefer to live in community A or community B, where A has a cost of living about the same as you currently face and risk of traffic death of X, but B has a higher cost of living by Y% and lower risk of traffic death X-d.78 The researchers also estimated the subjects' willingness to pay to avoid having a disability, with questions asking their preference to live with a particular type of disability or take a chance on an operation which could remove the disability, or result in death with probability P%. Through these interviews the authors were able to measure the subjects' valuation of their own lives as well as their willingness to pay to avoid disability. The authors found the median value of life reported as \$12 million and that value of avoiding a disability was between \$0.7 and \$1.4 million. Updated for inflation and currency conversion these value would be \$1.2 to \$2.5 million, and \$21.7 million.

Applying Valuation of Life to Reduce Family and Carer Stress

We can use the valuations of life we estimated above to place an economic value on the lives saved from carers and family experiencing reduced stress due the greater satisfaction with care that comes from NDIS. We estimated two scenarios above, one in 7,000 lives could be saved if all 38% of deaths each year which Trollor finds are preventable were in fact prevented. The second was a 3,100 lives figure in which Trollor's 38% was reduced to only those deaths among disabled individuals which proper carer attention could reasonably prevent.

Furthermore, we estimated several figures for the value of a life saved using the direct and indirect valuation methods. Combining those yields the following range of estimates. Between the two scenarios the 3,100 is a more conservative estimate of the numbers of lives which could be saved. Depending on one's chosen value of statistical life the economic valuation ranges between \$3.4 billion per year to \$67.3 billion per year. Several of the revealed preference valuations of life through the industry risk and reward comparisons hew closer to the \$6.7m figure. Using that combination, the economic valuation of lives saved through transition to NDIS would be close to \$20.8 billion.

The Value of Independence

One of NDIS primary benefits is the independence it provides to disabled individuals and their families regarding their ability to design an individualised funding plan and choose their service providers. The Productivity Commission report and policymakers have suggested that with increased funding and choices Disability Service Providers will be forced through competitive pressures to provide disabled persons the highest quality service at the lowest price. Thus, the freedom to choose providers will result in better care outcomes. Although the freedom to choose is in this way viewed as a means to better care, it is worth considering what its intrinsic value is as well. In many public policy debates, freedom, economically, or politically is viewed favourably and countries with developed political and economic systems place a high value on it.

Lives Saved	Value of Statistical Life	Economic Valuation	
3,100	\$1.9m	\$5.9b	
3,100	\$1.2m - \$2.5m	\$3.7b - \$7.8b	
3,100	\$21.7m	\$67.3b	
3,100	\$1.1m - \$6.7m	\$3.4b - \$20.8b	
7,000	\$1.9m	\$13.3b	
7,000	\$1.2m - \$2.5m	\$8.4b - \$17.5b	
7,000 \$21.7m		\$151.9b	
7,000 \$1.1m - \$6.7m		\$7.7b - \$46.9b	

Table 1. Economic Valuation of Lives Saved Due to NDIS and Reduced Carer Stress



Measuring the value of freedom of choice is challenging. One way to measure the benefit is to examine a market situation in which a product or service has been marketed specifically on the basis of its ability to deliver independence to the consumer. To find this situation we refer to the U.S. market for mobility aids and devices in the late 2000's. For many years companies in the U.S. competed to manufacture and sell electrically powered mobile scooters. These scooters were partially reimbursable through U.S. Medicare, and seniors with mobility issues (bad back, leg or hip injury, etc.) who qualified could buy such a device under a public subsidy program. In some sense, an electric scooter is a luxury purchase because other devices such as an ordinary walking cane or hand rolled wheel chair are low cost and low maintenance substitutes. In some situations, they even perform better than an electric scooter for negotiating kerbs, bumps, and small stairs. Additionally, a scooter is bulkier and requires battery upkeep and charging. They have more parts and points of mechanical failure.

