NEW ZEALAND
PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

Measuring state sector productivity

August 2018

The Productivity Commission aims to provide insightful, well-informed and accessible advice that leads to the best possible improvement in the wellbeing of New Zealanders.

Measuring state sector productivity

Final report of the measuring and improving state sector productivity inquiry, volume 2

August 2018

The New Zealand Productivity Commission

Te Kōmihana Whai Hua o Aotearoa[1]

The Commission – an independent Crown entity – completes in-depth inquiry reports on topics selected by the Government, carries out productivity-related research and promotes understanding of productivity issues. The Commission aims to provide insightful, well-informed and accessible advice that leads to the best possible improvement in the wellbeing of New Zealanders. The New Zealand Productivity Commission Act 2010 guides and binds the Commission.

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[1] The Commission that pursues abundance for New Zealand.

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Glossary

Term	Definition
Activities	The individual tasks public sector agencies perform that contribute to the delivery of an output. They may include, for example, answering phone inquiries, processing forms, court arraignment proceedings or a maths lesson.
Allocative efficiency	Maximum allocative efficiency requires the production of the set of goods and services that consumers most value in the current period, from a given set of resources.
Capital deepening	An increase in capital intensity; that is in the amount of machinery, equipment, etc., for each worker.
Capital inputs	The use/consumption of capital in the production of outputs. Capital inputs include, for example, buildings, vehicles and information technology.
Capital services	The flow of services from the stock of past investments. For instance, the capital services provided by an office building include protection against rain, the comfort and storage services that the building provides.
Collective services	Services whose outputs are consumed jointly by the entire population. Examples include defence, biodiversity protection, public health campaigns and road safety campaigns.
Consumables	A good or service consumed in the production of other products or services. For example, iron ore and coal are consumables in the production of steel. Also called *intermediate inputs*.
Co-production	Services that blend or require contributions from both producers and customers. Customers may specify the kind of service they want (eg, a haircut) or their effort is essential to service production (eg, fitness coaching).
Data envelopment analysis	A technique for estimating how close entities are to a productivity frontier.
Diffusion	The process by which a new idea, technology or product is adopted across a society or economy.
Dispersion	The amount of variation within members of a group. Productivity dispersion is, for example, the spread between high-productivity and low-productivity entities.
Dynamic efficiency	Dynamic efficiency is achieved when optimal decisions are made on investment, innovation and market entry and exit to create productive and allocative efficiency in the longer term.
Economies of scale	Reduction of cost per unit as the volume of production increases, due to large up-front or fixed costs being spread across more units.
Entity	The central unit of analysis, that is, the "thing" whose inputs, outputs and thus productivity is being measured. It can refer to a service line, public sector agency (eg, a school or hospital), region or country.
Individual services	Services provided to and consumed by individuals (c.f. *collective services*). Examples include payment of benefits and issuing passports.
Inputs	The direct and indirect factors involved in the production of outputs. Inputs can be organised into three broad categories: labour, capital and consumables.
Intangible assets	Assets that are identifiable but are not physical, such as reputation and brand recognition, skills, market research and patents.
Intermediate inputs	See *consumables*.
Intermediate outcomes	Intermediate outcomes are objectives that serve as goals along the path to achieving ultimate outcomes.

Term	Definition
Labour inputs	The labour utilised in the production of outputs, both directly (eg, teachers for school outputs) and indirectly (eg, administrative staff, who contribute to the functioning of an entity).
Labour productivity	Average output per unit of labour input.
Market-provided services	Services that are provided at economically significant prices, usually to generate a profit.
Measured sector	The measured sector is the industries included in Statistics New Zealand's standard productivity statistics from 1996 to 2011, covering all predominantly market industries. The measured sector covered 81% of New Zealand's GDP in 2009. The measured sector cuts across the three sectors of the economy, ie, primary, goods-producing and services.
Multi-factor productivity (MFP)	The change in output that cannot be attributed to changes in the level of labour or capital input. It captures factors such as advances in knowledge, improvements in management and production techniques, and mismeasurement. Also known as total factor productivity.
Non-market provided services	Services that are supplied for free or below economically significant prices, typically by governments or non-profit organisations. Health care and social assistance, education and training, and public administration and safety are the three service industries with the highest share of non-market provision in New Zealand.
Outputs	Goods and services produced by entities.
Outcomes	A state or condition of society, the economy or the environment, or a change in that state or condition. Examples include higher life expectancy and higher levels of adult literacy.
Productive efficiency	Maximum productive efficiency requires that goods and services are produced at the lowest possible cost. This requires maximum output for the volume of specific inputs used, plus optimum use of inputs given their relative prices.
Productivity	Productivity measures illustrate how well an entity uses its resources (inputs) to produce goods and services (outputs). Productivity shows the ratio of the volume of outputs to the volume of inputs.
Productivity frontier	The productivity level of an entity (or entities) that has the best possible production practices. The closer to the frontier the higher an entity's productivity.
Reallocation	The transfer of employees, capital or other resources from one entity to another. As new technology develops, reallocation is required to put assets to their most productive uses.
Ultimate outcomes	Ultimate outcomes are the final impact an activity has on society.
Value-added measures	Value-added measures remove consumables from measures of output.

About this guide

Productivity is a measure of the goods and services produced *(outputs*) by an economy, industry or organisation compared to the resources used in that production *(inputs*). Improving productivity is about making better use of inputs; producing more or better outputs with the same resources. It is not about increasing hours of work or cutting budgets. Neither of these will produce a measurable increase in productivity. Valid productivity measures account for changes in the quality of outputs. For example, a budget reduction (lower inputs) that leads to a reduction in quality (reduced output) is unlikely to boost measured productivity.

Measures of productivity have their origins in the private sector. The methods and concepts developed for measuring private sector productivity typically rely on assumptions that may not be valid in the state sector. This does not make state sector productivity measurement impossible. It simply means that you may need to apply different measurement techniques than those you would use to study the private sector.

Productivity measurement can be applied to a whole agency, to a functional unit, or to specific activities and programmes. An organisation that measures productivity is in a better position to know if it is achieving the best outcomes it can with the resources it uses. Without such measures it is difficult to know whether the organisation's performance is improving or declining.

The Commission has developed this guide to help people in the state sector to measure the productivity of their agencies, functional units, activities and programmes. This guide is part of the final report of the Commission's inquiry into measuring and improving state sector productivity. You can read it independently or in conjunction with *Improving state sector productivity*.

The Commission wrote this guide primarily for individuals and teams within the state sector who are intending to develop productivity metrics. You should also find this guide useful if commissioning or evaluating productivity studies, or just understanding the productivity measures created by others.

The guide does not present a one-size-fits-all approach. It aims to give practical advice on how to better understand your organisation and its performance. It assumes you already have a basic knowledge of productivity measurement concepts. The glossary may be useful to refresh or clarify these concepts and the terms used in the guide. This guide has eight chapters.

- Chapter 1 outlines important concepts, such as what is productivity, how it relates to outcomes, and how it can apply to state sector services.
- Chapters 2 and 3 discuss practical considerations in the development of productivity measures, including the need to establish what the measures will be used for, developing a clear research question, and planning the use of data.
- Chapters 4 and 5 discuss outputs and inputs, respectively. These chapters cover their definition and measurement.
- Chapter 6 then explains how to combine different outputs and inputs into a single index. This is necessary when measures cover more than just single outputs or inputs. The chapter also outlines the ways to account for price changes.
- Chapter 7 outlines approaches to accounting for differences in operating environments and when the quality of outputs and inputs change over time.
- Chapter 8 pulls the guide together by discussing the types of measures to use and benchmarking techniques. It also covers triangulating (sense testing) results with the findings of quantitative and comparative studies.

Measuring state sector productivity is a developing field. This a living document, which the Commission intends to update as the techniques for measuring state sector productivity evolve. The Commission invites your feedback to improve future editions. Please send suggestions to info@productivity.govt.nz

1 Key concepts

This chapter outlines the concepts behind productivity measurement, how they relate to outcomes, and how they apply to public services. The chapter also discusses state-of-the-art state sector productivity measurement, and its evolution from the "outputs equals inputs" convention. It discusses the role of aggregate data and micro-level data. It outlines productivity path analysis as one approach to measurement.

1.1 Productivity, inputs, outputs and outcomes

Public services make up close to one fifth of the economy and so poor productivity in this sector is a drag on the New Zealand economy (both in its own right and in terms of impact on the performance of the private sector). More productive public services offer governments improved choices and higher living standards for New Zealanders.

Productivity is a measure of how efficiently an economy, industry or organisation produces goods and services *(outputs*) using *inputs* such as labour and capital. More specifically, it shows the relationship between the volume of output produced and the volume of inputs consumed in that production.

Volume, in this context, is a measure of quantity. You can measure volume directly, for example, the number of hours worked, or number of widgets produced. More typically, you will need to convert volume measures to dollar amounts and adjust them for factors like quality. Subsequent chapters outline procedures for doing this.

Productivity measures can show how well an organisation uses its resources, both over time and compared to similar organisations. Such comparisons can provide you with useful insights about where and how to improve organisational performance.

Box 1.1 **Should you use partial or multi-factor productivity measures?**

Measuring the productivity of a single input (eg, labour) can provide valuable insights into performance. Such measures are called *partial productivity measures*. However, partial productivity measures can be misleading if the contribution of other inputs changes over time.

For example, suppose a measure of labour productivity shows a consistent increase in output per worker over time. The increase could be due to management practices, such as hiring more highly skilled staff or introducing new processes. But it could also be due to investment in technology (ie, a capital investment). Basing productivity measures on only labour inputs could mis-attribute the underlying cause of the measured productivity improvement. Worse, if the new technology was costly relative to the labour saved, overall productivity – in terms of all resources consumed – may have declined.

Technology is already shaping the delivery of many public services. Taxpayers submit their tax returns online. Airports have automated passport checks (SmartGate). Doctors increasingly provide services through patient portals and virtual consultations. It is likely that much of the future growth in state sector productivity will involve further investments in technology. Given this, productivity measures can be useful if they incorporate other contributing factors, especially capital and, in some cases, consumables. Such measures are termed *multi-factor productivity measures*.

Data limitations may mean that it is difficult (or impossible) to measure capital inputs (see Chapter 5) and so it may be more practical to measure labour productivity. Given the labour intensity of many public services, labour productivity may be a good proxy for the overall performance of these services. However, you should be aware of the limitations of such partial productivity measures.

There is widespread misunderstanding of the concept of productivity. It is about making the best possible use of resources like labour and funding, not increasing hours of work or cutting budgets. Properly measured, it should account for factors like changes in the quality of inputs and outputs.

Productivity is one dimension of performance

Performance frameworks for state sector agencies should include productivity as one dimension. It is not possible to achieve the best possible outcomes for New Zealanders unless public services are productive (Smith, 2018). It may, for instance, be possible to decide what outcomes are desired and to even predict the likely contribution of specific outputs to these outcomes. But unless the state sector can effectively convert the resources available into outputs it will fail to maximise desired outcomes with the resources available.

To put this more technically, the state sector cannot be allocatively efficient (on the optimal point on its current production possibility frontier) or dynamically efficient (expanding the frontier over time) unless it is also productive. But this also goes in the other direction. As Richardson (2012, p. 276) noted:

> the real reform of the public sector is only going to come when governments knuckle down to the real task of defining first what the state should (and should not) do, before embarking on the crusade for a smarter state. No point in the state doing dumb things in a smarter way.

Thus, a desire to both maximise productivity and to ensure allocative and dynamic efficiency are central to optimising the performance of the state sector. They are complements, not substitutes.

1.2 Applying the concept of productivity to public services

It is inappropriate to take the methods and concepts developed for measuring private sector productivity and to uniformly apply them to public services (Box 1.2). This does not mean that state sector productivity cannot be measured. It simply means that productivity in the state sector needs to be measured differently to how it is measured in the private sector. This section discusses some of these differences: the nature of the labour input, accountability for inputs, the observability of outputs and the role of reallocation.

Box 1.2 **Measuring productivity of the private sector**

The concepts and methods of productivity measurement were originally developed to apply to the private sector. Much of the terminology reflects a "factory" model of production. Despite the terminology, the concepts generalise well to other production models and to services. Nonetheless, analysts of private sector activities and organisations typically make assumptions that simplify data collection and analysis. These can include assuming market prices approximate the opportunity cost of inputs and outputs. In turn, this assumes no subsidies, and no monopoly production nor monopsony purchasing.

The nature of the labour input

Public services tend to be relatively labour intensive. This means they can face the "Baumol cost disease", where wage growth in labour-intensive industries becomes decoupled from productivity growth (Baumol & Bowen, 1966). This can happen when productivity improvements in a capital-intensive industry lead to wage growth in that industry. Competition for labour between this industry and other more labour-intensive industries can lead to wages in these other industries growing too. This increases the cost of labour inputs relative to the outputs produced and leads to lower labour productivity. Some service industries are particularly prone to this "disease".

Workers in the private and state sectors often receive different forms of financial rewards. State sector workers are more likely to have standardised pay scales – with constraints on pay levels and fewer incentives tied to performance – and greater job security. They typically have no claim on profits or cost savings. Some argue that state sector workers face greater non-pecuniary incentives, such as concern about their reputation, mission orientation, etc. According to this view, state sector workers are relatively more motivated by non-financial rewards, such as a shared sense of mission.

In practice differences in motivation of private and state sector workers are less clear cut (Le Grand, 2007). Non-financial rewards motivate many people working in the private sector, and it is naive to say state sector workers do not have financial motivations. The private sector produces many essential goods and services (eg, food). Others are produced by both the private and state sector (eg, education and health).

Relying on the mission orientation of state-sector workers may not always lead to productive services. "Knightly" people may not "always be motivated to be very efficient" (eg, recognise the opportunity cost of the resources they consume) and may have their own agenda (eg, "give users what the knights think users need, but not necessarily what the users think they need") (Le Grand, 2007, pp.20-21).

The uniqueness of the labour input into public services can be overstated. Many of the techniques used to account for labour input in the private sector are applicable to public services. However, be careful when using wage rates to cost weight different categories of workers (a technique used in the private sector) as these rates can be set in differently in the two sectors (see Chapter 5).

Accountability constraints

A further difference between the private and state sectors reflects the importance of accountability for inputs. A principle of the state sector reforms in New Zealand in the 1980s was to increase the flexibility with which state-sector managers could manage inputs. The principle was that the political executive would specify desired outcomes, contract agency chief executives for outputs to contribute to these outcomes, and agencies would then manage the inputs to achieve them (letting "managers manage"). Nonetheless, the allocation of inputs (eg, workers) in the state sector is subject to public law and administrative requirements. These are designed to ensure that public funds are used in a lawful, transparent and accountable manner.

Agencies may manage performance risk through highly specified contracts that describe the inputs used, the processes followed, and the outputs produced (NZPC, 2015). This reduces incentives and opportunities for innovation, limits the flexibility of providers to respond to changing needs of service recipients or changes in the wider environment, and limits the scope for providers to work together and to bundle services in a way that best meets the needs of recipients (ie, service integration).

This has implications for measuring productivity in the state sector. You should seek to understand the extent that productivity estimates reflect controls over the ways that inputs are managed. An observed change in productivity may reflect a change in public policy rather than choices made by managers per se. This is one reason why state-sector productivity measures should be treated as one input into performance decisions, rather than the sole factor (Tavich, 2017).

Management literature distinguishes between high- and low-powered incentives. High-powered incentives tie significant private rewards (or sanctions) to measured outputs or outcomes. For example, salespeople often receive a low base salary plus a commission on each sale they close. High-powered incentives can be effective to motivate staff where a goal is clearly measurable and well aligned with an organisation's overall purpose, the factors that influence the measure are under control of the staff concerned, and zealous pursuit of the reward is unlikely to create perverse consequences. Low-powered incentives are appropriate if multiple goals are sought, results are difficult to measure, teamwork is crucial, or success is determined by factors beyond the staff's control. Public services rarely meet the criteria for high-powered incentives. Reflecting this, the state sector generally offers its employees salary packages with low-powered incentives. However, high-powered incentives can feature in public service provision if status, continuation of employment, promotion prospects or other non-salary remuneration are conditional on performance measures. It is important to recognise such situations and manage potentially adverse consequences.

Observability of outputs

It is generally harder to measure outputs in the services sector, as compared to the manufacturing and primary sectors. This applies to production by the state and private sectors. Table 1.1 sets out some of the challenges in measuring the productivity of services.

Table 1.1 Challenges in measuring the output of services

Issue	Implications
Service output is "fuzzy". The process of producing a service does not result in a tangible good but in a "change of state"	• It can be hard to clearly identify the output of a service • It might be difficult to separate the output of services from factors used in its production (ie, distinguishing the output from the process) • It can be challenging to identify quality improvements
Some service outputs are co-produced with customers. Customers often determine what kind of service they want (eg, a haircut) or their effort is essential in producing the service (eg, a fitness programme)	• Problems defining and identifying a standardised unit of output, as the customer's involvement in production means each output is different and adapted to specific needs • Difficulties identifying the value added by the provider, as opposed to the customer
For some services, particularly social services, the purchaser and the customer are different people or entities	• The purchaser's assessment of quality and value may be different from the customer's assessment

Source: Djellal and Gallouj, 2008; NZPC, 2015.

Estimates of private-sector productivity generally use price information to:

- judge the relative value of different goods and services;
- account for changes in the quality of outputs; and
- weight different goods and services when aggregating data (eg, into industry or national measures).

However, for many public services there is no price information (as services are free to the consumer) or only limited price data (as they are subsidised or not in a competitive market) (Dunleavy, 2016). You will need to apply different techniques when comparing or aggregating state sector activities, and when accounting for changes in quality (see Chapters 6 and 7).

Private-sector firms typically have straightforward goals like increased market share or shareholder value.[1] By contrast, some state-sector services have relatively complex goals. These encompass, for example, concerns about who benefits (Tavich, 2017).

Even where agencies have clear high-level goals (eg, to increase human capital), it is difficult to define measurable indicators of performance for co-produced services. Public services are also likely to have multiple consumers – those directly receiving the service (eg, patients, schoolchildren) and the wider citizenry – who may have different perspectives on a specific service.

It is also important to consider what is driving observed changes in productivity and, if necessary, how these results compare with other sources of evidence. This is why Atkinson (2005) emphasised the need to supplement productivity measures with independent evidence – what he called a process of "triangulation".

Resource allocation works differently

A significant portion of productivity growth in the private sector is the result of influences that are external to individual firms (Conway, 2016). For example, competition between suppliers encourages firms to drive down production costs and/or improve product quality. Preferences by consumers for cheaper or better products can shift market share towards more productive firms at the expense of the less productive ones. Inputs (consumables, labour and investment capital) follow the market share, shifting to the firms with higher

[1] This is not to say that such goals are easily achieved, nor that they can be achieved without staying on the right side of suppliers, customers, employees, governments, etc. However, for analytical purposes it is usually reasonable to model private firms as if they had a single-valued objective.

productivity where they are, in turn, used more efficiently than previously. Such "reallocation" improves in the measured productivity of that industry.

Some of these external influences do not apply as strongly (if at all) to the state sector (Dunleavy, 2015). For instance, competition (either in output markets or for the ownership of the firm itself) is often absent in the state sector. Many of the agencies that deliver public services face little competition. And while governments can restructure, merge, split or disestablish state-sector agencies, this tends to be slower and harder to do than in the private sector. Structural change in the state sector is typically motivated by multiple goals, some of which are incompatible with improved productivity. The need to satisfy multiple stakeholders places further constraints on structural changes.