Nonetheless, the market for these devices boomed tremendously in the late 2000's in the U.S. The television advertisements for these products specifically touted their value as providing independence and mobility. One company, called The Scooter Store, advertised that, "a power chair can improve your mobility and your life". The advertisement features a senior citizen getting the device delivered and moving out of a perfectly operable wheel chair and doing circles around her living room in the scooter. Clearly, she was already mobile, but the electric scooter was valuable because it was more fun to drive around.79 The scooters usually costed between \$1,500 and \$3,500 USD.80 Another company in the same market, Hover-round sold similar products at a cost of around \$2,500.81

It is important to remember that these products were often sold as one-off items. They were not regularly consumed, so counting them as a proxy to the value of independence requires care. The NDIS is expected to serve a population around 460.000 Australians. If each of them had the mean of \$3,125 (AUD converted) worth of value from the independence which comes from switching to the NDIS, this would convey a one-time \$1.4 billion increase in economic value. Even expanding this further to the disabled individual's family of between 5 and 6 others would create \$7.2 billion to \$8.6 billion in value.

We don't mean to reduce the value of rights to dollars, but if we fail to quantify in some way, we often fail adequately to invest in public and social infrastructure necessary to sustain and realize these rights effectively.

True Program Cost, Residual Cost and a Just Society

As mentioned at the beginning of the section, the Productivity Commission report and the most recent NDIS Annual Report estimate the program will require \$22 billion to continue funding the scheme. In 2009, the Commission found that expenditure on ST programs was \$6.5 billion, which is \$7.73 billion in current prices. This leaves a \$14.2 billion gap. meaning that this program is more expensive than its predecessor. However, throughout this section we have identified several flows of value which could be applied to justify this increased expenditure.

Primarily, we discussed the benefits to the carers and family of disabled individuals who would experience greater certainty and a higher standard of care under the new system compared to the old. In initial and intermediate finding reports the NILS at Flinders, which is conducting an evaluation of the NDIS rollout across the country, found that 51% of respondents had decreased anxiety knowing that the NDIS was in place. We relate this reduced stress and anxiety to better performance in caring for disabled individuals such that the carers would notice and report health or condition problems sooner. Research from Trollor confirms that those with intellectual disabilities in Australia already suffer from higher rates of mortality from preventable causes. With lower stress and better attention capacity we predicted the number of lives saved could be around 3,100 per year and that reasonable economic valuation of life was \$6.7 million, implying a total economic value of \$20.8 billion per annum.

This figure entirely covers the cost of the expansion of the NDIS program from the old ST regime. However, if we use the lower end of the range for valuing life, around \$1.1 million, that implies a total economic value of \$3.4 billion, leaving a gap of \$10.8 billion per year in additional funds for the NDIS program for which we cannot find offsets.

Social Insurance

Public expenditures have three potential kinds of benefits: private, collective and 'fairness' benefits.

The first category—private

benefits—are goods provided by government to (some) individuals. These might be means-tested benefits or transfers programs, for example.

The second category—**collective benefits**—are what economists

call *public goods*. These are goods like national defense where all members of society benefit and individual's use of the good impacts other members of society. It would not be rational for any individual to provide such goods, but most people want them provided. The government solves this *coordination problem* by providing the goods.

The third category-fairness benefits-involve expenditures targeted at certain individuals or groups with the aim of providing a just society. One can think about this from a Rawlsian perspective as articulated in John Rawls' A Theory of Justice. Rawls argues that the fairest society is one in which economic and social distinctions would not have a binding effect on the outcome of one's life. Rawls asks, if we had a chance to hypothetically design a political and economic system before we had to live in it - behind a veil of ignorance, such that we did not know where in such a society we would be what would it look like? Would we have inequalities in our system? What would be the nature and permanence of those inequalities?

The NBN is a mixture of government expenditure that provides private benefits and collective benefits. The private benefits are faster internet for individuals or households. The collective benefits come from the fact that when one person has faster internet it makes it more efficient for another person to connect to them. The NDIS, by contrast combines a social insurance program aimed at providing fairness benefits, but also involves private benefits to carers and disabled persons. The Australian community has decided that insurance against the cost of caring for a loved one with a disability is a price the country is willing to accept.

In many other facets of life Australians volunteer to insure themselves against illness, car damage, home damage, theft, death, and income protection. The difference between these voluntary insurance transactions and the NDIS is the point at which the information about risk is known to the risk bearer. In insuring your car against damage, you buy the insurance before you potentially have an accident. The insurance company has worked out roughly how many times this happens per year to drivers in your demographic and the cost to repair and divides the cost and risk up for those willing to purchase the cover. There is no equivalent opportunity for individuals or families of those with a disability to do this calculation in advance of having a disability. Therefore, it is fundamentally a public issue to procure insurance for those who have disability.

In light of the insurance model, it is worth considering the percitizen cost per year of the NDIS. The remaining gap in annual funding net of economic benefits in the more conservative case considered above is \$10.8 billion. Australia is a country of 24.8 million people, roughly 2/3 of which are working aged individuals who pay income tax to support public programs. Per person, the NDIS residual costs \$435 if divided across the whole population, and \$659 if one considers working age (15-64) Australians only.

With average incomes of around \$62,000 for working-age Australians this corresponds to approximately 1% of income.

Conclusion

It seems uncontroversial to say that governing involves prioritising among different expenditures and investments. Yet the government budgeting process typically does not have a principled way to make comparisons among disparate types of expenditures. As a consequence, budgeting decisions are often made not on the basis of social benefit, but are influenced by political power, lobbying, and other influence activities.

The key challenge for government budgeting is that it lacks a clear and quantifiable measure of the benefits of an expenditure or investment. Unlike the private sector, it cannot rely on revenues or profits to capture these benefits. This makes it difficult to come up with a single number that distills the social benefits and costs, like an IRR does for private-sector projects.

Social Return Accounting addresses this challenge by providing a framework for analysing and prioritising government expenditures and investments in a principled way using a common measure. SRA begins by using the best available social science to understand the impact of a government policy on a tangible, measurable outcome. It then provides a bridge from social science to social benefit by mapping this outcome into other measures—from larger tax revenues or reduced crime, to increased social connectedness or decreased commuting times. In doing this it permits the same kind of discounted cashflow techniques commonly used in assessing private-sector investments to be applied to the public sector.

By providing a Social Internal Rate of Return (SIRR) for government expenditures and investments we hope that SRA will provide a more principled and rigorous way of choosing among different, competing calls on the public purse.

About the UNSW Grand Challenge on Inequality

The UNSW Grand Challenges program seeks to bring together researchers across the university to raise awareness of, and contribute concrete solutions to, some of the most pressing challenges of our time. The Grand Challenge on Inequality is the third of these, following on from the Grand Challenge on Climate Change and the Grand Challenge on Refuges & Migrants. Professor Rosalind Dixon and Professor Richard Holden are the academic co-leads of the Grand Challenge on Inequality.

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Technical Appendices

NBN Chapter

The NBN chapter contains several calculations. This appendix will help a curious reader digest the details of these calculations. It is divided into parts as discussed below.

- The largest flow of value to having high-speed NBN service, the wage and ICT skill increase to the human capital stock of Australia.
- The value of reduced medical costs to Australia through fewer intra and inter-state patient transfers billed to the health system.
- The value of videoconferencing take-up on reductions in depression and loneliness among aged-care residents.
 This benefit is ultimately derived through the impact improved aged-care resident mental health has on physical health through fewer hospital admissions and shorter hospital stays.
- The overall NPV calculation and subsequent scalings to account for internet speed effect on the FTTN's decreased value.
 - This calculation includes all subsequent streams of value to the extent that they accrue benefits in specific years based on intensity/decay functions as well as the costs.
 - The calculation also includes the costs stipulated by NBN Co. regarding how much it was going to cost to build and operate the newly built fibre network.
- Other by-calculations or estimates referenced in the text.

Wage and ICT Skill Returns to Human Capital

The wage and skill returns to human capital begins with parameter estimates extracted from the Falck, Heimisch, and Wiederhold 2016 paper. This paper discusses the estimates in wage returns experienced by ICT workers in Germany who benefitted from a quicker rollout of high-speed internet in the 1990's. Due to the way the West German government built its telephone distribution system, and the subsequent internet expansion using that system, only those within 4.2 km of the main distribution frame (MDF) got the faster internet. This created the conditions for a 'natural experiment' in which the authors could compare the wages of similar people whose only difference was living within or just beyond the 4.2 km perimeter. The authors found that the proximity to an MDF in the German case was associated with a high level of internet-computer-technology skills (ICT). They further observed that a 1 standard deviation increase in such ICT skills was attributable to a 17.4% increase in gross hourly wage. They note, however, that this is extraordinarily high, and that the cross European sample estimate of wage increase associated with the same increase in ICT skills is only 8%. The estimate is from the paper's appendices in Table 7 for the Germany-specific estimates. The European-wide estimate is in Table 5, column 3.