In response to societal demands for better outcomes (eg, in mental health), politicians and state-sector agency leaders may direct increased resources towards ineffective or inefficient services. Should those resources come from the budgets of relatively more productive services, then reallocation effects lead to an overall drop in state-sector productivity. This is the opposite result from the reallocation effects in the private sector, as described above.

Reflecting these considerations, state sector productivity growth is much more likely to rely on technological diffusion, defined broadly (Dunleavy, 2013). Fortunately measuring diffusion in the state sector is often a relatively straightforward exercise. Many administrative systems hold the data required to directly measure changes in practices. This contrasts with private firms where innovation cannot often be directly observed – measures of the number of firms engaged in innovative activity can range from 0.2% to 40% (Wakeman & Le, 2015).

1.3 Outline: building a productivity measure

Table 1.2 outlines the steps you will need to undertake – or at least consider – in defining and implementing a productivity measure, along with the relevant chapter for each step. For simpler measures you may be able to omit some steps.

While this guide describes this approach as a linear process, in practice it is likely to be iterative. You should refine the analysis as understanding and availability of data change over time.

Table 1.2 Steps in defining and implementing a productivity measure

Step	Considerations	Chapter
	Scope	
Establish the business case	Establish the benefits of measuring productivity; the ongoing resource commitment; how measures will be used and released; the role of staff in development and refinement; and risks that measures could be misunderstood or create harmful incentives	2
Develop a clear research question	Define the entity being studied; whether different entities will be compared; whether to measure productivity levels and/or growth rates; whether measures will be undertaken for a single period or repeated; whether partial and/or multi-factor productivity measures are most useful; and whether value-add or gross productivity measures are of interest	2
	Prepare	
Establish what data you need	Establish rules, protocols and procedures regarding the use of data; what existing data are available and how existing data map to the research question; whether data gaps can be addressed by linking existing datasets; and, if new data are needed, does their collection pass a cost-benefit test	3

Step	Considerations	Chapter
Define and measure outputs	Establish the appropriate level for defining inputs (eg, service line, individual provider, across several providers); which outputs can be measured; how representative/important the measured outputs are; whether the exclusion of some outputs biases the measure; and how to account for unmeasured outputs	4
Define and measure inputs	Establish how detailed data on inputs need to be; which inputs can be measured and whether exclusions bias the measure; how inputs can be apportioned to outputs	5
Convert diverse outputs and inputs into a consistent format	If valid market prices exist then use these to combine (weight) multiple outputs (or inputs) into a single index, otherwise use per-unit production costs (cost weights). Generally, use publicly available price indexes (such as the full CPI) to deflate expenditure figures. The approach taken must be transparent as it can have a major impact on results	6
Standardise inputs and outputs	Establish whether the quality of services or the operating environment are likely to have changed and whether these changes will affect the measure. You can account for changes by segmenting services or users into groups with similar characteristics. Other approaches include assessing the impact on intermediate outcomes (for quality) or changes in population characteristics (for the operating environment). The approach taken must be transparent as it can have a major impact on results	7
	Produce	
Measure	Following the scoping and preparation stages, undertake the productivity measurement. Compare productivity performance, across time and across entities. It is useful to start with simple measures and develop more complex approaches over time	8
Check	Discuss findings widely at draft stage and benchmark findings against similar studies. Follow a clear process for releasing and updating results	8

1.4 Productivity measurement: the state of the art

For many years, the default position in measuring the output of the state sector was to assume the growth rate of outputs was equal to the growth of inputs (implying no change in productivity). This is the “inputs equals outputs” convention. This convention reflected the absence of price data and easily observable output measures for publicly produced goods and services. This convention effectively assumes away the question of productivity. It implies that the social value of government outputs always grows at the same rate as the cost of inputs.

Since the early 2000s, many governments have made efforts to move beyond the inputs equals outputs convention. An improved understanding of productivity measurement and advances in data collection and analytics has supported these efforts (Dunleavy, 2016). The Office for National Statistics (ONS) in the United Kingdom has been at the forefront. Impetus came from an independent review of the measurement of government output and productivity commissioned in 2003 by the ONS and led by Sir Anthony Atkinson. This followed a European Commission requirement that national accounts should incorporate direct measures of government output. Valuable progress has also been made in New Zealand (see Box 1.3).

This guide outlines an approach to productivity measurement based on Productivity Path Analysis (PPA) (Dunleavy, 2016). This approach differs from the aggregate approach taken by Statistics New Zealand (Box 1.3). The advantage of aggregate measures is that they are potentially comprehensive. A limitation is that they do not address the distribution of outcomes across entities within a sector. In contrast, micro-data approaches like PPA can provide a relatively rich picture of service productivity and help illustrate important policy questions (such as the variation of performance across organisations). But these approaches can be data and resource intensive, and each study only provides a partial view of changes in aggregate state sector productivity.

Box 1.3 **Statistics New Zealand measures of state sector productivity**

Statistics New Zealand regularly publishes estimates for education and training, and health care and social assistance, as part of their annual releases of industry-level productivity measures. Statistics New Zealand (2013) and Tipper (2013) detail the methodology.

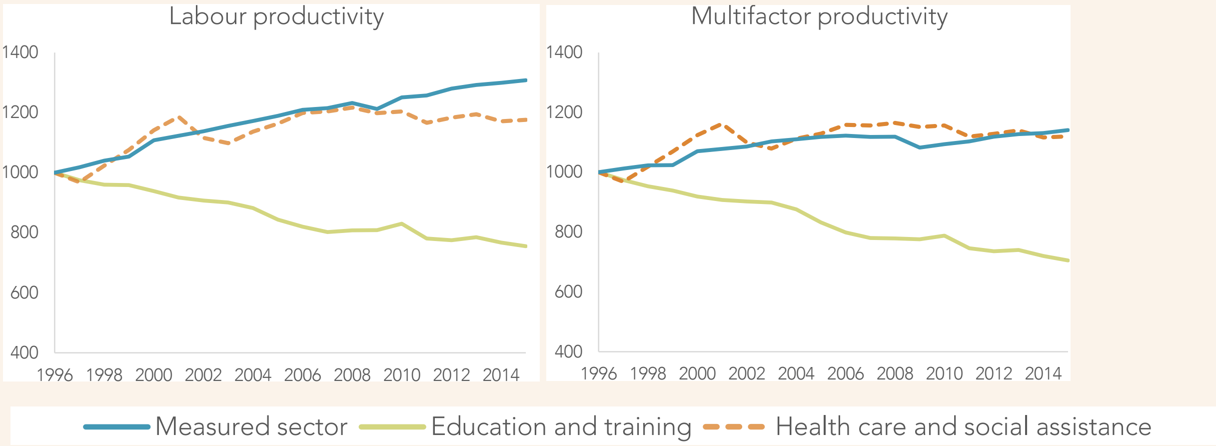
Tipper (2013) noted education and health care became priorities for Statistics New Zealand as these are where most progress has been made in defining output measures. Their output measures are based on a chain-volume value-added GDP production approach (see section 6.2 for an explanation of chain weighting). Value add is defined as output minus consumables (see section 5.1 for a discussion on consumables). Defining output in collective services such as defence, police or fire services remains relatively difficult and so estimates for these services continue to be based on the "inputs equals outputs" convention.

Having defined activity measures, their growth rates are calculated. Within subsectors, the growth rates of unmeasured activities are assumed to be the same as those of measured activities. The growth rates of the activities are then combined into a single output index for the subsector using cost weights for the different components of output which reflect their relative importance.

In the case of inputs, measures of labour and capital used in the production of the activities are estimated and combined. The labour input is based on hours paid, while the capital input is estimated by applying the user cost of capital to the total capital stock used in the industry. The latter is constructed using the perpetual inventory method (PIM) (see Box 5.1). An exogenously given rate of return of 4% is applied to all industries in the estimation of the user cost of capital (Macgibbon, 2010).

Figure 1.1 shows the labour productivity and multi-factor productivity indexes for education and training, health care and social assistance, and for the measured sector[2]. While these data are not explicitly quality adjusted, techniques exist for doing this (see section 7.2). However, in the absence of international standards for these techniques quality-adjusted measures should not be included in the national accounts.

Figure 1.1 Statistics New Zealand labour and multi-factor productivity indexes, 1996–2015



Sources: Statistics New Zealand, 2017a; Tipper, 2013.

Notes:

1. Index = 1000 for 1996.
2. The industry coverage of the productivity statistics is defined as the 'measured sector'. These industries mainly contain enterprises that are market producers. This means they sell their products for economically significant prices that affect the quantity that consumers are willing to purchase (Statistics New Zealand, n.d.).

The approach in this guide is consistent with the principles for measuring state sector productivity set out in the Atkinson report (2005). Although that report focused on measuring state sector productivity in the system of national accounts, its recommendations reflected best practice more generally. Atkinson argued that approaches to measuring state sector productivity should contain the following features.

- Output indicators should cover the full range of services for that functional area.
- Outputs should be adjusted for quality, taking account of the attributable incremental contribution of the service to the outcome.
- The measurement of inputs should be as comprehensive as possible and should include capital services.
- Independent corroborative evidence should be sought on government productivity, as part of a "triangulation" process, recognising the limitations in reducing productivity to a single number.

Productivity Path Analysis is consistent with these features.

1.5 Further information

The sources in Box 1.4 are a useful supplement to this guide.

Box 1.4 **Looking for more information?**

Statistics New Zealand's (2010) feasibility study *Measuring government sector productivity in New Zealand* provides a good introduction to the topic along with an overview of concepts and compilation challenges. This study also discusses measuring health care and education productivity in some detail. Likewise, while Statistics New Zealand's *Productivity statistics: sources and methods (10th edition)* (2014) focuses on the approach to measuring productivity in the measured sector, the chapters on the labour series and capital series can be helpful when measuring state sector productivity.

The Office for National Statistics in the United Kingdom has produced useful guidance material. *The ONS Productivity Handbook* (Office of National Statistics, 2007) includes chapters on public service productivity and quality adjustment. The *Atkinson Review: Final Report* (Atkinson, 2005) is a valuable resource and includes chapters on methodological principles, inputs and deflators, outputs and implementation, along with discussion of measurement issues in state-sector industries (health, education, public order and safety, and social protection).

Dunleavy and Carrera (2013) provide an overview of Productivity Path Analysis and present UK examples for several services, including customs, tax, regulatory agencies and hospitals.

A more general summary of the approaches to measuring state sector productivity in different OECD member countries can be found in Lau, Lonti and Schultz (2017). The OECD has also published useful technical guidance, including Schreyer's (2010) *Towards measuring the volume of output of education and health services: A handbook*.

The New Zealand Treasury's *Guide to social cost benefit analysis* (2015) includes useful material on topics such as willingness-to-pay approaches and approaches to discounting. Material produced as part of the development of the Living Standards Dashboard (Janssen, 2018; Smith, 2018) provide a valuable overview of issues such as how to value financial and physical capital.

Chapter 1 takeaways

- Productivity is a measure of how efficiently an entity converts inputs (typically capital, labour and consumables) into outputs (such as services). When the state sector produces outputs efficiently, available resources go further, and the government can achieve improved outcomes. Conversely, poor state sector productivity can be a drag on the whole economy.
- Methods for measuring productivity in the private sector cannot always be used to measure the productivity of state sector activities. This does not mean state sector productivity is impossible to measure, only that different approaches are often required.
- In the past, governments have assumed state sector outputs increase directly in proportion to inputs, that is state sector productivity was assumed not to change over time. This "inputs equals outputs" convention effectively assumes productivity is unchanged and unchangeable.
- Governments around the world are moving beyond this convention. The United Kingdom has been at the forefront of developing methods to measure state sector productivity. New Zealand has also made useful progress.
- Productivity Path Analysis (PPA) is one approach to measuring state sector productivity. This guide discusses the steps involved in undertaking a PPA:
  - clearly establish the productivity question the measure is trying to answer;
  - identify the core outputs of the entity being examined, identify the unit cost associated with each output, then develop a cost-weighted total output metric;
  - calculate the total cost of inputs used to produce the outputs; and
  - decide whether adjustments need to be made for changes in output quality or changes to the organisation's operating environment.

2 Scoping

Designing, measuring, checking, understanding, reporting, responding to and refining a productivity measure is an iterative process. But it needs to start somewhere. This chapter covers scoping the measure: establishing a business case and a clear research question.

2.1 The business case

The business case for a productivity measure needs to contain, in broad terms, what will be measured, the likely start-up and ongoing costs of measurement and what the agency might gain from measurement. The clearer this is, the easier it will be to get buy-in.

It is valuable to first establish what "business need" the measure will address. Performance measures can serve a number of distinct purposes (Gill & Schmidt, 2011; van Dooren, Bouckaert & Halligan, 2015). These include:

- to steer and control (eg, whether policies and programmes on track);
- to give account (eg, whether performance can be justified); and
- to learn (eg, whether improvements can be made).

There can be tension between these roles. Gill and Schmidt (2011) noted that a "focus on accountability and control tends to punish deviations from standards rather than providing an opportunity to learn" (p.16). Cooley (1983) argued that "indicators will be corrupted more readily if rewards or punishments are associated with extreme values on that indicator, than if the indicator is used for guiding corrective feedback" (p.9).

While accountability and steering are important, the main benefit from productivity measurement is the potential to encourage conversations and learning about service improvements. These measures should be used "as a diagnostic [tool] rather than a target" (Gill, Kengema & Laking, 2011, p.433). Where the primary objective of a measure is to promote learning and improvement it is worth considering:

- how directly the results of the measure will lead to a decision or action;
- the consequences of any decision that are based on the measure (eg, the significance for funding levels, managerial flexibility or team reputations); and
- whether productivity measures may lead to an incomplete or misleading picture of performance (eg, because of other, extenuating factors).

Of course, performance information is often used to achieve multiple objectives and the way the information is used may vary from its intended purpose. The Official Information Act 1982 provides public access to information, which can enable participation in government and hold governments and state-sector agencies to account. However, if information is made public without the necessary context, then measures intended to learn or steer may be used by the public or media for accountability purposes.

This is not a reason to avoid developing productivity measures or to keep them hidden. It simply shows that state-sector agencies need a clear understanding of what might be inferred from any measures they develop and to make this explicit when measures are released.

Guiding principles

It is also important that the broader agency environment is conducive to collecting and disseminating productivity measures. Adopting the following principles can help productivity measurement contribute to an agency's objectives:

- collect productivity data as part of business-as-usual activity;

- productivity measures complement measures of outcomes;
- productivity measures are just one input into evaluating performance;
- the primary use of productivity measures is to learn about service improvement;
- staff who deliver services are involved in designing productivity measures; and
- agency leaders actively support the use of productivity measures.

Following these principles will make it easier for agencies to measure productivity and make measurement more useful (eg, by contributing to existing performance frameworks and outcomes). See the companion volume to this guide: *Improving state sector productivity* for a fuller discussion.

Building a receptive culture

State sector leaders need to lay the groundwork for efficiency improvements by demonstrating a commitment to organisational learning and the use of productivity measures. There are several ways that the use of productivity measures can be encouraged. Box 2.1 lists some suggestions. Further detail on policy and leadership needed to establish receptive culture for measuring productivity is in the companion volume *Improving state sector productivity.*

Involve the staff who deliver services in the development of measures

Measures developed with staff are more likely to reflect the reality of service delivery and be more accurate, trusted, sustainable, and more effectively implemented and used. Knopf (2017) noted in her review of efficiency measurement in the health sector that the "workforce has strong views and most of the expertise on the best way to provide services. They are critical to implementing service improvements" (p. 14). Involving staff in the development and implementation of measures can help manage any undesirable effects they may create. Employee engagement in the development of organisational measures and strategies is also important for promoting higher performance, innovation and staff wellbeing (OECD, 2016).

Box 2.1 **How leaders can create a receptive culture for productivity measures**

- Regularly and consistently pay attention to and prioritise organisational learning and the pursuit of efficiency and effectiveness.
- Provide a role model for officials and coach other leaders in how to encourage learning and efficiency throughout the organisation.
- Put in place organisational systems and procedures to encourage learning and the use of productivity measures in decision-making.
- Foster an expectation that staff share information. Sanction staff who withhold information and reward those who develop systems to make sharing information easier.
- Create multiple channels of communication that enable staff to connect with and learn from others. This is particularly important in cases where staff operate from multiple (regional) locations.
- Seek input from staff on barriers to learning and improving productivity. Empower staff to develop solutions to the barriers and act on their suggestions. Encourage staff by publicly acknowledging and rewarding their efforts.
- Include learning and the pursuit of efficiency in statements of organisational beliefs and values.
- Link managers' performance measures to the steps they take to encourage staff learning and knowledge sharing.
- Reward staff who demonstrate a commitment to learning and the pursuit of efficiency.

- Create space for staff to experiment with new ways of operating. Treat unsuccessful experiments as learning opportunities rather than failures. Reward staff for experimenting, even when experiments are unsuccessful. Publicly emphasise the importance of learning from failure.
- Personally (and publicly) encourage people at all levels to ask questions and share stories about what they have learnt from previous experiences.
- Seed a workforce that embraces learning and productivity improvement by hiring and promoting staff on the basis of their capacity for learning and their ability to identify improvements in working practices.

Source: Adapted from NZPC, 2014.

2.2 The research question

A well-articulated research question is the bedrock of a good measure. Getting there is an iterative process that involves consideration of the following questions.

- What entity or activity will be measured?
- What will the productivity measure be compared against?
- What will be measured?

What entity or service will be measured?

What you are trying to achieve with productivity measurement. Typically, it will be to better understand the performance of an organisation, part of an organisation or a specific service. For brevity, this guide generally uses the term 'entity' to refer to the 'thing' whose productivity is being measured.

What will the productivity measure be compared against?

Are you interested in the performance of the entity over time? Or how its performance compares against similar entities?

In the first case you will need data collected over time. In the second, you will need data collected on different entities.

If you are interested in both questions, ie, how changes in the entity's performance compare to changes over time of similar entities, then you will need both types of data.

What will be measured?

The next step is to decide what type of productivity measure you require.

- For a one-time comparison between entities you will need to calculate a *productivity level* for each entity.
- For longitudinal study of a single entity you will need to calculate productivity levels for each period and turn these into *productivity growth* rates.
- For a cross-time, cross-entity study you may be interested in both levels and growth rates.

Chapter 8 provides more detail on these choices.

You should also decide whether to measure partial productivity (such as labour productivity) or multi-factor productivity (see Box 1.1).

2.3 Think about production too

Measuring productivity need not be rocket science. As described in Chapter 8, productivity measurement techniques can vary in complexity from a simple ratio analysis to more complex approaches based on frontier techniques. Sometimes complex analysis is necessary, but in many cases, a simple form of measurement will be enough to answer some questions and prompt valuable discussion. New Zealand Treasury (2015) commented in its guide to cost benefit analysis:

> A systematic method does not need to be complex, detailed and expensive. Even a rough back-of-the-envelope calculation can be logical and methodical (p. 6).

It is also necessary to consider the existing systems and capability levels within state-sector agencies. Some agencies will have a stronger ability to start developing and using productivity measures than others. Sometimes it will be easier to start with a partial measure, a measure of a service or a part of a service. Agencies could begin with simpler productivity measures and then, over time, build their capability to use more sophisticated techniques if these are required.

It is also important to think ahead to the time when you have results. These questions are important.

- How often will results be disseminated? To whom?
- What will the results be used for?
- How might the results be interpreted?

Chapter 2 takeaways

- A well-articulated research question is the bedrock of a good productivity measure. The limits of any measure need to be transparent. You should document this information and include it when presenting results. It is also important to consider how any measure developed could be used and by whom.
- Productivity measures are most valuable when used as the basis for conversations and learning about service improvement. Treat them as one input into performance measurement. Do not attach significant staff rewards and sanctions to productivity measures.

3 Collecting data

Productivity measurement rests on access to reliable, relevant data. This chapter covers some general issues in collecting, handling and sharing data.

3.1 Use existing data if possible

When developing productivity measures your first choice should be to use existing data, rather than collecting new data. New data collection will always come at a cost.

You can go a long way using data routinely collected for administrative purposes. To give one example, District Health Boards (sub. 17, p.6) noted that the health sector:

> has a range of IT systems that support the delivery of services in an operational context, for example, theatres, radiology, laboratories. Often these systems do not feed directly into national collections but generally support clinical coding processes and other analytical processes, such as costing and production planning.

All state-sector agencies collect financial and human resources data. In many cases this is well suited to building input measures and cost weights.

Think about data access, standards and linking. Useful questions include the following.

- What datasets are relevant?
- Who has control or ownership of these data?
- How were these data collected?
- Are there rules around the use of these data?
- Are there potential privacy concerns? How might these be addressed?
- What options already exist for linking datasets?

It is also important to recognise that existing data have limits. The following are examples from the health sector.

- Hospital data (both inpatients and outpatients) tend to be most readily available, and most often utilised for productivity studies. But hospitals are only part of the wider health system. To understand health trends more fully, it is necessary to link data.
- Some data on outcomes in other health services (eg, primary health care) can be found in the Integrated Data Infrastructure (IDI) (Box 3.1). However, this database contains little data on inputs. Data in the IDI can illustrate the relationship between outputs and outcomes but provides very limited information on how policy levers can drive the production of outputs (which, in turn, affect outcomes).
- There are significant opportunities to link disparate datasets and improve access for policy and operational personnel. As District Health Boards (sub. 17) and others, for example Downs (2017) noted, access to primary health care data is a challenge, especially data that would inform better outcome-based analysis.
- Dataset linking is easiest where there is consistency in data standards and systems. While some practices (eg, common costing standards) provide a good basis for developing productivity metrics, their implementation across providers could be more consistent.

Box 3.1 **The Integrated Data Infrastructure**

Statistics New Zealand's Integrated Data Infrastructure (IDI) is a large, secure, research database containing a wide range of data about people, households and businesses.

Personal data in the IDI is identified by the name and date of birth of the individual concerned when it enters the IDI. It is then "matched" with other data held in the IDI about the same person. The identifying detail is then stripped out and the data becomes "de-identified". An equivalent process is used to de-identify business data.

The data seen by researchers is always de-identified. It therefore has limited use for operational purposes.

The IDI began with Statistics New Zealand data from the 2013 census and other surveys. It now includes data from many government agencies and some non-government organisations. These include data on schools, tertiary education and some training programmes, IRD data on tax and income, MSD benefit data, housing data, Auckland City Mission data, ACC claims data and several datasets from the health sector.

For more information on accessing and using the IDI see www.stats.govt.nz/integrated-data/integrated-data-infrastructure/ and https://sia.govt.nz/assets/Documents/Beginners-Guide-To-The-IDI-December-2017.pdf. The Social Investment Agency has other tools on its website, including the Social Investment Agency Analytical Layer and Social Investment Data Foundation. See https://sia.govt.nz/tools-and-guides/.

Source: Statistics New Zealand, 2017b; Social Investment Agency, 2017.

One way to address these issues is to integrate data systems or build new ones (see Box 3.2). This requires the capability to design and construct processes for drawing together data from multiple systems, and rules and organisations to govern the flow of input and output data within and between agencies.

Box 3.2 **Building a measurement model: MSD's individualised Cost Allocation Model (iCAM)**[2]

The Ministry of Social Development (MSD) has developed (and continues to develop) an individualised Cost Allocation Model (iCAM). It estimates the costs of various staff activities using existing administrative data. The purpose of the iCAM model is to help MSD consider:

- cost effectiveness: to accurately estimate the cost of programmes and services;
- targeting: to better identify which groups of clients to invest in; and
- efficiency: to track and assess the efficiency of delivering individual outputs (iMSD, 2017).

iCAM uses information from administrative datasets to estimate how much time front-line case management staff spend on different computer-based activities. The time staff spend on each screen in the various IT systems is calculated from time stamps generated when a system action is completed.

Estimates of other costs, such as staff time that is not allocated to a computer-based activity (eg, training time), and indirect costs (eg, overheads and corporate support) are then added to the model. These costs are broken down into specified individual service outputs or activities, such as applications for a benefit, use of an employment service, benefit payments, etc.

This assignment of costs to individual components is at the core of the model, with the total cost of each service output being built up from a set of cost components – specific tasks involved in delivering

[2] The iCAM model needs to be distinguished from MSD's finance Cost Allocation Model, which allocates costs at an aggregate level to help MSD make decisions about future budget allocations for service lines and specific interventions (iMSD, 2017).

a service. For example, a "wage subsidy placement" would include five components: referral, vacancy placement, subsidy amount, subsidy administration and overhead. Table 3.1 provides examples of metrics used to calculate costs associated with specific activities.

Table 3.1 Example service delivery cost components

Component	Definition	Metric for allocation[1]
Appointment	Scheduling an appointment with a client	Staff time
Benefit administration	Assessing and maintaining entitlement to income support assistance	Staff time
Client contact	Contact with clients to help them plan and move into employment or updating their records	Staff time
Seminar	Staff time in administering and running seminars (eg, work readiness) for clients	Staff time
Overhead costs	IT, corporate services, property and support staff costs	Departmental cost per output

Source: iMSD, 2017.

Notes:

1. Metric for allocating group costs down to individual activity or outputs.

3.2 Privacy and handling issues

State-sector agencies collect and store a lot of data in their administrative systems that could be useful for productivity measurement. However, there are important constraints on the use of existing data. The Privacy Act 1993 defines "personal information" as "any information about an individual (a living, natural person) as long as that individual can be identified" (s 2). The Act also contains 12 information privacy principles that set out how agencies may collect, store, use and disclose personal information. The two most relevant principles are:

- **Principle 10: Limits on use of personal information,** which prevents personal information that is obtained in connection with one purpose from being used for another purpose. There are exceptions to this, which include where "the purpose for which the information is used is directly related to the purpose in connection with which it was obtained" (s 6) and where the information is "to be used in a form in which the individual concerned is not identified" (s 6) or "for statistical or research purposes and will not be published in a form that could reasonably be expected to identify the individual concerned" (s 6); and
- **Principle 11: Limits on disclosure of personal information,** which prevents personal information from being disclosed to a person, agency or body except in specific circumstances. These exceptions include (as above): when the information is "to be used in a form in which the individual concerned is not identified" (s 6) or "for statistical or research purposes and will not be published in a form that could reasonably be expected to identify the individual concerned" (s 6).

The re-use of data collected as part of daily business must be consistent with principle 10 of the Privacy Act 1993 and any data matching that involves sharing or disclosing information to other agencies or bodies must be consistent with principle 11. Both principles require agencies to protect the identities of the individuals the data relates to.

Productivity measurement need not involve sharing information between agencies. However, the impact of productivity improvement is often felt more strongly across a whole system – or in a different part of a system – than in the area where the measured output is produced. For example, improvements in one part of the health system will usually impact on other health services, so a measure which only looks at the service in which a particular change was made may not uncover the full impact of that change.

Box 3.3 **Protecting patient records: Research on Health Care Homes**

The Commission conducted a study on Health Care Homes in the greater Wellington region as an example of innovation in primary health care. The study had two goals. The first was to look at the impact of Health Care Homes on general practice – the part of the health system in which it was being implemented. The second was to look at the impact of Health Care Homes on the wider health system – in particular, on the demand for hospital services.

This required data from the General Practice Patient Management Systems (held by Compass Health PHO) to be matched with data from the National Minimum Dataset (a national collection of public and private hospital discharge information). Consistency with the Privacy Act 1993 requires that information to be shared must be in a form in which individuals cannot be identified. The IT staff at Compass Health PHO and Capital & Coast DHB matched data using patients' National Health Identifier (NHI) numbers. The IT staff then removed NHI numbers before sending the data to researchers at Auckland University of Technology (AUT) for analysis.

Capital & Coast DHB and Compass Health PHO (and the PHO's member general practices) have long working relationships that go back many years. These well-established relationships, along with the reputation of the AUT researchers, facilitated this information sharing.

Before using or sharing administrative data it is important to ensure there are rules, protocols and processes around how the data will be used and for what purpose (eg, standards for the collection, storage, reporting and sharing of data). Questions can include how to get agreement to use the data, how to ensure that only authorised people can access it and how to ensure datasets cannot be reverse engineered to reveal individual records.

Box 3.4 **Who can help with questions about data?**

Several organisations can provide guidance about the collection, storage, reporting and sharing of data. These include the following:

- Privacy Commissioner: Provides advice and guidance on its website, including a privacy impact assessment toolkit and an interactive data safety toolkit with tips on how to manage a privacy breach.
- Social Investment Agency (SIA): Has developed tools and guidance to help agencies to work with IDI data (such as the Data Exchange, the Social Investment Data Foundation code, the Social Investment Measurement Map and a *Beginners guide to the IDI*, among others). The SIA is also leading work to develop a data protection and use policy for the social sector.
- Government Chief Privacy Officer: The GCPO has issued core expectations for good practice for privacy management and governance in the state sector. It has also developed guidance on privacy management and a privacy maturity assessment framework to help agencies assess and build their capability.
- Government Chief Data Steward: The GCDS is the Government Statistician and Chief Executive of Statistics New Zealand. The GCDS oversees the development of policy, infrastructure, strategy and planning to develop capability and the use of data across government. The GCDS supports government agencies to build their capability and manage the data they hold.
- Data Futures Partnership: The Partnership's guidelines enable organisations to maximise the value of data through building the trust of clients and developing wider community acceptance (Data Futures Partnership, 2017).

Protecting data helps ensure public trust in government's use of data. The Data Futures Partnership has specifically addressed this challenge. It noted that:

> … data reuse interests tend to address only their own needs – frequently overlooking the interests of the data contributor. At best there is lip service to consent, minimal personal control for the contributor, or at worst coercive harvesting of data. Because these attempts fail at trust they become costly and hard to scale (Mansell et al., n.d., p.7).

State-sector leaders interviewed by Pickens (2017) noted that it can be difficult to obtain information from other organisations, including government agencies and contracted service providers, due to privacy concerns and suspicion about how the information might be used. Yet the benefits from the greater use of administrative data are potentially very high, so agencies need to seriously consider how to share and use data in a safe way. Box 3.5 describes how a large organisation developed internal rules for data use that protect personal data.

Box 3.5 **Protecting individual data: MSD's privacy, human rights and ethics framework**

MSD started developing and implementing a privacy, human rights and ethics framework (PHRaE) in 2016. The framework was prompted by the need to protect people's rights and information in the context of predictive models MSD was developing. MSD experienced negative media coverage on privacy issues and decided it needed to improve its level of maturity measured against the using the Chief Privacy Officer's privacy maturity assessment framework.

To strengthen its privacy, information sharing and, to a lesser extent, information security systems across the board, MSD expanded the PHRaE to cover all its activity in 2017. The PHRaE comprises materials, including a guidance document, a how to guide, and an interactive tool, and a centralised team of specialists to support project teams at the design and development stage of new initiatives.

Source: Ministry of Social Development, 2017.

Box 3.6 discusses the development of a system for sharing data across an operational network.

Box 3.6 **Building trust to handle and share data across a clinical network**

The Canterbury Clinical Network is a collective alliance of health care leaders, professionals and providers from across the Canterbury health system. Since 2009 the Network has developed new service delivery and funding and contracting models, which "are based on principles of high trust, low bureaucracy, openness and transparency" (Pegasus Health PHO).

An important development was HealthOne, which created a single shared health record across all the health providers in the district. This means that all health professionals can see a patient's entire health record. This was a huge shift from the previous situation where general practitioners, secondary care and allied health professionals kept their own records and manually notified each other when they treated the same person.

The incentive for providers to share data was that they would not be able to access other parties' data unless they shared theirs. HealthOne would not have been possible without the trust between general practices, PHOs and Canterbury DHB built through positive relationships over 15 years.

Source: Canterbury DHB; Pegasus Health PHO; Canterbury Clinical Network.

Chapter 3 takeaways

- Productivity measures should draw on existing data where possible, rather than collecting new data. It may take time to understand what data is currently available and how these data could be used. Linking datasets can provide significant benefits.
- It is important there are rules, protocols and processes around the use of data. These measures can help build trust and facilitate data sharing.

4 Defining outputs

This chapter examines the measurement of outputs. It begins by discussing the difference between outcomes, outputs, and activities. It then describes how the observability of outputs can vary depending on the type of service under examination. Finally, it discusses coverage of outputs in productivity measures.

4.1 Outcomes, outputs and activities

Outputs can be distinguished from outcomes and activities. In this guide:

- *outcomes* are a state or condition of society, the economy or the environment, or a change in that state or condition (New Zealand Treasury, 2011);
- *outputs* are goods and services commissioned by ministers from state, non-government and private sector producers (New Zealand Treasury, 2011); and
- *activities* are individual tasks that state-sector agencies perform that contribute to the delivery of an output.

Box 4.1 illustrates these concepts.

Box 4.1 **Measuring outputs and activities in the court system**

The Ministry of Justice developed a "cost of case" model for the District Court to estimate the staff time and the Ministry's costs of each different type of case to progress through the Court.

Rather than measuring the "disposal" (or completion) of cases as outputs, the model measures "events", defined as a single interaction with the Court or with a judge. (These events correspond to "activities".) The model used survey data and expert opinion from experienced front-line court staff on the expected length of time to prepare for and conduct court events. Individual court events are weighted by these estimates to provide an overall estimate of each court's workload and the associated costs. Cases are also weighted by seriousness, as more serious cases typically require more court events and therefore spend longer in the system. Courts have their actual performance compared to these workload estimates to ensure continual optimisation of resourcing and results.

This information allowed the Ministry of Justice to better understand the variation in cases and effort required for each Court's workload. This analysis helped identify variations in service levels around the country. For example, the Ministry's *Annual Report* noted that it took:

- 69% longer to go through the administration stage in Waitākere compared to Tauranga;
- 52% longer to go through the review stage in Gisborne compared to Whangārei;
- 50% longer to go through the trial stage in Nelson compared to Rotorua; and
- 61% longer to go through the sentencing stage in Whanganui compared to New Plymouth.

This analysis allowed the Ministry to better understand its cost and demand pressures, to allocate front-line resources based on need and to work on providing service consistency across Courts.

Source: Ministry of Justice Annual Report, 2017, p.5; Ministry of Justice, pers. comm.

As simple as this distinction seems, there are a variety of ways to apply these concepts in practice.

Ultimate and intermediate outcomes

Tavich (2017) noted the distinction between ultimate and intermediate outcomes. Ultimate outcomes are the final impact an activity has on society. Intermediate outcomes are objectives that serve as goals along the path to achieving ultimate outcomes (Coglianese, 2012). Intermediate outcomes tend to be easier to observe in the short term than ultimate outcomes. Consequently, it can be easier to measure intermediate outcomes and to attribute them to a specific government activity. In contrast, ultimate outcomes tend to be influenced by many factors, many of which are outside the control of the state sector. For example, overall health outcomes, such as life expectancy, are affected by factors including lifestyle choices, environment and education (Sharpe, Bradley & Messinger, 2007). This makes it difficult to attribute changes in ultimate outcomes to government activities. For this reason, ultimate outcomes are rarely included in productivity measures.

Choosing outputs

Outputs can also be conceptualised in different ways. They could be the daily activities undertaken by individual officials performing a given task (Gregory, 1995a; cited in Tavich, 2017). Alternatively, they could be defined at a more aggregated level, for example, the number of clients seen (Laking, 2008). This distinction is also, in practice, not clear cut. Take the example of an emergency department in a hospital. An output might be the initial diagnosis and course of treatment, even if the patient is then transferred elsewhere for further treatment. This represents the complete activity of the entity (ie, the emergency department) under examination. However, if the purpose of the analysis is to understand the productivity of a hospital the services performed by individual departments might be considered as individual activities in the overall output of treating a patient.

Table 4.1 Examples of outcomes and outputs

Example	Outcomes	Outputs
Hospital care	Healthy population Quick recoveries from injury or illness Reduction in preventable diseases	Hospital discharges for different diagnosis-related groups Number of treatment courses for specific medical conditions
Schooling	Well-educated population Young people who are confident, connected, actively involved lifelong learners	Number of student places provided
Court proceedings	Cases resolved in a procedurally fair and just manner Safe communities Public trust and confidence in the justice system	Number of cases resolved Number of hearings or mediation sessions conducted Fines collected
Work and income services	More people in sustainable work and out of welfare dependency Fewer people commit fraud The system operates with fairness and integrity More people contribute positively to their communities and society	Number of individuals who receive a main benefit Number of young people placed on a training programme Number of emergency housing requests placed

4.2 Measurability of outputs

Some outputs are easier to measure than others. This section looks at different types of outputs (services) and the methods you can use to account for their characteristics.

Individual and collective services

Much of the output of the state sector takes the form of services provided to individuals (Atkinson, 2005). These can be referred to as *individual services*. However, the outputs of other services (such as national defence) are consumed jointly by the whole population (Atkinson, 2005). These can be referred to as *collective services*.

This guide focuses on individual services. For collective services or particular services with both individual and collective features, there are three main approaches for measuring their outputs:

- Assuming the productivity growth of collective services is equal to that of similar services provided by the private sector. For example, it could be possible to assume the productivity of public health campaigns is equal to comparable campaigns in the measured health services.
- Applying direct output measures where possible and reverting to an input method for the remaining collective services. In effect, this means that collectively consumed services are excluded from the productivity measure.
- Measuring outputs where possible and using activity indicators for collectively consumed services. For example, in the case of fire prevention services the total number of hours spent delivering prevention activities might be an appropriate substitute for outputs (Office of the Deputy Prime Minister (UK), 2005).

Transactional and variable services

It is also possible to distinguish between *transactional services* and *variable services*. Outputs from transactional services tend to:

- be standardised, high volume and repetitive;
- entail relatively little interaction with, or involvement of, consumers; and
- be relatively easy to specify in advance; and
- have relatively easy measurement of actual performance (OECD, 2001b).

An example of a transactional service is the payment of income-tested benefits. Transactional outputs are generally relatively straightforward to measure. They are usually supported by comprehensive procedure guides and operating manuals, which detail rules to be followed and standards to be met during the production process (OECD, 2001b). Dunleavy and Carrera (2013) suggested that quality can be assumed to be relatively constant for these types of outputs. They recommend that researchers take note of any substantive failures of quality control when presenting productivity data, rather than seeking to quality adjust the output numbers.

Variable services include teaching and individual health care. For these services outputs can be defined and counted but they are subject to much greater variation than transactional services. Variable services are often delivered with a high degree of interaction with, or involvement of, the consumer of the service. The variability in production process introduces much greater scope for differences in quality. This makes quality adjustment (discussed in Chapter 6) more important.