Using these estimates, we apply a formula for wage growth and returns to the Australian economy using ABS data on average weekly earnings. We used the 6306.0 release from ABS on Employee Earnings and Hours, which was published in May of 2016. Specifically, we used Table 7 for "Average Weekly Total Cash Earnings", adult rates. This ABS table estimates cash earnings in various Australian industries. However, we only applied the wage growth from ICT skills to the industries whose compensation is based upon their skills related to gathering, processing, or managing information or information technology. Therefore, we selected only 7 of the ABS's 18 industrial categories to apply the wage growth. These included 'Information media and telecommunications', 'Finance and insurance services', 'Professional, scientific and technical services', 'Administrative and support services', 'Public administration and safety Education and training', and 'Health care and social assistance'. We omitted categories such as 'Mining', 'Manufacturing', and 'Construction'. While these workers have the same opportunities to improve their ICT skills as others with an NBN rollout, they are less likely to be rewarded with higher wages for such skills compared to the information industries. For the selected industries we then annualized the weekly pay rates, multiplied by the ABS' estimate of total national employment. and summed. This value was approximately \$340 billion.

State and Territory Expenditures on Patients Transfer Assistance Programs

State	Spend	Source	
Queensland	\$80m	There were parliamentary inquiries into the PTSS in Queensland. In 2007, 2008, and 2009 QLD DoH spent \$31m, \$35m, and \$41m on the program. In 2016 an ombudsman found that QLD spent \$80m on this program.	
Victoria	\$18m	In 2006, Victoria spent over \$6m on the same program and \$11m in 2011. There is additional confirmation that the budget was \$16m in 2016. The most recent budget proposed increasing it by \$2m to \$18m.	
Northern Territory	\$9.5m	NT was spending at least \$9.5m as of 2013.	
Western Australia	\$32m	Evidence found that WA was spending at least \$10m as of 2001. They spent over \$32m in 2014.	
South Australia	\$8.6m	SA was spending \$8.6m in 2013, including administrative costs for the program.	
New South Wales	\$31.5	NSW DoH says they spent \$28.2m in 2013. This was increased in 2016 by \$3.3m. Now roughly \$31.5m.	
Tasmania	\$8.4	Tasmanian DoH 2016-17 service agreement between the Minister for Health and the Tasmanian Health Service stipulates \$8.4m for the Patient Transfer Assistance scheme.	
Australian Capital Territory	N/A	We could find no information on such a program in the ACT.	

Although the timing of the benefits will be discussed in more detail later, it is worth noting how the wage growth is calculated. The \$340 billion figure is then imported into the NPV spreadsheet in time period 1. It is multiplied by the 8% wage growth figure in the first period and then the 8% growth figure is itself diminished by 10% for each subsequent period (e.g. 7.2% for period 2). The reduction of 10% is meant to account for the decay of benefit/ value, and prevent runaway compound growth. We do not empirically justify the 10% parameter, however we believe it is reasonable given the existing economic literature on returns to skills. Labour is an input into firms' production functions, and increased worker wage demands could at some point incent firms to substitute physical or technical capital in its place. The reduction in the value of the ICT-induced wage growth is meant to account for technological substitution and the reduction in marginal value of productivity gains in human capital.

In bulk, this benefit produces \$260 billion in *growth* over 30 years. This reduces to \$205 billion when discounted to present at 3%.

Reduced Medical Costs from Fewer Patient Transfers

The text explains the logic behind NBN's effect on reducing costs associated with medical transfers. Evidence from the Queensland Department of Health showed massive cost savings associated with fewer patient transfers to hospital within state. We construct a flow of value for this portion of human capital by examining how much states and territories have budgeted for Patient Transfer Assistance Scheme programs (PATS/ PTAS), or similar derivatives thereof. Review of the state departments of health websites and materials gave us insight into how much each state and territory spends on these programs. We compiled this information in a table, however some of the estimates were out of date. Therefore, these amounts should be considered conservative on the low end.

These amounts total to over \$188 million per year. Using this amount, we input the value into period 1 of the NPV spreadsheet. We then reduced the amount by 50% to account for the fact that introduction of NBN would not save all State departments of health the entirety of their patient travel assistance budgets. Queensland's department of health showed that a 33% reduction of their patient travel budget was possible with telemedicine. We believe that 50% represents a good focal value, and it could be more or less depending on the effectiveness of NBN rollout, the nature of the illness for each patient, and the geographic distribution of patients and cost of travel in each state. In particular, Queensland's example provides proof to the latter point, in that expensive long-distance travel from the far north to Brisbane may still be necessary. Whereas, it may be less costly for Victorians to travel to Melbourne. Our parameter estimate of savings is an average.