4.3 Coverage of outputs

Ideally, the range of outputs included in productivity measures would be comprehensive (Statistics New Zealand, 2010). Including a subset of outputs may lead to a misleading picture of changes in performance and/or encourage state-sector agencies to focus on measured outputs at the expense of unmeasured ones (Simpson, 2009). The New Zealand Council of Trade Unions raised this concern:

> Elevating any subset of measured outputs to 'core' status [….] risks distorting the operations of the organisation or programme if more effort is devoted to improving that indicator at the expense of its complete set of objectives (sub. 9, p.6).

Yet a principle that always required complete coverage of outputs would be impractical. There may be gaps in data availability. In practice, a balance is needed between coverage and the cost of a measurement (Atkinson, 2005).

There may also be diminishing marginal returns from attempting to measure all outputs. As one submitter noted:

> It is neither necessary nor desirable to measure every single output of any sector, service or function. The Pareto principle states that, for a lot of events, roughly 80% of effects come from 20% of the causes … This 80/20 rule can be applied in this context by focusing on the critical 20% of functions of any sector which would produce roughly 80% of the outputs. This would maximise the cost/benefit ratio for the project, deliver the most gains in productivity, and avoid wasting time dealing with problems which are trivial (Hermann Grobler, sub. 5, p.6).

Statistics New Zealand (2010) suggested that if comprehensive coverage is not possible then the next best option could be to aim for representativeness. In this case, it is necessary to identify outputs whose growth rates can reasonably be assumed to be representative of growth rates for outputs where data is not available or is costly to collect.

Other authors noted the importance of capturing the fundamental goods and services produced by the agency in measures (SSC & Treasury, 2008; Dunleavy & Carrera, 2013). Dunleavy and Carrera (2013) suggested asking (about a state sector agency) "what its broad mission is, and what few main outputs capture that mission and can be cost-weighted in a reasonably accurate manner" (p.36). This approach effectively measures productivity for these priority outputs and then, if an aggregate measure for an agency is required, assumes the productivity of other outputs grows in line with growth in inputs. Note that in developing this aggregate measure it is necessary to also estimate what share of total output is being measured, what share is not being measured and whether this changes over time. For example, if a specific output is used as a proxy for total output, then the calculation of aggregate productivity needs to consider whether this output changes in importance to the agency over time. This is discussed in more detail in the section on cost weighting in Chapter 5.

This guide emphasises defining outputs according to the availability of data and the ease with which any additional data might be gathered. Statistics New Zealand (2010) noted that output coverage is typically based on what information and classifications are already available, rather than on purity of concept. However, it is important to not only measure what can be easily measured (Atkinson, 2005). While there are practical constraints on what can be measured it is important to not lose sight of the central question (understanding the services provided to households and firms). As he wrote:

> … the procedure of defining direct output indicators within a government function should start by seeking to identify the services provided by government to households and firms, and attempts made to find data to reflect these services as comprehensively as possible, with appropriate allowance for quality change. The services should be the starting point, not the available indicators (Atkinson, 2005, p.47).

This should not be taken as meaning the absence of complete data necessarily prohibits measurement efforts. Instead, it simply means the limitations associated with measures should be clearly articulated and efforts to improve the availability of data should be undertaken in parallel with measurement efforts.

Chapter 4 takeaways

- In practice, distinguishing activities and outputs can be difficult and will depend on the purpose of the analysis and the level at which the analysis is framed (service level, sector level, agency level, etc.).
- The output of collective services can be difficult to measure. In some cases, it may be possible to assume productivity of these services has grown at the same rate as a similar (measurable) service or by employing the "inputs equals outcomes" convention.
- Transactional services tend to be highly standardised. For these services it may be reasonable to assume quality is constant through time.
- The production of variable services is less standardised. There is, therefore, more scope for changes in service quality through time (see Chapter 6).
- Ideally a productivity measure would include all outputs. However, this may be impractical and so a "second-best" approach is to aim for representativeness. The outputs selected should capture the core functions or mission of the entity.

5 Defining inputs

This chapter discusses the measurement of inputs. It begins by discussing three main categories of inputs. It then covers the measurement of labour and capital inputs, before discussing considerations such as missing inputs and co-production.

5.1 Defining inputs

Inputs are the direct and indirect factors used in the production of outputs. They can be organised into three categories.

- *Labour*: people involved in the production of outputs, both directly (eg, teachers) and indirectly (eg, administrative staff who contribute to the functioning of an entity).
- *Consumables*: other goods or services consumed as inputs in the production of the output. Consumables can be further disaggregated. For example, the KLEMS framework breaks them into energy, materials and services (London Economics & DIW Econ, 2017).
- *Capital*: the use and consumption of capital in the production of the output (eg, buildings, vehicles, information technology).

Table 5.1 extends Table 4.1 in Chapter 4 by attributing inputs to outputs.

Table 5.1 Examples of outputs and contributing inputs

Area	Outputs	Inputs that contribute to production
Hospitals	Hospital discharges for different diagnosis related groups Number of courses of treatment for specific medical conditions	Labour: doctors, nurses and other staff directly associated with producing the output (eg, ward clerks) and indirectly associated with its production (eg, laundry staff) Consumables: products and materials used as part of procedures or treatments (eg, bandages, scalpels, medicines) Capital: contribution to capital costs related to the hospital (eg, internal charging for space and overheads)
Schools	Number of student places provided	Labour: teachers, principals, teacher aides, administrative staff Consumables: teaching materials Capital: depreciation, capital charge
Courts	Number of cases heard Number of hearings held Number of mediation sessions conducted Fines collected	Labour: judges, adjudicators, stenographers, court security staff Consumables: law books, software, electricity Capital: capital costs relating to the operation of courts (eg, depreciation and capital charge)
Work and income services	Number of individuals who receive a main benefit Number of young people placed on a training programme Number of emergency housing requests placed	Labour: case management and administrative staff Consumables: cost of training courses for clients Capital: internal charging for space; or depreciation and capital charge

Differentiating between types of inputs is important when:

- developing partial productivity measures, such as measures of labour productivity (see Box 1.1); or
- decision-makers want to understand the impact of changes in particular inputs, such as the impact of hiring more staff or buying new technology.[3]

Measures of multi-factor productivity (MFP) are useful when it is not possible to differentiate inputs into labour, capital and consumables. MFP measures show the amount of output produced from each unit of resource employed. The analysis includes all resources. Total expenditure can be used as a proxy for total inputs (Gemmell, Nolan & Scobie, 2017b).

The inputs used in production can be calculated using a volume measure or an expenditure measure:

- volume measures track changes in the number of inputs (eg, staff numbers, hours, or full-time equivalents for labour); and
- expenditure measures track changes in spending on the different types of inputs.

It is theoretically preferable to use volume measures in place of expenditure measures as they more directly capture input changes (Atkinson, 2005). For example, a change in salary expenditure, even if adjusted for inflation, reflects both changing hours of work (the volume of labour) and changes in wage rates (the price per unit of labour). Yet in practice it will be unlikely that the volume of all inputs will be observable and so it may be necessary to use some expenditure measures to ensure comprehensive coverage of inputs. Likewise, in many cases the change in expenditure-based measures will be a reasonable proxy for changes in the volume of inputs. Unless there are reasons for thinking that expenditure-based measures may be misleading, the simpler approach of measuring inputs based on expenditure is generally recommended.

For cases where there is a need for a direct volume of inputs, the "Measuring labour volumes" section below discusses approaches.

Measuring capital inputs

Capital refers to the fixed assets owned by the service provider and used in the production of outputs. Buildings, computers and infrastructure are all examples of capital. Measuring capital can be difficult, as discussed in Box 5.1.

The principle is to measure the flow of capital services. As Atkinson (2005, p.215) noted, for:

> any given type of asset, there is a flow of productive services from the cumulative stock of past investments. To illustrate, take the example of an office building. Service flows of an office building are the protection against rain, the comfort and storage services that the building provides to personnel during a given period… the appropriate measure of capital input for production and productivity analysis is the flow of capital services of an asset type. This involves adding to the capital consumption an interest charge, with an agreed interest rate, on the entire owned capital.

Dunleavy and Carrera (2013) suggested "a good proxy of capital consumption is capital depreciation, which is published in most public organizations' annual reports" (p.43). Depreciation measures reductions in the value of the capital stock over the useful life of assets. Depreciation rates often vary, depending on the asset in question and its expected useful life. These variations in depreciation rates are significant given the growing use of digital technology in the state sector (Dunleavy, 2016).

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[3] Labour productivity measures the amount of output produced from each unit of labour employed, while capital productivity measures the amount of output produced from each unit of capital employed.

Box 5.1 **Depreciation and capital charges**

As Statistics New Zealand has noted capital productivity shows how a change in the volume of assets, such as buildings, machinery, computers and IT, and land, affect output growth. An increase in capital productivity means that a unit of capital is producing more output than in the previous year, or that the same amount is being produced for fewer capital inputs.

Yet, capital inputs do not conform with the simple production model as they are not consumed in production. Nonetheless, capital goods need to be deployed to produce services.

An often-used measure of capital input is the flow of services provided by capital goods. However, the flow of capital service is an abstract notion and it is rarely possible to measure it directly. Statistics New Zealand uses an index number technique based on assets measured in the national accounts. This is based on the perpetual inventory method, which incorporates investment flows and applies retirement, efficiency and discount parameters to derive estimates of productive capital stock, net capital stock and consumption of fixed capital.

For micro-studies an alternative approach is likely to be suitable. This is based on depreciation and capital charges. Depreciation is an accounting adjustment to reflect the consumption of capital over a specified period. Accounting practice is to treat depreciation as an operating cost. Capital charges are a capital cost.

In general, measurement of productivity in the state sector should, as far as possible, mirror the approaches used in the measured sector. For example, leasing charges in the private sector incorporate a rate of return on the investment (including a risk premium for holding the asset) and an additional margin to cover maintenance and depreciation costs. In the New Zealand context, the equivalent for this rate of return on investment would be the capital charge applied to departmental assets.

The capital charge is "an expense derived from the capital cost of the Crown's investment in each department" (New Zealand Treasury, 1996, p. 42). It is designed to ensure that prices for government services reflect full production costs, allow comparisons of production costs with the private sector, and create incentives for departments to dispose of surplus fixed assets (New Zealand Treasury, 1996).

Thus, depreciation and capital charges should be included in the calculation of capital services. For agencies that are not subject to capital charge, current Treasury discount rates could be used.[4]

Another way to think of capital input is to apply the principle that the means of financing an asset should not affect the measured productivity of using that asset. For example, suppose that three otherwise identical organisations use a machine in their production. Organisation (1) owns the machine outright, (2) leases it and (3) owns it, mortgaged with a bank loan. Their annual capital costs are calculated as (1) a capital charge plus depreciation; (2) an annual lease payment and (3) interest payments plus depreciation. All three calculations should arrive at the same number, to equalise the three organisations' measured productivity. This "equivalence rule" allows you to use whichever one of the three calculation methods you can most easily obtain data for.

Internal charging regimes used by state-sector entities, such as hospitals, are likely to already allocate these costs. Service weights can also be calculated and used for this purpose (see Box 5.2).

[4] Treasury discount rates typically vary depending on the nature of the asset in question. For example, the rate applied to general purpose office and accommodation buildings has historically been lower than the default rate or the rate applied to IT equipment.

Box 5.2 **Using service weights when measuring the productivity of hospital services**

District health boards use service weights to attribute spending to a specific service (eg, on an operating theatre) when measuring productivity. Service weights enable them to calculate more accurate efficiency and productivity measures for sub-outputs such as theatres, wards or radiology.

District health boards developed service weights as part of their health system performance programme. They reflect the relative cost or input consumed by the outputs of a service. Conceptually, they are same as output weights or cost weights. However, service weights relate to a specific service while cost weights relate to an entire hospital.

For example, output weights should match the inputs consumed per output. For service components it is necessary to include only those related to the service. When all costs are used they include some that do not represent input into the production of the service. For example, in determining the efficiency of theatres outputs should be weighted using theatre weights. These weights would reflect the inputs consumed in theatre, not the resources consumed by the entire hospital.

Service weights can be developed in the same way as cost weights (eg, using actual cost information to determine the relative cost of output). To produce cost weights the fully absorbed cost (entire hospital cost) would be used, while service weights would use just the cost of the given service in the production of outputs.

Source: District Health Boards, 2015.

Measuring labour inputs

As noted above, unless there are reasons for thinking that expenditure-based measures may be misleading, the simpler approach of measuring inputs based on expenditure is generally recommended. However, there may be cases where there is a need for a direct volume of inputs. This section discusses approaches to measuring labour volumes based on the Statistics New Zealand approach. The main approaches are summarised in Table 5.2. The preferred measure of labour input is composition-adjusted hours of work. This measure accounts for skill (often proxied by qualifications or years in work) differences among workers, so an hour worked by a skilled person is given a greater weight than a less skilled person (Statistics New Zealand, n.d.).

If the data needed for composition-adjusted labour measures are not available a “second-best” approach can suffice. For example, in the Commission’s case study of early childhood education, the most detailed data available were the number of full- and part-time teachers and their qualification status (Green, 2017). For a more disaggregated measure of labour input the Commission:

- weighted the part-time headcount numbers to distinguish their contribution to output production more clearly (using a range of weights, from 0.25 to 0.75); and
- used wage rates in the sector’s collective contract and Statistics New Zealand average income data for early childhood teachers to weight the headcount numbers.

This allowed the labour input measure to reflect changes in the quality/composition of the teaching cohort (Green, 2017).

The calculation of labour inputs should also account for the indirect costs associated with the production of goods or services, such as labour provided through administrative or support services. Agency finance divisions will have accounting rules for calculating or attributing the overhead contributions to outputs (New Zealand Treasury, 1994).

Table 5.2 Options for calculating labour input

Labour input measure	Issues
Employment count (ie, number of workers)	Most straightforward to collect but gives all workers the same weight regardless of whether they are full or part-time. Will not capture changes in input mix (and hence productivity) arising from changes in the full-time/part-time mix
Full-time equivalent	Takes into account the mix of full and part-time employment. However, often requires assumptions to be made about the relative contribution of each (eg, part-time workers are often given a weighting of 0.5). This may not reflect actual labour contributions
Hours paid	Does not require assumptions to be made about the relative input of full to part-time workers. However, may not fully capture changes in actual labour inputs as workers are often paid for a set number of hours, but change the number of hours worked each week
Hours of work / actual hours	More accurate than hours paid, but treats hours worked by all individuals as equal, regardless of their "quality"/skill level/seniority
Composition-adjusted hours worked	The most representative measure of labour volume, as it explicitly recognises differences between workers. Allows changes in labour composition that affect output to be reflected as change in labour contribution, and not as a change in productivity

Source: Statistics New Zealand, 2014.

Measuring consumable inputs

Consumables – at least those purchased from the private sector – can generally be costed at market prices, ie, the price paid. However, if the consumable is subsidised, or produced by another government agency, then the price paid is unlikely to reflect the cost of resources applied to its production. In effect, there is a "missing" or mis-priced input, which you may need to account for. This is covered in the next section.

5.2 Additional considerations

Missing inputs

When measuring service productivity, it may be important to take into account the pre-existing attributes of consumers and the contribution consumers make to production. One often-cited example is the knowledge and attributes a young person brings to school. The learning the student gains from school will be the combined result of the teaching services received and the student's inherent talents. Another example is the pre-existing conditions that a patient brings to a medical treatment, which may affect the success of any subsequent intervention.

In theory, both the pre-existing competencies of students and conditions of patients are inputs to production and could be included in the input calculation. In practice it is often easier to deal with these issues by quality adjusting the outputs. Examples include using "casemix" for health, and value add for education (eg, progress over the course of the year against the curriculum or standards). Chapter 6 looks at quality adjustments in more detail.

Another issue to consider is co-payments. These are usually monetary contributions to the production of an output, but can also be donations of labour (eg, volunteers in the Department of Conservation or parents volunteering in schools). If productivity measures do not account for co-payments (or co-financing):

- a government agency could appear more productive than in reality because the cost of producing its outputs is artificially low; and

- agencies may have an incentive to shift costs onto the public; for instance, by increasing the proportion of costs covered by co-payments. By shifting costs, an agency may appear to be increasing productivity without any real improvement in efficiency.

When studying the productivity of service, co-payments should be included as an input. However, if studying the productivity of government funding only, then co-payments should not be included.

When other agencies' outputs are the entity's inputs

There is also a choice whether to use gross output or value-added measures. Value-added measures remove consumables from gross output. Gross output measures are useful for understanding the total output of a sector or organisation, while value-added measures are useful for assessing the marginal additional value added. Statistics New Zealand (2010) illustrated this difference with a health sector example:

> …if interest lies in understanding the marginal extra value added by the health system (for example, the fact that medications are typically bought in and not produced by the government health sector, so are not part of its value added), then a value added single or multifactor productivity methodology should be constructed. If interest lies in understanding the total output of the health system, then a productivity measure based on gross output should be constructed (p.19).

Chapter 5 takeaways

- There are three types of inputs: labour, capital and consumables. Separating inputs into these categories is important when seeking to understand how efficiently a specific input is being used (eg, labour productivity) or what effect changes in an input have had.
- It is theoretically preferable to use volume measures of inputs rather than expenditure measures, but in practice it will be unlikely that the volume of all inputs will be observable. In many cases changes in expenditure will be a reasonable proxy for volume changes. Unless there are reasons for thinking that expenditure-based measures may be misleading, the simpler approach of measuring inputs based on expenditure is recommended.
- Include depreciation and interest or capital charges when estimating capital inputs (the consumption of capital services). When measuring productivity at a service level it is important to allocate capital inputs to particular services in proportion to the services' consumption of those inputs.
- For cases where there is a need for a direct volume of labour inputs, composition-adjusted hours of work is the preferred measure of labour. If composition-adjusted data are not available a simple measure of labour will often suffice (eg, the number of hours of paid work).
- Identify any relevant "missing inputs", such as the pre-existing attributes of consumers. It may be easier to account for such attributes through adjusting the quality of outputs (Chapter 6).
- When assessing the productivity of a service, include co-payments. However, if assessing the productivity of government funding only, you would exclude co-payments.

6 Cost weighting and price deflation

This chapter explains how to combine different outputs and inputs into single indexes. This is necessary when measures cover more than just single outputs or inputs. The chapter also outlines how to account for price changes.

6.1 Combining multiple outputs and inputs into single indexes

When measures cover multiple outputs or inputs they need to be combined into a single metric or index. This can be a complex exercise. A simple count of the total number of outputs produced is unlikely to give an accurate picture of how productive an entity is. Dunleavy (2016, pp.5-6) noted that for most private firms, the presence of sales volumes and prices makes the process of calculating a total output metric relatively straightforward.

> … suppose a firm has two products, the first X priced at $5 and selling 20,000 units and the other Y priced at $10 and selling 5,000 units. Its total output is thus: ($5 *20,000) + ($10 * 5,000) = $150,000. Price is important here in two ways. First, it allows us to easily price-weight across completely dissimilar products. Second, in competitive markets with consumer sovereignty, we can make welfare implications about the sales patterns observed – in this case that consumers would not freely pay $10 for product Y compared with $5 for product X unless they were getting commensurate benefits from it.

This approach is rarely feasible for the state sector because outputs are not priced, and many outputs must be consumed whether citizens or enterprises wish to do so or not (Dunleavy, 2016; Gemmell, Nolan & Scobie, 2017b).