In total, this stream of value produces \$2.8 billion in benefits over a 30-year window. When discounted to the present under a 3% rate the NPV is \$1.8 billion.

Videoconferencing Reduces Depression in Aged-Care Residents

The evidence from the literature regarding videoconferencing shows durable improvements in the mental health of aged-care residents. The Tsai and Tsai paper shows these effects, but it does not quantify them in an economic way. We again approach the value statement from the perspective of the health system. Using other literature we also obtained a good estimate that relates the physical and mental health of older persons together (Bula 2001). From this connection we made extensions to costs on the health system which we believed could be reduced assuming NBN enhances the ability of aged-care residents to videoconference, they take up this benefit, improve their mental health and thus remain more physically healthy.

Logically, we start with the population of aged-care residents in Australia. These data are provided to the public through the "GEN" database published by AIHW, under the Commonwealth's Department of Health. Specifically, their database provides the number of agedcare residents by state, age bracket and type of facility. We began with the total Australian population of permanent aged-care residents 75 years or older in 2016. This figure was 155,295 persons. An AIHW factsheet from 2016 indicated that 46% of aged-care residents may be experiencing symptoms of depression or loneliness. This yields a figure of 71,436.

The next step of the calculation was to link the population of aged-care residents suffering from mental health issues to those likely to suffer physical health issues. Further AIHW data from 2016 indicates that 63% of the aged-care population have "high" health care needs. We then apply the estimated effect of the videoconferencing Tsai and Tsai found from their paper, which was a 50% reduction in depressive and loneliness symptoms. Multiplied together this yields 22,502 depressed aged-care residents. We then bring in discussion of medical system costs to the estimate. A 2011 paper by Brown, Abello and Thurect published by the National Centre for Social and Economic Modelling (NATSEM) at the University of Canberra studied the issue of cost per day of hospital beds. Brown's paper found that the total cost to public hospitals for cardiac and pulmonary admissions was \$1.76 billion in 2004-5. The paper also reported that patients admitted for those conditions occupied approximately 876,000 hospital bed days. Dividing these two amounts yields an estimate of \$2,009 per day. However, since this figure was from 2004-5 we inflate it to the present using an average compound growth rate from a study produced by AIHW. The AIHW study on medical cost growth showed medical costs had risen by 5.6% per year on average over the period. We use this cost index to inflate the \$2,009 per day figure to present of \$4,075 per day.

Further, AIHW information reveals that the average aged-care resident who requires a transport to hospital stays 6 days.⁸³ The Bula 2001 paper also shows that those who are experiencing symptoms of depression are 1.57 times more likely to be readmitted. Using the base population of aged-care residents likely to have health and depression issues (22,502), the cost index (\$4,075), the average stay (6), and the likelihood of readmission due to depression, we calculated the potential savings to the health system as \$863 million annually.

Because the Tsai and Tsai paper already accounts for the marginal effect of the reduction in loneliness and depression which is achieved through videoconferencing we do not employ any further benefit reduction scaling. In total, the health system savings from reductions in depression and loneliness amount to \$25.9 billion over a 30-year window. The NPV of this amount discounted to present at 3% is \$16.9 billion.

Overall NPV Calculations and Scaling for Internet Speed

The above passages have shown that there are three distinct streams of value over time through adoption of some kind of NBN system which upgraded Australians' internet capability. This passage discusses how those streams of benefits are aggregated and weighed against the known costs of providing two different levels of NBN service, the Fibre to the Node (FTTN) and Fibre to the Premises (FTTP). The costs of the NBN system installation and maintenance were and remain crucial components of public debate and choice around which system Parliament should adopt. Our information from the costs of NBN installation and maintenance come mainly from the 2013 NBN Strategic Corporate Review published in December 2013. This document laid out precise capital, operating, interest and other expenditures on an annual basis. We have used this document extensively along with other projections to fill in cost amounts.