Diewert (2017) suggests three methods for valuing state sector outputs, ranked in order of their desirability:

- first best: valuation at market prices or purchaser's valuations;
- second best: valuations at producer's unit costs of production; and
- third best: output price growth is set equal to an index of input price growth.

The third-best method (assuming that inputs equal outputs) is a convenient way to overcome measurement difficulties in the state sector. But, by definition, it will measure productivity growth as zero. So this method is of little value. The following sections examine the advantages and disadvantages of Diewert's first and second-best approaches.

Valuation at market prices or purchaser's valuations

One method for valuing outputs is to obtain price information from comparable services provided in the private sector. Atkinson (2005) gave two examples:

- In the case of road use, "we may attach value weights to passenger miles and to freight tonne miles, based on the alternative costs of using rail" (p.89).
- The provision of personal care by social services, where there is a parallel private market. The price that people are willing to pay for daily care in the private sector can be used for the marginal valuation.

Simpson (2009, p.255) also noted that comparable prices in the private sector can be used to value state sector services, but offered the following caveats:

> … private sector alternatives might differ in their scope and characteristics; private healthcare might offer reduced waiting times and higher quality accommodation. In addition the characteristics of individuals using private sector alternatives, for example their underlying health, may differ from those using public sector provision and may also affect the price. Hence in each case questions would remain about how reliably these methods would capture the relative valuations of different goods.

In addition, the sheer size of the state sector as a provider of certain services (eg, health care) can skew the price of parallel services provided in the private market. In other cases, (eg, police, fire service) there is no comparable private market (Parker, Waller & Xu, 2013).

Willingness-to-pay (WTP) methodologies can also be used to estimate the value consumers place on particular outputs. WTP approaches seek to establish in advance what somebody would be prepared to pay to receive goods or services, for example, a particular health intervention. There are two broad approaches for estimating WTP (Accent & RAND Europe, 2010):

- *Revealed preference methods* observe people's preferences indirectly; as revealed by actual market behaviour and other choices they make. Examples include the premium that individuals are willing to pay to live in the catchment area of particular schools, how long individuals are prepared to wait for a certain service, or how far they are willing to travel to access a certain hospital (Simpson, 2009).
- *Stated preference methods* ask people how much they would pay. In an environmental context this might involve asking how much an individual would agree to pay for avoiding a degradation of the environment or, alternatively, how much they would ask for as compensation for the degradation. Alternatively, people can be asked to make trade-offs among different alternatives, from which their willingness to pay can be estimated.

The New Zealand Initiative (sub. 8) supported the investigation of techniques for assessing the value of non-market outputs including revealed preference methods. In particular, it noted the "risk-premium that obtains for particular jobs, for example, can provide a reasonable benchmark for the value that workers place on avoiding relatively small risks" (p.3).

Other submitters were less optimistic about WTP methods. For example, New Zealand Council of Trade Unions (sub. 9) and the Public Service Association (sub. 14) argued that "public services are not market goods and there is no value in a subjective measure based on the assumption that they could be treated as such".

While there can be benefits from using WTP methods, designing and executing a reliable approach requires time and expertise. In many cases a weighting approach based on unit costs is likely to be sufficient.

Valuations at producer's unit costs of production

The per-unit production costs method applies weightings to different outputs based on the cost of providing that output. In doing so, these costs act as a proxy for the per-unit value to the service recipient. If a state sector entity has three core outputs – A, B and C – output would be calculated using:

> (units of A * unit costs for A) + (units of B * unit costs for B) + (units of C * unit costs for C)
> (Dunleavy, 2016)

The use of market prices or purchaser valuations attempts to attribute societal value to public services. By contrast, cost weights reflect willingness of governments to pay for public services. Box 6.1 and Box 6.2 provide examples of applying cost weightings in various measures of state sector productivity. Box 6.3 discusses the sensitivity of these measures to different approaches to cost weighting.

Box 6.1 **Examples of cost weightings in state sector productivity measures**

- In their study of the evolution of productivity in the UK customs service, Dunleavy and Carrera (2013) measured two outputs: the total numbers of import and export declarations processed per year. These volumes were weighted by the relative unit costs in each year to create a total outputs data series.
- The Office for National Statistics (2012) calculated output of the UK education sector using the number of students in nine different learning services, including schools, the higher education training of teachers and health professionals and further education. Student numbers were weighted by their share in aggregate education expenditure and converted into a single education output series.
- Administrative costs can be a useful proxy where reliable data on per-unit costs are not available. In their study of productivity in UK tax administration, Dunleavy and Carrera (2013) used the share of administration costs for different taxes collected to weight the different tax volumes. Weighted tax volumes were added together to create a total index of tax output.
- In an analysis of police productivity in England and Wales, Pritchard (2003) applied weightings to categories of crimes investigated based on the costs involved. Results showed that although the total number of recorded crimes reduced between 1995 and 2001, the weighted output of investigations actually increased. This was due to a sharp increase in violent crime (which is the costliest type of crime to investigate) and a reduction in several types of crime that are less expensive (such as thefts from vehicles and burglaries).

Box 6.2 **Combining police outputs related to mental health and attempted suicide incidents**

The Commission worked with the New Zealand Police to produce productivity metrics for police responses to mental health and attempted suicide incidents. Mental health-related calls received by police have grown rapidly, increasing nearly tenfold from 5 000 in 1996 to 47 000 in 2017. In addition to increasing in volume, the New Zealand Police has suggested that mental health incidents are becoming increasingly complex.

Potential difficulties in measuring mental health and attempted suicide incidents were overcome using case weights derived from administrative data. The police central dispatch system allocates tasks to police officers and records staff activity information. Case numbers were calculated for mental health and attempted suicide incidents. To account for differences in the complexity of incidence, cases were weighted using the average time a police officer spends responding to each incident class. More complex incidents require more police time.

The New Zealand Police is seeking to improve policing services for people with mental health conditions. The study showed police officers spent not only more time on mental health incidents, but more time on each incident over the seven years of the study.

The use of administrative data to derive weight and other information removes judgments and potential sources of human error in constructing productivity metrics. However, careful attention needs to be paid to ensuring the weights are sensible and are representative over time.

Source: Genet and Hayward, 2017.

Box 6.3 **Sensitivity of productivity estimates to cost weighting approaches**

Gemmell, Nolan and Scobie (2017a) examined university productivity separately for teaching and research. This required total staff FTEs and expenditures to be separately estimated for teaching and research.

They recognised that academic staff in universities typically split their time between teaching, research and administration, and so allocated non-academic (mainly academic support) staff FTEs to teaching and research on a pro-rata basis. This led to a staff FTE split between teaching and research that on average was around 40:60 in favour of research, over the period 2000 to 2015.

Similarly, they used income sources in universities' published financial accounts to estimate expenditure allocation between teaching and research, and allocated some government tuition and student fee income to research to capture the fraction of time academic staff, funded from this income, spend on research on average. This yielded a teaching/research expenditure allocation around 40:60 across all universities on average, similar to that of their first approach.

The authors also explored the impact of changing these assumptions on university productivity growth estimates. To examine sensitivity they adopted the extreme alternative that all academic staff FTEs were allocated to teaching, with research FTEs obtained from the "research staff FTE" category in Ministry of Education data. Similarly, they treated tuition/student fee income as teaching related for the purposes of expenditure allocation.

Overall, assuming a much more heavily weighted allocation of university resources towards teaching suggested that productivity growth was substantially lower than it would appear with a more research-weighted allocation. And, while quality-adjustment generally produced faster productivity growth than basic measures, both those measures were lower with greater input allocation to teaching.

Source: Gemmell, Nolan and Scobie, 2017a.

6.2 Accounting for price changes

Productivity is a volume measure. Sometimes it is not possible to measure the volume of inputs and outputs directly, and expenditure will need to serve as a proxy. Yet changes in expenditure can reflect changes in volume, changes in prices, or both. For instance, a change in expenditure on staff could reflect changes in the volume of labour (say the number of hours worked) and/or changes in salaries. As such, expenditure figures need to be "adjusted" to account for price movements. This allows changes in volume to be identified (Atkinson, 2005).

Consider a service where the direct volume of output cannot be measured and where input prices have fallen over time, so it is now cheaper to provide the service. In this case, expenditure on the service could remain the same while the volume of output increased. Failing to "deflate" input costs (ie, remove the effect of price changes) would overstate any productivity improvements.

Crucially, the approach used to deflate expenditure can have a material impact on productivity estimates. The following sections provide more detail on the selection and use of price deflators.

Characteristics of a good price deflator

Atkinson (2005) presents criteria for assessing the adequacy of price deflators (Table 6.1). The criteria cover:

- the quality of the deflator (eg, comprehensive, full coverage);
- the availability of data (eg, sustainability, timeliness, periodicity, availability of cost weights); and
- the capacity of the deflator to illustrate the questions under consideration (eg, relevance, homogeneity and quality change).

Table 6.1 Quality criteria for price deflators

Criterion	Description	Examples and explanation
Comprehensiveness	The set of deflators should cover all components of expenditure to be deflated	There should be full geographic and sector coverage of the expenditure being deflated (eg, health deflators should cover the whole of the health system not just hospitals)
Coverage	The individual deflator should relate to all expenditure on the item to be deflated	Deflators for labour expenditure should cover all aspects of employee compensation (eg, all direct taxes and social security contributions and pensions as well as earnings)
Relevance	The deflator should correspond to the expenditure item to be deflated	For example, expenditure on books should be deflated using an indicator of the price change in books
Sustainability	The deflator should be available for the foreseeable future, and for a reasonable number of periods in the past	Micro-studies of changes in price for only a single year have limited use: long time series are preferable
Homogeneity	Deflation should be carried out at a level of disaggregation that maximises homogeneity of items within a category	For example, significant difference in the movement of pay between staff grades would suggest that separate deflators are needed
Timeliness	The deflator should be available in good time after the end of the reference period	Estimation for missing periods may introduce bias
Periodicity	The deflator should be available on a quarterly basis	Annual figures may be satisfactory, but only where there is evidence of insignificant short-term change
Quality change	Where changes in characteristics of a good or service occur, price indexes should reflect pure price changes only	Improvements in composition and consequently effectiveness of a drug should be distinguished from pure price change
Availability of cost weights	Corresponding weights (of the same periodicity) for deflators should also be available	

Source: Atkinson, 2005.

Calculating deflators

In some cases, market price information (such as the Consumer Price Index) can be used to deflate values of non-market outputs (Schreyer, 2010). An alternative is to construct *direct volume indexe*s. Different indexes can be combined using fixed base or chain-weighted approaches.

Market price information

Where the data required to estimate direct volume indexes are not available, it may be possible to use publicly available Statistics New Zealand deflators. Important sources of data from Statistics New Zealand include the following.

- Consumer Price Index (CPI): The CPI measures the changing price of a fixed basket of goods and services. This basket is representative of the spending habits of New Zealand households and remains a fixed quantity so that changes in the CPI represent only price changes. As the quantity must remain fixed, Statistics New Zealand makes adjustments for any changes in the size, performance or functionality of products. Every three years Statistics New Zealand reviews the basket of goods to account for changes in household spending habits over time. The goods and services covered by the CPI are classified into nine groups, 21 subgroups and 73 sections.

- CPI subgroups: A number of the CPI groups and subgroups include data on public services (such as primary and secondary education). These subgroups reflect consumers' spending in these specific areas, while the CPI reflects price movements more generally.
- Purchasing Price Index (PPI): Another possible deflator is a subgroup of Statistics New Zealand's PPI. This index only covers the "productive sector" and measures changes in the prices of outputs that generate operating income and of inputs that incur operating expense. It does not include prices for items related to capitalised expenditure, non-operating income, financing costs or employee compensation. The subgroups are not published at a further disaggregated level (eg, split into primary and secondary schools).

When considering the use of market price information, it is necessary to check the data is suitable for deflating non-market production (Schreyer, 2010). In particular:

- the services supplied by market providers have to be sufficiently similar to those supplied by non-market providers – this has to be true for each type of service and for the mix between different services; and
- the deflator needs to reflect the full cost of production.

On the second point, some market information (such as the CPI) only reflects consumer's out-of-pocket expenditure. However, many public services are subsidised meaning the "out-of-pocket" price does not reflect the costs of delivering the service. For example, in the CPI the price for medical services only reflects patients' out-of-pocket expenditure, yet these services are heavily subsidised by the state. Using CPI data for medical services would therefore likely underestimate price changes.

For example, Gemmell, Nolan and Scobie (2017b) compared quality adjustments based on the full CPI with those based on the CPI level 2 subgroup for primary and secondary education (reflects consumers' spending on schooling) (see Box 8.3). They argued for using the full CPI to deflate teacher salaries and school revenue. The full CPI provides a "common numeraire" as the basis for all real comparisons, so it indicates a common average real basket of goods that the funds in question could alternatively buy.

Direct volume indexes

A *direct volume index* is the weighted average of the volume indexes of different types of activity, where the cost share of each type of activity constitutes the weight (Schreyer, 2010). There are several approaches to producing direct volume indexes such as the Paasche and Laspeyres indexes (see Box 6.4).

Box 6.4 **Three approaches to calculating direct volume indexes**

- The *Paasche index* calculates the expenditure needed to buy current year quantities. It is expressed as a percentage of what the expenditure would have been in the base period if the quantity consumed had been at current levels (Goodridge, 2007). It divides spending on a basket of goods and services in the current period (ie, the sum of price multiplied by quantity for each product) by how much the same basket would cost in a base period. More formally this can be expressed as:

$$(\Sigma(Pt_n)*(Qt_n))/(\Sigma(Pt_0)*(Qt_n))$$

  where Pt_n and Qt_n are prices and quantities at time n, and Pt_0 is the price in the base period.

- The main feature of the *Laspeyres index* is that the weights used are taken from the base period. This can be expressed formally as:

$$(\Sigma(Pt_n)*(Qt_0))/(\Sigma(Pt_0)*(Qt_0))$$

  where Pt_n is the price at time n, and Pt_0 and Qt_0 are the prices and quantities in the base period.

Source: Goodridge, 2007.

The choice between approaches largely depends on the availability of data and how volatile prices are likely to be. The Laspeyres index holds base prices constant and the Paasche index uses current prices. The Paasche index requires data that are more recent while the Laspeyres uses historic prices. As such, the Laspeyres index is likely to be most useful.

Fixed base versus chain weighting

When dealing with multiple inputs and outputs, it is necessary to have a method for combining indexes. Simply averaging the change in indexes could be misleading as the volumes of different goods are likely to vary.

For example, consider an entity with two outputs – A and B – where one unit of A has the same value as one unit of B. Assume that initial production is 1 000 units of A and 10 000 units of B, and over a year production of A increases by 5% and production of B increases by 1%. Averaging the two growth rates would give a result of 3% while the actual growth in output would only be 1.4% (from 11 000 to 11 150).

There are a number of ways to combine different indexes. One option is to use a *fixed-base approach*. This approach implicitly assumes that the value shares of different goods do not change over time. However, this assumption is flawed in cases where the relative importance of goods is prone to change. For this reason, weights are often adjusted regularly (annually or every five years).

Chain-linking is an approach where the weights are adjusted annually. This simply means that for each period, the base used is the weight from the previous period (Goodridge, 2007). Chain-linking has advantages over a fixed-base approach:

- new outputs can be added to the "basket" every year. If the index is non-chained, new items can only be added to the base year;
- because the comparison is with the previous year (rather than a base year), chain-linking makes it easier to identify annual changes (such as changes in price or the quantity of outputs produced); and
- chain-linking removes the substitution bias encountered when there are large shifts in both the weight and in the actual variable being indexed (Goodridge, 2007).

The ability to chain-link depends on the timeliness of the data used for the weights. Further, if the relative values of goods do not shift over time, then chain-linking is unlikely to provide additional useful information.

Notably, chain-linking affects Paasche and Laspeyres indexes differently. When applied to Paasche indexes, chain-linking has the effect of reducing the index because growth is not calculated as a percentage of expenditure in the base period but instead is backward-looking. This means substitution effects are less pronounced when the index is chained together. By contrast, a chain-linked Laspeyres index would rise by a greater amount than the standard Laspeyres.

Chapter 6 takeaways

- In many cases it will be necessary to combine multiple outputs (or inputs) into a single metric or index. For private sector outputs market prices can be used. Many state-sector outputs are unpriced or subsidised, so a different approach is usually required.
- The generally recommended approach is to use per-unit production cost as a way of weighting (combining) different outputs. These weights, however, reflect the value producers put on services rather than consumers' valuations.
- Another way to value outputs is to use willingness-to-pay (WTP) measures. While there can be benefits from using WTP methods, designing and executing a reliable approach requires time and expertise, and in many cases a weighting approach based on unit costs is likely to be sufficient.
- Changes in expenditure can reflect changes in volumes, changes in prices, or both. As such, expenditure figures need to be "adjusted" to account for price movements. The approach used to "deflate" this expenditure can have a material impact on productivity results. The use of publicly available deflators, particularly the full CPI, is generally recommended. The approach taken must be transparent as it can have a major impact on results.

7 Accounting for differences in operating environments and quality changes

A raw measure of productivity – the ratio of inputs to outputs – is not particularly useful by itself: it is only meaningful as part of a comparison (Statistics New Zealand, 2010). Comparisons can be made between:

- the productivity levels or growth rates of different entities; or
- the productivity growth rate of a particular entity over time.

In making comparisons it is important to account for differences in the operating environments of entities and for changes in operating environments over time. For example, differences in the performance of schools may reflect the socio-economic status of their students as well as the performance of their staff. Failing to account for these differences could mean measures overstate the performance of staff in schools that draw students from advantaged backgrounds.

The quality of services may also differ between organisations and over time. Productivity measures must account for these differences as well. For example, suppose a hospital increases the quality of its care and as a result readmissions fall. The fall in readmissions results in the number of patients treated increasing at a slower rate than the hospital's inputs. Without accounting for the change in the quality, productivity measures would tell a story of falling productivity and would miss the hospital's improved performance.

The following sections discuss approaches for accounting for these differences and for changes in quality.

7.1 Differences in operating environments

Differences that organisations face in their operating environments can be seen in the example of two hospitals that produce the same number of operations for the same quantity of inputs. These hospitals may appear to have equal productivity but if one is treating patients with more complex conditions then the value it is adding is higher. It is therefore important to account for differences in the complexity of activity in measuring the output of public services such as hospital care. Differences in operating environments that can be useful to account for include:

- the characteristics of the clients of the services (eg, age, socio-economic background, pre-existing status, support networks);
- the size and scope of the organisations (eg, whether hospitals have specialist units);
- market structure (eg, presence of other suppliers or competitors); and
- overall performance of the economy.

Approaches to accounting for these factors include:

- measuring the outputs related to different population subgroups separately (segmenting the population) and treating them as distinct outputs;
- limiting the range of providers studied to those from similar environments; and
- adjusting the volumes of outputs for differences in the operating environment (eg, severity of treatments).

Te Puni Kōkiri noted that in measuring state sector productivity the Commission should

> focus on population segmentation to help build a more constructive understanding of how the public sector engages with and delivers benefits to Māori, recognising that Māori needs are often complex and intergenerational (sub. DR27, p.1).