Using the revised financial outlook (section 2.5, pages 55-56) of the Review we specified nearly all of the costs for the FTTP plan exactly as they were laid out. We made several exceptions in constructing the FTTP costs from the Review. Because the Review only made 14 years of projections we had to extend the cost window to 30 years consistent with our benefits. We assume in the FTTP cost construction that capital expenditures would halve in the 15th year and remain at those levels until the end of the window. We made this assumption in order to balance our calculations with other publicly reported projections of total NBN Co. profit and loss. Under these assumptions, total nominal capital expenditures for the FTTP plan are estimated at \$82.4 billion. We also projected 4% revenue growth for NBN Co. from the 15th year to the end of the 30-year window. This projection is based on a trajectory contemplated in the 2013 Review and helped to us formulate our capital and operating expenditure projections from the 15th year to the end of the window.

We constructed the FTTN costs similarly, using the Review's figures up until we had more actual operating and capital expenditure amounts from NBN Co. Corporate Plans. Using the 2016 Corporate Plan we populated 2014-16 amounts. We then relied their projections for future years. For example, the 2017 Corporate Plan specifies actual capital expenditure amounts for the reported year and presents projections out to 2021. The last projection is for \$600 million in capital expenditure. We populate \$600 million out to the end of the 30-year window. In total this arrives at \$44.5 billion in capital expenditure for the FTTN plan.

To make the IRR calculation work in the Excel platform we were forced to frontload all capital expenditures, as if they were an initial investment, to the zero period of the calculation. For FTTP this was \$82.4 billion and for FTTN this was \$44.5 billion. Subsequent periods were also assigned costs-based sums of the Review's or Corporate Plans' stated operating, interest, or 'other' costs.⁸³ As mentioned above, these values were adjusted in some cases in order to balance the 30 year projections with publicly available cost sources.

From this point we had a cost series for each FTTP and FTTN, but only one benefit series. As the text describes, the chief argument over the plan was whether the benefits of FTTP speed would be worth spending the additional cost to the public. To simplify the calculations we assume the total of the benefit series enumerated are those benefits which would be attributable under the fastest scenario (i.e. FTTP). So far, we have enumerated \$224 billion in present discounted value over 30 years. We apply all of this value to the FTTP scenario. To generate the FTTN scenario we start from the FTTP benefit level and scale it down proportional to several estimates of Australian internet speed relative to faster Asian country peers. To estimate the benefit reduction parameter we reviewed three quarters of Akamai State of the Internet reports on megabit-persecond (mbps) internet speed from late 2016 to early 2017. In general, we preferred to focus on comparisons of Australia and New Zealand given the cultural and economic similarity between them, and the clean natural experiment New Zealand has afforded (assuming the similar assumptions hold) by having already adopted high-speed fibre internet. Each quarter of Akamai reports affords four mbps measurements on each country reported: the average mbps of a user in the country, the percent of the population with access to speeds above 4 mbps, 10 mbps, and 15 mbps. To compare Australia and New Zealand we took the ratio of each of these four metrics across the three quarters. Among the twelve data points was a minimum ratio of 59%, a maximum of 89%, and an average of 75%. The main text discusses the contingency in which we use variants of the 50% scaling parameter.

Finally, with a cost and benefit series in hand for FTTP and FTTN respectively we calculated the internal rate of return using the Excel version of this formula. The FTTP IRR is 21.1%. When scaled at 50% of the FTTP benefit value, the FTTN IRR is 15.1%. Due to its dramatically lower cost structure FTTN's internal return exceeds FTTP's at 56.8% of FTTP benefit value. However, we have reason to believe the text that 50% is the most reasonable linear scaling figure. The FTTP benefit levels are averages across Australia and include assumptions that ignore geographic distribution of benefits that may undermine the linearity assumption of the 50% scaling. In particular, the benefits of videoconferencing, wage growth, and telemedicine benefits may be have the strongest effects in the areas that are currently the least well served by existing internet infrastructure. FTTN, with all of the reports of faults, may be holding these more isolated areas back more than in urban ones. Australia's population is also much more widely dispersed than New Zealand's. Given all of this we judged it wise to go below the Akamai speed ratio averages.

National Disability Insurance Scheme (NDIS) Chapter

The NDIS chapter contains several calculations. This appendix will help a curious reader digest the details of these calculations. It is divided into parts as discussed below.

- The largest flow of value comes from the reduction in carer stress and the impact that will have on reduced medical mistakes of disabled individuals in care.
 - One portion of calculations involve the medical mistake ratio and how many disabled individuals' lives could be saved.
 - The second emanates from a scaling of lives saved into an economic measurement using life-valuation techniques.
- The second flow of value is a one-time injection of feelings of independence that can come from taking care of oneself in a way previously unavailable.
- Finally, we discuss the calculations regarding residual value and any other calculations in the text which haven't been accounted for.

Reduction in Carer Stress and Impacts from Medical Errors

In general, the text does well to explain these calculations. However, we restate them briefly here. Many disabled individuals receiving supports under the old ST system have in-home carers. These carers, whether professional or family, are under enormous strain as the NILS study shows. We propose, with justification from the NDIS trial data presented by NILS, that NDIS can and will reduce the stress experienced by carers.

We liken the carer's role to that of a medical doctor. In the U.S. studies showed that young medical residents were more likely to make mistakes when put on longer shifts and deprived of sleep. Likewise, we believe if implemented NDIS will reduce the mistakes made in care of disabled individuals. Evidence from Trollor shows that those who have an intellectual disability suffer higher rates of death from preventable conditions. We know from the NDIA and the Productivity Commission report that there are roughly 460,000 individuals who could be eligible for the NDIS. Further, we know that in general there is a 4% mortality rate annually for those with intellectual disability. We then apply the Trollor figure of 38% to the population of disabled individuals and the generalized mortality rate to estimate that 7,000 disabled individuals die each year from preventable causes.

However, we know from examination of Trollor's study that they included deaths from cancer and other complex conditions in their estimate. The individual breakdown provided in the paper shows that those who died from injury, poison, infections, or respiratory conditions adds to 17%. This figure scaled against the disabled population and generalized mortality rate yields 3,100 preventable deaths.

Valuation of Human Lives Saved

We present several options for valuation of human life. Two of these involve reporting estimates obtained in other studies, and we do not change these calculations ourselves in anyway, except to account for USD/AUD exchange rates. Note that all values reported this way used the Reserve Bank of Australia's G1 Consumer Price Index (GCPIAG) and converted AUD to USD at 0.8 : 1. The third way requires some calculation to estimate an average worker's willingness to take on risk. As the text discusses, directly asking a person about how much they value their life tends to elicit unreliable estimates and is highly dependent on the way the question is asked. Another way to estimate the value of life is to examine revealed preferences, meaning how people show that they really value their lives. One way to estimate revealed preferences of life valuation is how much risk someone is willing to take on in order to earn more money, even though that higherpaying role could cost them their life.

Thanks to the data published by Safe Work Australia (SWA), we can generate our own estimates. SWA's website provides industry-level statistics on total industry employment, the number of deaths in the current year per industry, the same averaged over 10 years, and the average weekly earnings for that industry. Using these pieces of information we can construct a measure of risk and reward and evaluate potential switches for their implied life valuations. Please note, that these are averages based on a hypothetical switch and we do not know how many people, if any, have switched between these industries. Further, because the SWA industrial categories differ from the ABS ones used in the NBN wage-growth calculation we use a different ABS average weekly earnings dataset for wages.

We were able to perform 10 comparisons between hypothetical industries. For each hypothetical switch we have a reference industry and risk rate. The risk rate is the 10 year average number of fatalities by industry divided by current total industry employment. The wage is the average weekly cash earnings as reported by the ABS. We compared 10 hypothetical switches, including some which showed low, even negative life valuations. Each valuation was done as follows:

Valuation = (Reference Industry Wage – New Wage) / (Reference Risk – New Risk) Among the positive, reasonable life valuations we estimated this way were:

- \$1.1 million if a worker changed from the transportation and warehousing industry to manufacturing, where manufacturing is lower risk and lower reward.
- We estimated \$5.6 million valuation for a change from transportation to retail trade, where the latter is lower risk and reward as well.
- We estimated a \$5.3 million valuation for a change from construction to the 'wholesale trades', where the latter is lower risk and reward.
- We estimated a \$6.7 million valuation for a change from manufacturing to construction, where the latter is higher risk and higher reward.

Not all changes we estimated were positive, meaning they were either higher risk and lower reward or lower risk and higher reward. There are obviously other considerations in taking a job than workplace safety and wage, which makes this a crude estimation.

We then take the estimations of human life value and multiply the various ranges against the high and low case for preventable deaths found in the earlier section. These products provide a range of potential economic valuations of the NDIS program. Being conservative we move forward with the \$3.4 billion estimate generated from the lower case of lives saved and a life valuation of \$1.1 million.

Valuation of Feeling Independent

We posit that the main innovation of the NDIS is that it gives patients and their carers choice about shaping their own plan of supports and funding. However, unlike the other flows of value in this or the NDIS chapter, independence is reliant upon a one-time injection of value.