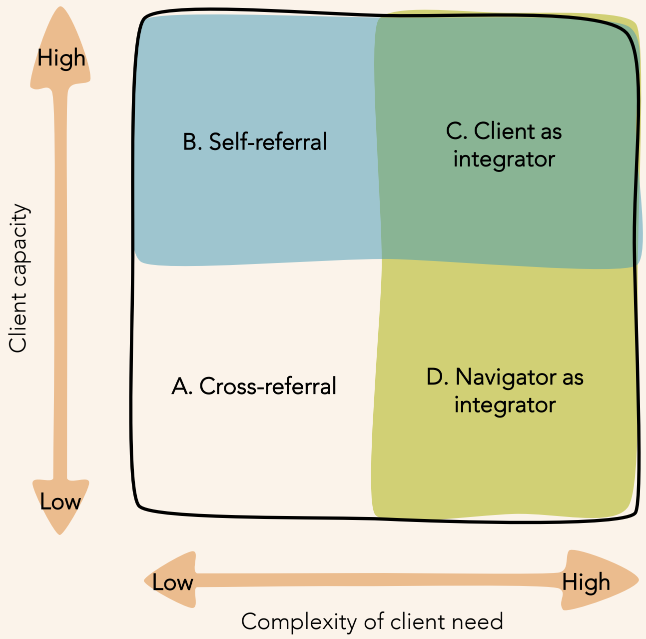
An example of segmenting a population is the Commission's approach in distinguishing users of social services depending on how they access the system and their reasons for doing so (see Box 7.1). Under this approach the productivity of the services received by clients in the four quadrants would each be measured separately. However, studying different population groups separately (or limiting the range of providers studied) can limit the scope of the analysis, unless cost weighting or other methods are used to combine the results for different quadrants. The segmentation of District Health Boards into peer groups (Box 7.2) illustrates another approach.

Box 7.1 **Segmenting a population: people interacting with the social services system**

In *More effective social services* (NZPC, 2015) the Commission highlighted how clients access the social services system in different ways and for different reasons. For some, their main interaction with the system is through their local school or childcare centre. On occasions, they may need to visit their local general practitioner or perhaps a hospital if the issue is more serious. For these people, coordinating services to meet their needs is relatively straightforward and, in many cases, they prefer to coordinate their own interactions with the social services system.

The Commission segmented service users according to the complexity of their needs and their capacity to extract the services they need from the system. The Commission found it useful to group clients under four headings:

- people with relatively straightforward needs who require assistance to access services (quadrant A);
- people with relatively straightforward needs who have the capacity to access services for themselves (quadrant B);
- people with complex needs who have the capacity to access services for themselves (quadrant C); and
- people with complex needs who require assistance to access services (quadrant D).



Box 7.2 **Grouping district health boards into "peer" groups**

The Hospital Quality and Productivity framework was established in 2009 and concluded in 2015. The framework established a series of performance indicators that allowed comparisons between DHBs. The ministerial review group that initiated the framework noted:

> There is much to be gained by reducing the substantial gap between the best and worst performers within and between hospitals. This requires an independent set of productivity measures at the appropriate level that are credible, useful and make sense to those hospital clinicians and managers who are best placed to make productivity improvements within the hospital. (p.5)

DHBs were clustered into peer groups to enable comparison of performance. DHBs were grouped based the New Zealand Role Delineation Model (NZRDM) which differentiated the degree of complexity between services provided across District Health Boards.

Source: District Health Boards New Zealand (2010).

An example of adjusting the volumes of outputs for differences in the operating environment is casemix adjustment in the health sector (Box 7.3). This approach accounts for the characteristics of patients and is used to allow for comparisons across settings or time. Volumes can be adjusted for case severity, typically using cost weights (Rouse & Swales, 2006). These weights group together treatments that are clinically similar, consume similar quantities of resources and are likely to be similar in cost. Casemix adjustment can be applied to productivity measures for other public services. See Appendix C for an example.

Box 7.3 **The casemix system used in the health sector**

Health sector analyses use the casemix system to account for differences in patients' pre-existing conditions.

The casemix system is the basis for 28–29% of District Health Board funding in New Zealand. The system has two parts: a clinical coding classification used to group events; and a cost weighting system applied to these groupings.

The first step is to turn patients' clinical records into clinical codes. The clinical coding classification contains almost 2000 codes and can indicate:

- major diagnosis category;
- medical, surgical, or other procedures; and
- level(s) of complication(s).

Given the number of clinical codes, similar events with comparable resource use are assigned to Diagnostic Related Groups (DRGs). They enable hospital production to be measured by linking the characteristics of patients treated (hospital activity) and the resources used in treating their patients (input costs).

Cost weights – termed Weighted Inlier Equivalent Separations (WIES) – are then assigned to events based on the DRG group, with adjustments for length of stay. Different cost weights exist for inlier events, low and high outliers, and same day and one day events.

WIES is the system developed by the State of Victoria for casemix funding public hospitals. A version of WIES has been adapted for New Zealand use (WIESNZ) and is updated annually.

Source: Casemix Project Group, 2015.

Box 7.4 **Implicit adjustments for differences in operating environments**

Moore and Hayward (2017) used the Ministry of Social Development's (MSD) individual Cost Allocation Model to develop productivity measures of benefit-related transactional services. The study implicitly adjusted for the impact of the operating environment by selecting "applications" as the output metric. While demographic and socio-economic factors can have a significant impact on the quantity of benefit applications, selecting applications as an output metric implicitly incorporated such factors.

Adjustments for the operating environment are only relevant if external factors are not sufficiently accounted for within any output metrics. Common adjustments include demographic and socio-economic characteristics, regional differences and the economic cycle.

If the benefit-applications study selected the overall serviced population (or region) as an output metric, then it would have been important to adjust for the operating environment. Such adjustments could have included the demographic characteristics and socio-economic status of the population, which may be reflected in variations in dependence on welfare services.

Adjustments for the operating environment are common in other sectors that consider impacts at a population level, such as the health sector's use of a population-based funding formula for the allocation of resources. In such cases, it can be appropriate to incorporate the impact of the wider operating environment through such adjustments or models.

Source: Moore and Hayward, 2017.

7.2 Quality adjustment

Quality can have many dimensions, as consumers may value a wide range of characteristics when consuming public services. Schreyer (2010) outlines three general approaches to adjusting for changes in the quality of the output of public services.

- *Implicit quality adjustment (stratification):* This approach groups outputs so that only products and services of the same specification are compared (Schreyer, 2012).
- *Explicit adjustments:* Explicit approaches to quality adjustment are based on measures that adjust outputs for changes in outcomes. There are two broad approaches to explicit quality adjustment.
  - *Explicit adjustment (proximate outcomes):* The first approach is based on a resulting change in status directly attributable to the services received (Schreyer, 2012). In this case, quality adjustments could be based on factors like examination scores or attainment levels for education outputs (O'Mahony & Stevens, 2009) or the change in health status associated with an intervention (Schreyer, 2012).
  - *Explicit adjustment (ultimate outcomes):* A second approach is based on a broader definition of outcomes as "a state that consumers value, for example the health status without necessarily relating the change in this state to the medical intervention" (Schreyer, 2012, p.259). In this case, quality indicators could include the population's education level, life expectancy or level of crime. Proxies for these indicators have included future earnings as a measure of the underlying population's education level or prices of houses as a measure of school quality (Black, 1998; Cannon, Danielsen & Harrison, 2015; Gibson & Boe-Gibson, 2014).

Further, as Gemmell, Nolan and Scobie (2017a; 2017b) illustrated, it is also possible to use similar techniques to quality adjust the inputs (eg, staffing) into state sector production. Different approaches are illustrated below with examples from the education and health sectors.

Examples of possible quality adjustments in education

In education, quality adjustments can relate to inputs (eg, teacher quality or pupil to staff ratios), proximate outcomes (eg, performance in school inspections or student attainment) or final outcomes (eg, impact on human capital or on house prices due to school zoning). Table 7.1 lists some approaches to quality adjusting school data. For examples related to tertiary education see Gemmell, Nolan and Scobie (2017a).

A further issue in quality adjusting data for state sector productivity is the proportionality problem. This arises when comparing indexes of quality with indexes of inputs and outputs. It is necessary to establish a "factor of proportionality" between the change in quality scores and the change in output (Schreyer, 2010). Quality-adjusted outputs will not necessarily reveal how much extra quality is valued by the service users. Should, for example, a 5% increase in student test scores mean the value of school output should be 5% higher? This consideration is especially important when comparing productivity outcomes across industries, for example, whether a 10% increase in the quality of education is equivalent to a 10% increase in quality of health care.

Table 7.1 Approaches to quality adjusting school data

Concept	Variables	Measures	Challenges
Labour inputs (resources used in production)	Labour	Labour force (employment count, FTEs, hours paid, actual hours worked, quality adjusted hours)	Combining non-commensurate inputs into an index Informal inputs (such as student attributes)
Total inputs (resources used in production)	Labour, capital, consumables (eg, teaching aids, electricity usage and building maintenance)	Total real operating allowances	Implicitly assumes expenditure weights are appropriate
Proximate outcomes	Acquisition of skills and qualifications Transfer or increase in knowledge	Pupil based: pupil numbers (hours vs. EFTS), educational attainment (milestones, credits, degrees) Teaching based: number of lessons, class size, school inspections	Combining non-commensurate outputs into an index Attribution (eg, informal inputs) Accounting for teacher quality Grade inflation Teaching to the test
Final outcomes (direct)	Human capital	Additional lifetime earnings	Lags and attribution to expected earnings
Final outcomes (indirect)	Social network	Housing value approach	Accounting for more general neighbourhood effects

Source: Howell, 2016; cited in Gemmell, Nolan and Scobie, 2017b.

Examples of quality adjustments in health

Approaches to quality adjustment can also be illustrated with the case of health care. There is a sizeable literature on applying quality improvement approaches to health care and researchers such as Professor Martin Connor of the Centre for Health Innovation, Griffith University, have illustrated the potential of hospital performance data.

Marshall (2009) noted that statistical approaches first developed in the manufacturing sector could support quality and reliability in health care. When it comes to defining quality, as with education, it is possible to think about inputs (eg, wage rates; the qualifications of clinicians), proximate outcomes (eg, variations in care; quality and safety markers) and final outcomes (eg, patient experience data; measures of whether people are being treated in the right setting). Table 7.2 summarises some approaches.

Table 7.2 Approaches to adjusting health sector data

Concept	Variables	Measures	Challenges
Labour inputs (resources used in production)	Labour	Labour force (employment count, FTEs, hours paid, actual hours worked, quality adjusted hours (eg, based on wage rates or qualifications))	Combining non-commensurate inputs into an index Informal inputs (such as patient characteristics)
Total inputs (resources used in production)	Labour, capital, consumables (eg, electricity usage and building maintenance)	Total real operating allowances	Implicitly assumes expenditure weights are appropriate
Proximate outcomes	Avoidance of direct harm Avoidance of excessive variation	Quality and safety markers Atlas of Healthcare Variation	Whether markers based on priority areas reflect system performance more generally How to define appropriate variation
Final outcomes	Direct	Patient experience data	Currently limited to adult inpatients, but being extended to primary health care
Final outcomes	Indirect	Changing population shares in levels of chronic care	Sampling bias and attribution issues

Other examples of quality adjustments

Atkinson (2005) noted that the output of prison services is often measured by numbers of nights spent in prison by prisoners on remand, prisoners under sentence, non-criminal prisoners and prisoners in police cells. But this failed to quality adjust for overcrowding, reoffending and achievements during incarceration such as educational attainment or drug rehabilitation. It also failed to weight according to cost, for example, high risk vs. low risk prisoners. Atkinson (2005) argued that overcrowded cells could be given a lower weight in output, although developing a precise weight requires robust evidence of the extent of overcrowding or the threshold at which it becomes a problem. Atkinson (2005) also noted similar concerns about the standard approaches to measuring outputs in benefit administration (see Table 7.3).

Table 7.3 Approaches to adjusting data in other sectors

Sector	Unadjusted output	Limitations	Possible quality adjustments
Prisons	Number of nights	Fails to reflect overcrowding, reoffending, rehabilitation and prior risk	Proportion of overcrowded cells
Benefit administration	Raw activity numbers	Fails to reflect whether recipients receive a high-quality service	Measures of timeliness and accuracy of payments

Source: Productivity Commission.

Pros and cons of different approaches to quality adjustment

The choice of how to account for quality changes can have a significant impact on estimates of productivity growth. Work in New Zealand and Australia has shown how sensitive estimates of productivity can be to the approach taken to control for the quality of inputs and outputs.

- Gemmell, Nolan and Scobie (2017b) tested a range of quality adjustments to productivity estimates for New Zealand schools based on sector level data. They found that although most adjustments provided a broadly (though not completely) consistent picture of flat or declining productivity, in one case the change of method led to the measured productivity trend reversing.

- The Australian Productivity Commission (Lovell & Baker, 2005) developed experimental productivity estimates for 10 government services drawing on data contained in the *Report on Government Services*. They found that the estimates of productivity were sensitive to the approach taken to control for the quality of inputs and of outputs.

In the UK, the Office for National Statistics (ONS) takes a case-by-case approach to quality adjustment. It uses stratification of services (implicit adjustment) and explicit adjustments (based on the attributable contribution of the activity to outcomes). The ONS found that the greater degree of subjectivity involved in quality adjustment compared to volume measures, means a higher standard is needed for judging their use.

Gemmell, Nolan and Scobie (2017b) tested approaches to quality adjusting productivity estimates. They advise caution in making quality adjustments to labour inputs given important caveats on the use of salaries as a proxy for quality of inputs. This reflects the nature of state sector labour markets (eg, whether a change in total salaries reflects quality or compositional changes). They also highlighted the importance of missing inputs such as the previous performance of students (needed for measures of value added).

Likewise, they argued that approaches based on final outcomes (such as the impact of the education system on earnings) raised attribution issues. They showed how the decline in measures based on ultimate outcomes was likely to reflect changes, at least partly, in unemployment and real wage growth following the Global Financial Crisis. Changes in these measures reflect differences in the economic context facing different cohorts of school leavers, not just the performance of schools.

Gemmell, Nolan and Scobie (2017b) argued that explicit adjustments should be based on the attributable contribution of the activity to intermediate outcomes (such as student performance in tests). This was similar to the conclusion reached by the ONS. However, even in this case there can be scope for ambiguity. For example, student performance can be measured against performance in domestic or international tests and, in recent years, the performance of New Zealand students in domestic tests has contrasted markedly with their performance in international ones.

While Gemmell, Nolan and Scobie (2017b) pointed to challenges in quality adjusting state sector productivity measures, they did not support relying only on unadjusted measures. Instead they noted that quality adjusted measures should be treated as one (albeit essential) element of a broader framework for the assessment of performance. Measurement approaches should be reviewed and may change as data availability and analytical techniques improve.

Chapter 7 takeaways

- Productivity measures are only useful as part of a comparison. Typically, comparisons are made between the productive level (or growth rates) of different organisations, or between the productivity of a specific organisation at different times.
- When making comparisons, it is important to account for differences in the operating environments of organisations and for changes in operating environments over time. Differences to look for include differences in client characteristics, the size and scope of organisations, and the structure of the market the organisations operate in.
- Segmenting organisations or clients into comparable groups is one way to deal with differences in the operating environment. Population segmentation can help build understanding of how agencies engage with and deliver services to important population groups, such as Māori and Pacific peoples.
- Adjusting outputs, say through a casemix approach, is another way to deal with differences in the operating environment. It may also be possible to limit the comparison to organisations with similar environments.
- Comparisons also need to account for differences in the output quality – either between organisations or over time. Three approaches are used to adjust for quality.
  - Implicit quality adjustment or stratification. This approach groups outputs so that only products and services of the same specification are compared.
  - Explicit adjustments based on proximate outcomes. This approach adjusts outputs based on an observable change that is directly attributable to the services. For instance, the output of a school could be adjusted based on the examination scores of its students.
  - Explicit adjustments based on ultimate outcomes. This approach adjusts outputs based on a change that consumers value, but which is not necessarily attributable to the services. For instance, the output of a hospital could be adjusted using national life expectancy data.
- Productivity measures can be sensitive to the approach used to adjust for quality. No approach to quality adjustment is flawless, all have pros and cons. However, it is possible to develop reasonable proxies for quality that can enhance unadjusted measures.

8 Measuring and checking

This chapter pulls the guide together by discussing frequently used productivity measures. It also discusses the value in triangulating (sense testing) results with the findings of other studies.

8.1 Recap: productivity measures

Multi-factor productivity

Productivity is a measure of the effectiveness of an entity at converting inputs into outputs. As an illustrative example, assume a one output and one input. The entity's productivity can be measured as Q/I, where Q is the total volume of output and I is the total volume of input. As there is a single input, this is a multi-factor (or total) productivity measure.

Partial productivity

Partial productivity measures are where only one production factor (labour, capital or consumables) is used as the input measure. The most commonly used partial productivity measure is labour productivity, which is the ratio of total output to the total labour input. By contrast, when all the factors of production (inputs) are included in the calculation, multi-factor productivity measures are produced.

A partial productivity measure like labour productivity has some advantages. It can show the impact of changes in one specific factor on overall productivity. They can also be easier to undertake, as the data requirements are lower. And for services that are labour intensive, labour productivity may offer a reasonable indication of overall productivity performance.

However, partial productivity measures also have some drawbacks. Substitution between different inputs (eg, greater use of technology in the treatment of health conditions) can lead to productivity changes. This substitution between factors is unlikely to be captured in a partial productivity measure (Box 1.1). Using a partial measure for performance evaluation may encourage gaming or goal displacement.

Comparison across time

Both partial and multi-factor productivity ratios are most useful when tracked over time or compared across entities. Tracking a measure over time can show increases and decreases in the productivity of an entity. There are several ways of conceptualising productivity growth: growth in a productivity index, in outputs compared with inputs, and in real revenues with real costs. For example, with an index approach productivity growth between periods 1 (t1) and 2 (t2) equals $(Q^{t2}/I^{t2})/(Q^{t1}/I^{t1})$, where Q^{t1} and Q^{t2} are the quantities at periods 1 and 2 and I^{t1} and I^{t2} are the inputs in these periods.

Adjusting inputs and outputs

The next step is to account for the fact that there are likely to be multiple inputs and outputs. As discussed in Chapter 6, one approach is to use cost weights, so labour productivity can be written as Q/wL and multi-factor productivity as Q/(wL+rK+mM), where:

- w is the cost of labour and L the volume of labour input, and together they make up expenditure on labour;
- r is the user cost of capital and K the capital input, and together they make up the flow of capital services, which can be proxied by depreciation and capital charges (see Box 5.1); and
- m the unit price of consumables and M volume of consumables and together they make up expenditure on consumables.

Likewise, where there are two outputs (a and b), Q is equal to $c_aQ_a + c_bQ_b$, where c_a, p_b, Q_a, and Q_b are the costs and quantities of a and b. You should consider whether the weights should be fixed over time (using constant or current prices) and, if fixed, for how long or over what periods (eg, completed business cycles)?

8.2 Benchmarking

Benchmarking refers to a performance comparison across different entities to find the best performers and provide information to assist poor performers.

Benchmarking can be point in time or over a period.

Point in time benchmarking

In making comparisons across entities it is important to be careful when comparing productivity levels. Given the difficulty in accurately establishing productivity levels, these comparisons should generally emphasise variations in growth rates. This, however, requires time-series data.

Benchmarking across time

Comparisons in the productivity measures of different entities over time can show how relative performance is changing.

Benchmarking techniques

Benchmarking techniques are based on the principle of measuring the performance of one organisation (or part of organisation) against a standard. This can either be an absolute standard or relative to other organisations. It can be used to:

- assess performance;
- identify where improvement may be needed;
- identify other organisations with processes that result in superior performance (encouraging the diffusion of these processes); and
- illustrate whether improvement programmes have been successful.