To value independence we look to an example in the US where for a period of years expensive motorized scooters were popular due to their Medicare price subsidy. Using several example models we estimated that a one-time flow of independence could be valued between \$2,500 and \$3,500 US. We took the smaller figure and converted to AUD at 1.25: 1. This value of \$3,125 is then multiplied by the entire NDIS target population of 460,000, yielding the \$1.4 billion value. However, we omit this calculation from subsequent considerations of program cost because it is fixed and not-recurring.

Other Calculations in the Text

Other one-off calculations in the text are discussed below:

- Near the beginning of the NDIS chapter we inflate the legacy ST budget of \$6.5 billion to present value using the RBA CPI index. As discussed above we use the RBA's G1 CPI index to inflate the value of this money to the fourth quarter of 2017 from the fourth quarter of 2009 and estimate \$7.73 billion in present value.
- At several points in the text we estimate currency conversions from USD to AUD. We did these at a point earlier in 2018 and late 2017 when the prevailing rate was close to 0.8:1, or inversely, 1.25:1. While the exchange rate as of May 2018 is closer to 0.75:1, or inversely, 1.33:1 we stand by our estimates. First, they are close in value. Second, the exchange rate has little material effect on the analysis given that these are purely domestic programs and depend little on Australia's trade balance with the US.
- At another point in the text we do a simplified valuation of life calculation based on increased risk of death. As noted above the implied valuation of life is the change in risk divided by the change in reward, assuming a calculation in perpetuity and equal time preference between the present and future.

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The authors concluded that broadband expansion meant that it was easier for kids in school to use the internet as a distraction rather than enhancing their educational experience. However, this study has a serious flaw. The authors measured internet usage per student based on the megabyte (MB) volume of broadband data consumed at the school level. Naturally, content such as videos and other image-heavy websites consume more MB of data than those that are primarily text. Thus, measuring a relationship between megabytes and test scores produces a spurious correlation. Of course, the schools that watch the most YouTube© content are likely to be the worst performing students. This type of statistical relationship does not signal that broadband access and use leads to lower test scores it only signals that the most MB-rich content is the least likely to be educational. The last section of this paper attempts to reckon with this flaw by appending regressions in which the authors gathered information at the school level about website blocking policies. They found out which schools blocked all negative websites and which blocked YouTube© only. Those that allowed YouTube© in any form had significantly lower test score results. The baseline measurement of MB per student (the broadband use variable) showed positive, but insignificant impact on test scores. Therefore, the authors did not find a bona fide negative effect, rather they found a near zero effect.

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- 74 Trollor et al. 2017.
- 75 Smith, S. V. (2000). Jury Verdicts and the Dollar Value of Human Life. Journal of Forensic Economics, 13(2), 169–188. See table II.1 "means of selected variables".
- 76 RBA inflation statistics.
- 77 \$30,000 / 0.03 = \$1,000,000.
- 78 Perreira, K. M., Sloan, F. A. (2002). Living health and living long: valuing the nonpecuniary loss from disability and death. Journal of Risk and Uncertainty, 24(1), 5-29. https://link.springer.com/ article/10.1023/A:1013234309490.
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- 80 CBS News, Associated Press. 29 April, 2013. The SCOOTER Store, Hoveround blasted by lawmakers, physicians. Retrieved from https://www.cbsnews.com/ news/the-scooter-store-hoveround-blastedby-lawmakers-physicians/ . The company later filed for bankruptcy after it was discovered it had overcharged Medicare and senior citizens for the scooter products.
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- 83 We followed NBN Co. projections of revenue in balancing the accounting costs to achieve projections that were compatible with publicly available estimates. However, the NBN Co. revenue is irrelevant in our economic comparison of costs and benefits NBN collects revenue and writes an accounting statement of profit and loss from its financial perspective. While it is a gain to NBN, it is a loss to consumers to who must pay for it. NBN was formed with the idea that it would build the network and protect the taxpayer financing it accepted. If NBN accomplishes its goal and safeguards the taxpayers' investment it has simply gone around in a circle. The taxpayers are the same constituency as the NBN customer base. The public paying for NBN is simply a tax to fund the network's construction. The NBN Co, revenue is therefore not a real cost or benefit, but the flow of a transfer necessitated by the government's creation of an intermediate body with its own accounting statement requirements.





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