There are three main approaches to benchmarking:

- *benchmarking standards*: setting a standard of performance that an effective organisation could be expected to achieve;
- *benchmarking results*: comparing the performance of a number of entities that provide a similar service. This can illustrate whether an entity is making effective use of its resources compared to other entities; and
- *benchmarking processes*: examining the processes that produce a particular output, with a view to understanding reasons for variations in performance.

Frontier analysis

A relatively technical form of benchmarking is frontier analysis. This approach can explain whether relatively poor performance of a sector is due to a lack of productivity growth among the best performing organisations (the frontier), or best practices failing to diffuse throughout a sector (eg, from the best performers to the worst). Yet frontier approaches can be relatively data and resource intensive. Gemmell, Nolan and Scobie (2017b) identified the following general stages in a frontier analysis.

- *Define the entities* – entities (sometimes referred to as "decision-making units" in this literature) are the units of frontier analysis. An entity could be an individual, firm, state-sector agency (eg, a school or hospital), region or country.
- *Calculate the efficiency frontier* – the efficiency frontier (sometimes called the reference set) is made up of entities whose input levels are the lowest for any given level of output; this becomes the set against which the efficiency of all entities can be assessed. There are two broad approaches to estimating frontiers: non-parametric and parametric (see Box 8.1).

- *Estimate the distance of entities to the efficiency frontier* – each entity receives an efficiency score that is determined by their performance relative to that of the best performers.

Further detail about frontier approaches can be found in Gemmell, Nolan and Scobie (2017b), SCRCSSP (1997) and Gabbitas and Jeffs (2008).

Box 8.1 **When to use non-parametric and parametric frontiers**

There are two broad approaches to estimating frontiers: non-parametric and parametric.

Non-parametric approaches make no allowance for "random noise" such as measurement errors or other random shocks. As a result, any observation falling within the frontier is treated as technically inefficient. The most widely used non-parametric approach is data envelopment analysis (DEA).

Parametric approaches, on the other hand, do not attribute all of the observed differences between entities to differences in technical efficiency, as they allow for measurement error and other random noise. As a result, no entities necessarily need to lie on the efficiency frontier (Gabbitas & Jeffs, 2008). A widely used parametric approach is stochastic frontier analysis (SFA).

Considerations that influence the choice of technique include the following.

- Cases with less heterogeneous samples are more suited to DEA. SFA is better suited to more heterogeneous samples. DEA is more sensitive to heterogeneity in the sample (influenced by outliers) and will tend to give lower average efficiency scores although not consistently. The regression approach of SFA gives less weight to outliers.
- Cases where output supplied is subject to variable or unpredictable client demand are less suited to DEA. Unpredictability of client demand can introduce a source of variance in outputs and weaken the relationship between inputs and outputs. SFA is better suited to coping with unpredictable demand.
- Both methods can deal with cases where exogenous variables influence operating environments. Where these variables could be an important consideration, a DEA approach to restrict the comparison set (to entities with similar or less favourable operating environments) is likely to be less suitable. Other DEA approaches or an SFA approach based on regression analysis would be better.
- SFA requires the parameters of the production function and the random error term to be estimated. DEA is more suitable for cases where these parameters cannot be feasibly estimated, such as where there are a limited number of observations available for robust regression analysis.

Gemmell, Nolan & Scobie (2017b) provides further detail about DEA and SFA. SCRCSSP (1997) and Gabbitas and Jeffs (2008) provide practical guidance on DEA and SFA respectively.

Source: Gemmell, Nolan and Scobie, 2017b.

8.3 Bringing it all together

Table 8.1 is a useful summary of productivity questions that an entity may have and how these might be answered with different measurement techniques.

Table 8.1 Productivity questions and measurement techniques

Productivity question	Measurement technique	Data requirements	Suggested interpretation
Has the entity's productivity changed over a given period?	MFP analysis over the target period	The flow of total outputs produced by the entity over the target period Proxies for any changes in output quality during the target period The flow of total (aggregate) inputs used over the target period Price deflator	Changes in MFP (ratio of outputs to inputs) through time reflect changes in the productivity of the entity
Over a given period, has the entity's productivity in using a specific input changed?	Partial productivity analysis over the target period (Common measures are labour productivity and capital productivity)	The flow of the input used over the target period Proxies for any change in the quality of the input during the target period The flow of total outputs produced by the entity over the target period Proxys for any change in output quality during the target period Price deflator	Partial productivity measures show the impact of changes in a specific input on overall productivity. For instance, capital productivity shows the amount of output generated per unit of capital input over the target period
Are some entities more productive than others? What should an entity do to improve its performance?	Benchmarking, comparing entities at one point in time	If the aim is to understand why some entities are more productive than others, input data should be disaggregated into specific input categories (labour, capital etc). Quality adjusted inputs and outputs for all target entities is required. As required to calculate MFP levels for each entity at each time	Dispersion of MFP shows how much room to improve there is for those short of the frontier
	Benchmarking, comparing entities over a time period	As required to calculate MFP and partial productivity for each entity at each time	Partial productivity measures, and changes over time, provide information about the drivers of better and worse performance

Source: Productivity Commission.

8.4 Sense testing results

For any study it is important to sense test the results. Box 8.2 contains useful questions that can be asked of any productivity study. Box 8.3 discusses the approach taken to sense testing a study that quality adjusted data on school productivity.

Box 8.2 **Useful questions to ask of any productivity study**

These questions can be used as a checklist for your analyses, or in understanding the work of others.

- Outputs: How comprehensive were the range of outputs? If a subset of outputs was used, are the most important or representative outputs included? How were changes in quality and/or collective services accounted for?
- Inputs: Did the study measure partial or multi-factor productivity measure? Was it sensitive to changes in input mix? If so, does this impact on the usefulness of the productivity measure?
- Labour inputs: How were labour inputs measured (expenditure or volume approaches)? What is the likely impact of this? Were outsourced or contracted labour inputs included in the productivity measure?
- Capital inputs: Did the study employ both depreciation and a capital charge? If the study considers a specific service line, how was capital apportioned to particular outputs?
- Missing inputs: Did the study account for the pre-existing attributes of clients, or any co-payments?
- Cost weighting: How did the study weight (value) different inputs and outputs? If market prices were used, does the study explore the similarities or differences between state sector services and private sector services?
- Price changes: Has the study accounted for price changes over time? Does the deflator used display the characteristics of a good price deflator?

Productivity measures are just one dimension of the performance of the state sector. When drawing conclusions, you should consider what is driving observed changes in productivity and, if necessary, how these results compare with other sources of evidence. Atkinson (2005) emphasised the need to supplement productivity measures with independent evidence, what he called a process of “triangulation”. It can also be useful to consider the following questions.

- What impact did the chosen approach and methodology have on the results? For example, as Gemmell, Nolan and Scobie (2017a) highlighted, measures of tertiary sector productivity are highly sensitive to approaches for cost weighting teaching and research activities and deflating outputs for price
- How might changes in data collections and funding arrangements affect the results? For example, if revenue from non-government sources is not included in the measure of inputs then changes in these revenue sources can impact on the results

Box 8.3 **Sense testing results for quality-adjusted school productivity**

The following example of quality-adjusting school productivity illustrates the importance of sense testing results. It also shows that international comparisons can be a useful source of supporting evidence.

Gemmell, Nolan and Scobie (2017b) estimated a range of quality adjusted productivity measures for New Zealand schools and discussed the benefits and risks of different approaches (eg, regarding teacher salaries, students' performance in tests, or impact on earnings).

Adjusting these data for quality changes was complex in practice. As an example, the Office for National Statistics (ONS) in the United Kingdom had to revise its approach to quality adjusting education quantity when practices regarding students sitting exams changed. This is significant as any quality adjustment can make a substantial difference to measured productivity.

One issue in the New Zealand study was the choice of deflator for school revenue data and the salary data to account for the effect of price changes. The choice of deflator has a material impact on results. The authors thus tested a range of deflators, including the education and training subgroup of the CPI rather than the full CPI. However, using the subgroup meant that salary-based measures would grow faster than unadjusted productivity measures, even though the growth in total salaries (4.4% nominal, or 2.1% real when deflated by the full CPI) had been much faster than the growth in teacher FTEs (1.2%) or price growth more generally (the CPI at 2.2%). This deflator failed a sense test.

One series of results for schools in this work was benchmarked against a series produced by the ONS. It is important to recognise that given differences in public policies, policy contexts and data availability it is appropriate for there to be some small methodological differences in the approaches and findings for the two countries. Yet similarities in the general magnitude and direction of effect from making broadly similar quality adjustment (based on performance in domestic assessments) can be expected.

In both countries the unadjusted series show similar trends. They both show a downward shift over time reflecting policy choices regarding smaller class sizes. Making a quality adjustment based on pupil attainment leads to average labour productivity growth around zero in both countries between 1997 and 2014, although in New Zealand a higher proportion of students achieving NCEA level 2 or above is reflected in stronger multi-factor productivity growth since 2005.

Source: Gemmell, Nolan and Scobie, 2017b; Office of National Statistics, 2012.

As well as the quantitative techniques emphasised in this guide, qualitative techniques can be valuable for the purposes of triangulating (or sense testing) the results. For example, comparative satisfaction surveys can indicate the value that users attribute to public services in different jurisdictions. However, Bouckaert and van de Walle (2003) argued that criteria such as "trust" and "more satisfaction" do not necessarily imply better quality. Indeed, Boyle (2006) showed that for 15 European countries there was only, for example, a moderate association between expenditure per capita on public services and satisfaction with public administration. Making country comparisons can be difficult given changes in relative prices in countries (measured in purchasing power parities) and the composition of international datasets (eg, with lower-income countries joining the OECD).

Chapter 8 takeaways

- There are two types of productivity measures. Partial productivity is the ratio of total output to a specific input (ie, labour, capital or consumables). Multi-factor (or total factor) productivity is the ratio of total output to all inputs.
- Both partial and multi-factor productivity ratios are most useful when tracked over time or compared across entities. Tracking a measure over time can show increases and decreases in the productivity of an organisation or part of an organisation.
- Benchmarking techniques information on how well an entity is performing relative to the best performers in the sector.
- Comparing productivity measures of different organisations can show how relative performance is changing. Yet, comparisons of the absolute level of productivity must be done with care. It is preferable to compare productivity growth rates rather than the absolute level of productivity.
- For any study it is important to sense test the results. When drawing conclusions you should consider what is driving observed changes in productivity and, if necessary, how these results compare with other sources of evidence.

Appendix A Worked example: case study on early childhood education

Green (2017) estimated the productivity of the early childhood education (ECE) sector in New Zealand using publicly-available data. This appendix summarises features of the study to illustrate the steps involved in defining and producing a productivity measure.

Establish the business case

The Productivity Commission wanted to illustrate concepts for its state sector productivity inquiry with case studies. It identified early childhood education (ECE) as a possible topic. Previously the Commission had looked at parts of the education industry (school and tertiary education) but not the ECE sector. The Commission wanted a case study that drew only on publicly available data to illustrate how far these data could be taken, and the pros and cons of different measurement approaches. The Commission did not intend for this to be an ongoing exercise.

Develop a clear research question

The research questions developed were:

- using publicly-available information, estimate the labour and multifactor productivity of the ECE sector; and
- discuss options for quality-adjusting ECE outputs.

The availability of data constrained the time period for the analysis. Green decided that the productivity measures produced would be gross, so no allowance was needed for consumables or intermediate inputs. As the research questions relate to the whole sector, Green did not need data disaggregated by provider.

Establish what data you need

The statistics page of the Ministry of Education's Education Counts website provided most of the necessary data. The data were divided into outputs (participation rates and hours), inputs (labour and financial inputs, serving as a proxy for total inputs), and proxies for changes in quality of inputs (staff qualification levels and pay rates).

The website included annual ECE census report, along with statistics on ECE participation, services, teaching staff, finances and language use. These included:

- Participation data: statistics on children's participation in ECE including tables on prior participation rates of children starting school, enrolments and average hours spent in ECE. The relevant worksheets were: "Time Series Data: Enrolments in ECE (2000-2017)" and "Time Series Data: Hours of Participation in ECE (2000-2017)".
- Teaching staff data: the numbers and characteristics of ECE teachers. These came from the "Time Series Data: Number of teaching staff by full-time/part time status (2011-2017)" worksheet. The methodology for collecting these data changed in 2014 (with a change to the treatment of relievers and temporary staff) and so the years prior to this were not strictly comparable with later years.
- Financing data: statistics on expenditure on ECE, including tables on government expenditure on ECE, and tables on the Consumers Price Index for the fees charged by ECE services. Two worksheets were identified as having useful information: "ECE Expenditure" (which provided annual data for 2001/02 to 2014/15) and "ECE Fees" (which provided quarterly data from March 2005 to March 2015).

Green noted that additional data would be required to undertake quality adjustment. He used data on teacher registration status (from Education Counts), short-term ECE teaching reliever wage rates (from NZEI), and mean and median salaries in the preschool education sector (from the LEED dataset on Statistics New Zealand's infoshare website).

Green collated these pieces of data into a single Excel workbook, with labelled tabs and data sources (including internet addresses where available) and date of collation noted in each worksheet. This approach is helpful as readers and reviewers are easily able to check original sources. It also makes it easier for researchers to update calculations in future years or when new data is available.

Define and measure outputs

Outputs were defined as funded child hours by service type ("Child Hours"). These data were available for 2001/02 to 2014/15. Te kōhanga reo funded child hours were excluded from the analysis (as there were no staff input numbers).

Define and measure inputs

Labour inputs were defined as weighted staff numbers ("Staff Numbers"). These data were available for full-time and part-time teachers and for 2002 to 2015. Staff numbers were based on:

- Part time staff numbers for home-based and teacher-led services multiplied by 0.5 to construct a weighted teacher numbers index. Other weights (0.25 and 0.75) were tried to test the sensitivity of these results to this assumption.
- Playcentre adults numbers multiplied by their average weekly hours of duty, divided by 35 (to provide a weekly fraction) and then added to the weighted teacher numbers figure.

The 2004/05 year was used as the starting point for the analysis of overall labour productivity, as this was the first year for which there were staff data for the home-based sector.

Total government expenditure on ECE ("Govt Expenditure") was used as a proxy for total inputs.

Convert diverse outputs and inputs into a consistent format

Neither Child Hours nor Staff Numbers needed to be adjusted to account for changes in price levels. The effect of changes in price levels on Govt Expenditure, however, did need to be taken into account. Expenditure was deflated by the full CPI to give a series of real Govt Expenditure. The formula for this was

$$(\text{Govt Expenditure}_n/\text{CPI}_n) * \text{CPI}_b$$

where Govt Expenditure_n was government expenditure in year n, CPI_n was the CPI level in the year n and CPI_b was the CPI in the base (starting) year.

Standardise inputs and outputs

Changes in the composition of the teaching workforce (such as the proportion of teachers who are qualified or registered) were treated as changes in the quality of inputs. To address this Staff Numbers was adjusted by the share of teaching staff who were "qualified" versus "not qualified" (based on Education Counts data) and the wage premium for qualified teachers (based on NZEI data).

This wage premium varied among qualification levels. A teacher with a Diploma of Teaching had a premium of 3% over an unqualified teacher, while a teacher with a 3-year degree or higher had a 23% premium. As the qualification levels of teachers was not known, Green modelled two different scenarios. One where all qualified staff received the lowest premia and one where they received the highest. These two scenarios provided a range for the effect these premia may have.

The formula for adjusting Staff Numbers was:

$$\text{Adjusted Staff Numbers} = ((\text{Staff Numbers} * \%\ \text{Staff Qualified}) * (1 + \text{Wage Premia})) + (\text{Staff Numbers} * (1 - \%\ \text{Staff Qualified}))$$

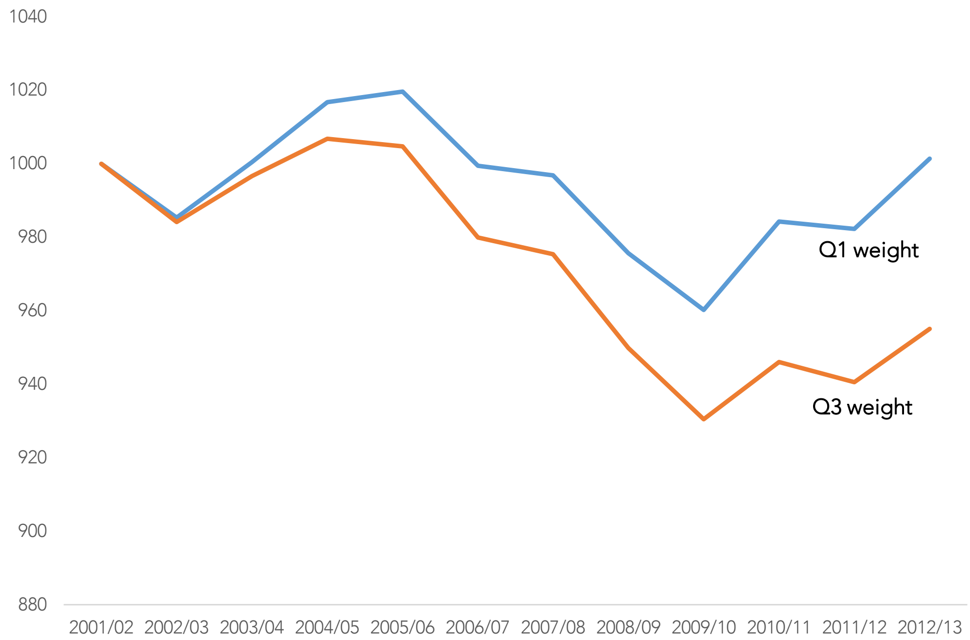
Measure

Based on the steps above, the measures developed were:

- Unadjusted labour productivity: Child Hours/Staff Numbers. This grew by an annual average of 0.4% between 2004/05 and 2012/13.

- Unadjusted multifactor productivity: Child Hours/Real Govt Expenditure. This declined by an average of 3.4% from 2001/02 to 2014/15.
- Adjusted labour productivity: Child Hours/Adjusted Staff Numbers. Between 2000/01 and 2012/13 this measure was, on average, either flat or fell by an average of 2.8% per annum. These results for adjusted labour productivity are shown in Figure A.1.

Figure A.1 Labour productivity in the teacher-led ECE sectors, adjusted for wage premia for qualifications, 2001/02 – 2012/13



Source: Green, 2017.

Notes:

1. The weights make different assumptions about the characteristics of "qualified" teachers. "Q1" weight assumes entry level qualification and little-to-no teaching experience. "Q3 weight" assumes an advanced qualification. Labour productivity should fall within these two bounds.

Check

Green presented preliminary results to an internal workshop at the Commission, and then discussed them with stakeholders, including the Ministry of Education. Care was taken when writing up the findings given the potential for misunderstanding. The paper was upfront about the fact that the ability to assess productivity change in early childhood education (ECE) was limited by incomplete or inconsistent data. This could be improved with:

- teaching staff data on a full-time equivalent or actual hours-worked basis, rather than simple headcounts; and
- data, in monetary terms, on average hourly parental financial contributions (to match the data available average hourly government subsidy rates).

Finally, Green discussed the broader setting for the use of any measures and noted that "measures used for quality adjustment should have a close causal and empirically-demonstrated link to early childhood activities, be relevant to the entire sector, and avoid overlaps with other parts of the education system."

Appendix B Worked example: case study on New Zealand Police

Genet and Hayward (2017) estimated the productivity of police responses to mental health incidents in New Zealand. The steps undertaken in this study are summarised below as an illustration of the process of defining and producing a productivity measure.

Establish the business case

The Productivity Commission wanted to illustrate concepts for its state sector productivity inquiry with case studies. The Commission engaged with the New Zealand Police who wanted to improve their understanding of responses to mental health incidents. The number of calls for police assistance has been growing rapidly, and the New Zealand Police wanted to improve policing services for people with mental health conditions.

The Commission was keen to publish a case study that used administrative data from within an organisation to construct productivity measures.

Develop a clear research question

The research questions developed were:

- how has the labour productivity of police responses to mental health and attempted suicide incidents changed over time; and
- are there regional differences in labour productivity in these responses?

Establish what data you need

Police collect a significant amount of data about the volume of different outputs and their corresponding labour inputs. Staff hour information is derived from the Police central dispatch system, which allocates tasks to police officers. This system records, with a relatively high level of accuracy, the time a police officer takes in responding to a certain incident, and the time taken before the incident is "closed". Where dispatch information is not available, estimates of staff time are used for cost allocation.

Define and measure outputs

This case study focused on *initial scene attendance* relating to mental health and threatened or attempted suicide incidents.[5] Incidents are coded when a call is placed with Police dispatch and coded again at the closure of the initial scene attendance. A mental health incident is coded as "1M" and a threatened or attempted suicide is coded as "1X". Incidents initially coded as 1M or 1X but closed under another coding are classified as "Other" for the purposes of this case study.

Incident classification may change during scene attendance. Changes include:

- Incidents that start as mental health (1M) or threatened or attempted suicide (1X) that are then closed as "Other". For example, an incident may be classified as a mental health incident by dispatch but could be reclassified due to other circumstances (such as a crime that results in an arrest). This occurs for approximately 15% of mental health and threatened or attempted suicide incidents.
- Mental health incidents that are closed as threatened or attempted suicide or threatened or attempted suicide incidents that are closed as mental health incidents (ie, they change classification between the two). This occurs for less than five percent of mental health or threatened or attempted suicide incidents.
- Incidents that were first classified into another category ("Other") but end as a mental health or threatened or attempted suicide incident. This occurs in 35 to 40% of all incidents that end as mental health or threatened or attempted suicide.

[5] Attempted suicide incidents where there is a fatality are coded separately in the police dispatch system. They are not included in this analysis.

Table B.1 shows trends in mental health and threatened or attempted suicide by Police District – the raw volume output measure for this study. Incidents are opened or closed as mental health or threatened or attempted suicide increased by 79% over the period 2010/11 to 2016/17. Much of this increase is due to a doubling of threatened or attempted suicide incidents responded to by Police.

Table B.1 Total outputs (responses to mental health incidents), 2010/11–2016/17

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	% change
Auckland City	1 316	1 262	1 709	1 750	1 677	1 829	2 205	68%
Bay of Plenty	1 251	1 371	1 644	1 985	2 063	2 108	2 383	90%
Canterbury	1 910	1 931	2 384	2 796	2 811	3 094	3 471	82%
Central	1 621	1 683	2 256	2 447	2 644	2 782	3 116	92%
Counties/Manukau	1 392	1 571	2 072	2 188	2 244	2 339	2 435	75%
Eastern	825	885	1 151	1 299	1 250	1 419	1 507	83%
Northland	566	541	697	726	822	946	970	71%
Southern	1 073	1 028	1 309	1 461	1 604	1 747	1 914	78%
Tasman	532	603	797	866	887	1 081	1 259	137%
Waikato	1 404	1 377	1 753	1 994	2 043	2 069	2 346	67%
Waitemata	1 465	1 576	1 964	2 223	2 203	2 472	2 777	90%
Wellington	2 034	2 181	2 606	3 039	2 918	3 233	3 240	59%
Total	**15 389**	**16 009**	**20 342**	**22 774**	**23 166**	**25 119**	**27 623**	**79%**

Source: Data supplied by the New Zealand Police.

Notes:

1. This dataset is a subset of the New Zealand Police's total mental health demand and response.

Define and measure inputs

This study uses the number of Police hours responding to mental health and threatened and attempted suicide incidents as an estimate of inputs. As capital and intermediate inputs are not captured, it is not a complete reflection of inputs. However, labour hours provide a reasonable estimate for inputs because policing is labour intensive, and most overheads are allocated proportionately to staff time.

Convert diverse inputs into a consistent format

The total hours include both dispatch time and frontline police time. Dispatch staff members are paid a comparable amount to frontline staff members and hence no weighting has been applied to these hours. An extension to this study could involve weighting hours by individual staff members' salary, or by groups of staff members, to better reflect the staff input costs incurred by the New Zealand Police.

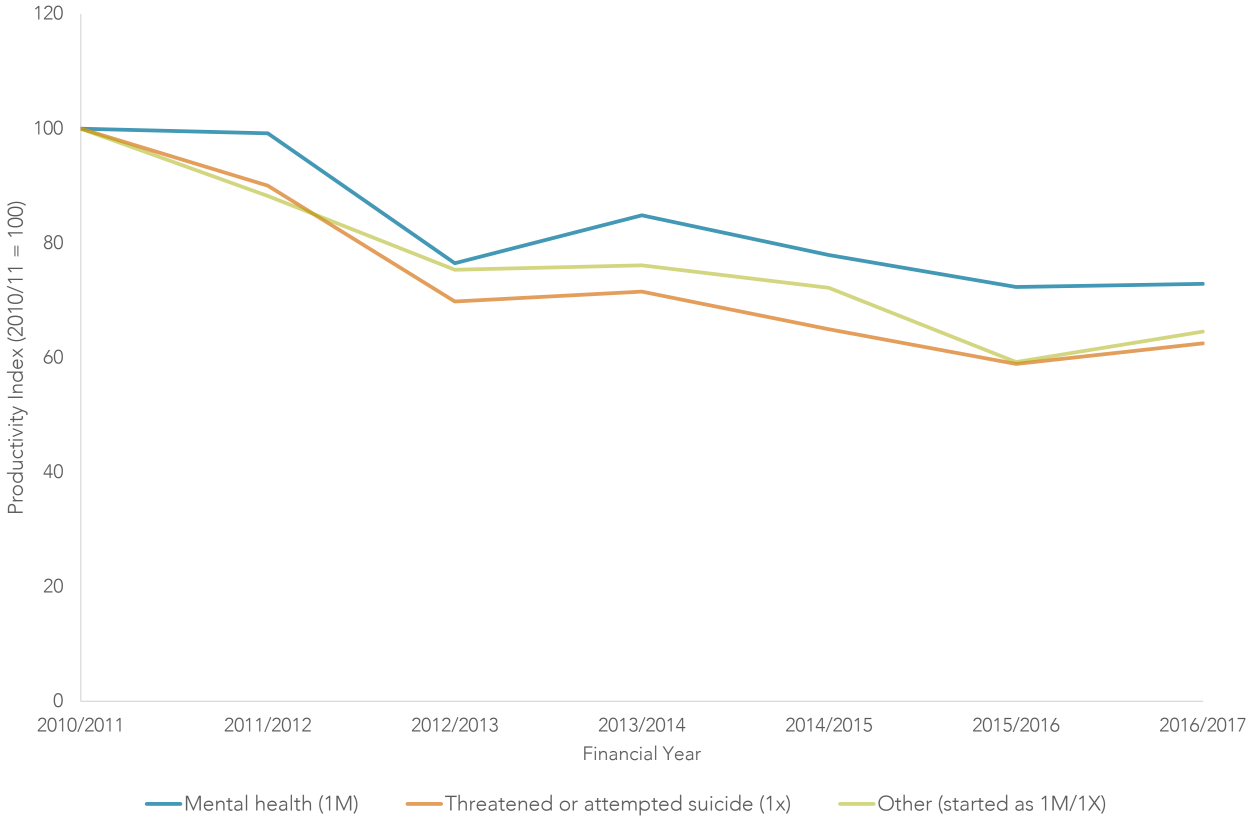
Standardise outputs

The total number of incidents are weighted for the purposes of this study. This is because mental health and threatened or attempted suicide incidents are not necessarily comparable and are increasing at different rates. The weights are derived using the average number of hours spent on mental health and threatened or attempted suicide incidents in the 2010/11 year. Weights are calculated for each combination of start and end codes for incidents. The total output metric is derived by multiplying the total outputs for each category by these weights.

Measure

Figure B.1 shows the productivity index for police responses to mental health and threatened or attempted suicide incidents over time. The results show a sharp increase in the amount of officer time required to respond to mental health incidents between 2011/12 and 2012/13, after which the trend remained relatively flat. For threatened or attempted suicide and other incidents, the results show a significant increase in the amount of officer time required to respond to events over the first two years of the series, followed by more gradual increases for most of the remaining years in the series.

Figure B.1 Productivity of responses to mental health and threatened or attempted suicide incidents, 2010/11–2016/17



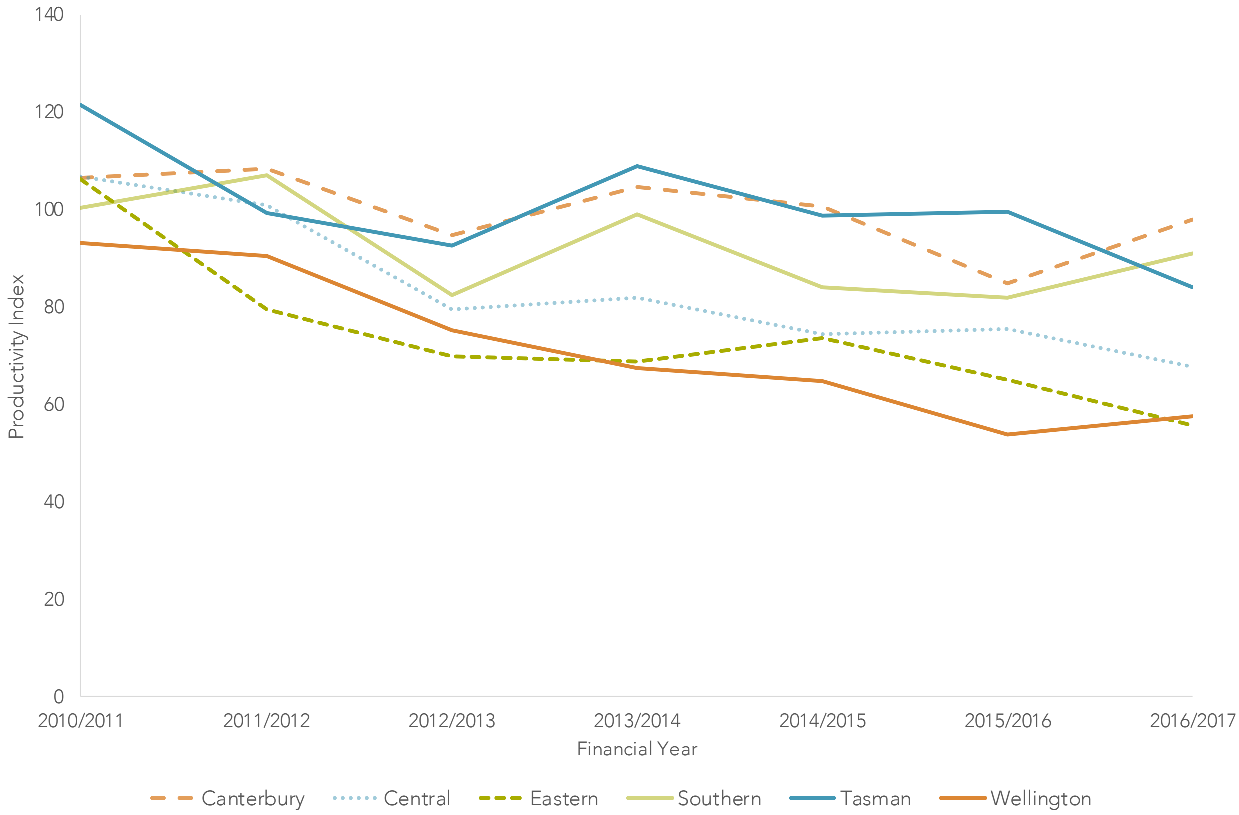
Source: Genet and Hayward, 2017.

Figures B.2 and B.3 show police productivity in responding to mental health incidents, disaggregated for each police district. The amount of officer time required to respond to mental health incidents in some districts has remained relatively constant (eg, Canterbury and Southern). However, for most districts, the trend mirrors the overall results shown in Figure B.1 of a rapid increase in the duration of responses in the first two years of the series, followed by a stabilisation or more gradual increase.

These results are "raw" and do not account for changes in quality or casemix. In addition, the comparisons between different police districts do not account for any differences in operating environment that might affect the duration of responses. For example, response times in some districts might be longer if the population is more dispersed leading to longer travel times to attend incidents.

Figure B.2 Police productivity, upper North Island districts, 2010/11–2016/17

Figure B.3 Police productivity, South Island and lower North Island districts, 2010/11–2016/17



Check

The case study was undertaken with the New Zealand Police, and staff members from the Police were involved throughout the study. Results of the study were discussed with relevant stakeholders in the New Zealand Police and in internal meetings at the Commission. Considerable care was taken in writing up the results due to the potential of any productivity measures concerning mental health or attempted suicide to be misunderstood or misused.

The paper noted that the measures were "raw results", and there are a number of factors that could impact productivity performance that are not captured in the measure. Genet and Hayward (2017) noted the analysis could be improved with adjustments for:

- *Quality* – taking account of any changes in the quality of responses to mental health incidents. For example, the amount of time police officers might be spending discussing the incident with the family of the person suffering from mental health problems.
- *Case complexity* – mental health incidents becoming increasingly complex and more challenging to respond to, affecting the duration of responses.
- *Differences between districts in access to support services* – no account is taken of the availability or ease of access to District Health Board mental health services and how this may have changed over time. This may affect how quickly Police are able to resolve an incident by transferring care to an appropriate mental health service.

Appendix C Worked example: case study on universities

This guide is written from the perspective of an organisation that seeks to improve its own performance through better understanding of its own productivity. However, the performance of public sector organisations is of broader interest. Some public-sector entities have wide responsibilities to monitor various aspects of the performance of other public entities. Examples include the Controller and Auditor-General, the New Zealand Treasury and the State Services Commission. Others have narrower responsibilities, including, for example, the Education Review Office (schools), the Ministry of Health (District Health Boards) and the Productivity Commission (on inquiry topics as specified by Ministers). And public-sector entity performance is, or should be, of concern to those who use and fund the services supplied.

The Controller and Auditor-General (2017) and NZPC (2017) inspired this example. Both studies sought to understand how efficiently tertiary education institutions were using their physical assets. They relied on data collected and published by the Tertiary Education Commission (TEC).

Establish the business case

Any visitor to a university is usually stuck by impressive buildings and the land they occupy. But are these assets necessary for teaching? Or do they serve other purposes? Looking at a group of universities might answer this question. The productivity measure of interest is the volume of teaching per unit of physical capital. Should universities' scores be closely bunched, then it is likely that they are efficient on this measure. By contrast, significant dispersion might indicate the poor performers have significant room to improve.

For a single university, the business case lies in understanding its own performance relative to comparable institutions, and the reasons why that may be the case. To the extent the underlying factors are under their control, such understanding offers an opportunity to improve its performance.

For monitoring agencies, the business case revolves around understanding the wider application of public resources. Information about productivity dispersion may inspire a change to policy, closer monitoring or redirected funding that leads to better societal outcomes.

Develop a clear research question

The underlying question in both Controller and Auditor-General (2017) and NZPC (2017) is:

> How does teaching capital productivity vary across New Zealand universities?

This case study demonstrates an iterative approach to answering this research question.

Establish what data you need

Answering this requires measurement of the capital productivity levels of each university on a consistent basis, and then looking at the dispersion of those levels.

This example is intended to be illustrative rather than definitive. It is limited to publicly accessible data. Conveniently, the TEC collates the annual audited data on the financial performance of all public tertiary education institutions for comparative purposes. For simplicity of exposition, this example is limited to the eight universities.

Define and measure outputs

The TEC dataset contains a teaching output measure – equivalent full-time students (EFTS). This measure adjusts for part-time and part-year students. EFTS has known limitations as an output measure. However, it (or its equivalent) is widely used for this purpose in New Zealand and internationally.

Define and measure inputs

The TEC dataset also holds a convenient measure of physical capital stocks – property, plant and equipment (PPE). Table C.1 reproduces the EFTS (output) and PPE (input) data.

Table C.1 Source data, EFTS and PPE for New Zealand universities, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Total EFTS	199 16	30 97	189 44	31 867	12 398	18 547	9 806	17 390
Property, plant & equipment ($000)	773 626	186 183	1 048 451	2 432 637	1 046 794	1 539 646	409 107	794 828

Source: Spreadsheet published at http://www.tec.govt.nz/funding/funding-and-performance/performance/financial/. Accessed 19 July 2018.

Notes:

1. Property, plant & equipment is the average of the stocks at the end of 2015 and 2016. Other data is for the 2016 calendar year.

Convert diverse outputs and inputs into a consistent format

No conversion is required, since:

- EFTS are a standardised measure, reflecting both teaching and student time; and
- PPE values are measured in dollars.

No deflators were required, because this was a point-in-time comparison.

Measure

This example is iterative, and four productivity analyses are undertaken:

- P1: unadjusted capital productivity: EFTS/PPE.
- P2: research-adjusted capital stock productivity: EFTS/teaching capital.
- P3: research-adjusted capital flow productivity: EFTS/teaching capital flows.
- P4: casemix- and research-adjusted capital flow productivity: casemix-adjusted EFTS/teaching capital flows.

Each step brings in any extra data it requires. All data comes from the same source. The first and second cuts show the steps towards the analysis presented in NZPC (2017). Subsequent steps use the techniques outlined in this guide to further refine the measure.

First cut: unadjusted capital productivity

Output: equivalent full-time students (EFTS)

Input: physical capital stock, as measured by PPE

Productivity measure 1 (P1): EFTS per thousand dollars of PPE.

Calculation: P1 = EFTS / PPE

For AUT: P1 = 19916 / 773626 = 0.026

This appendix shows the calculation steps for AUT only. Other ways of expressing this result include:

- AUT requires one million dollars of physical capital to educate 26 full-time students; or
- for each full-time student, AUT needs $38,500 of physical capital.

Table C.2 shows significant dispersion on the P1 measure. AUT is more than twice as productive as Canterbury and Otago.

Table C.2 First cut: capital stock productivity, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
EFTS per $000 PPE	0.026	0.017	0.018	0.013	0.012	0.012	0.024	0.022

A limitation

Universities produce more than just teaching. They devote much of their resources to research outputs. The proportion of research to teaching varies across universities, so raw capital productivity may present research-intensive universities unfairly.

Second cut: adjusting inputs to account for a second output

The TEC data do not include an output variable for research. However, the data does split university income into teaching and research sources. The ratio of teaching income to the total of teaching and research income is a weight that can be used as a proxy for the teaching intensity of the university. Table C.3 shows the income data used to calculate this weight. 'Teaching capital' can be calculated using this teaching weight to scale PPE.

Table C.3 University income data, 2016

($000)	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Government tuition funding	146 937	28 462	153 067	329 375	125 478	230 530	72 645	137 762
Student fees & charges	168 174	23 873	169 570	286 356	101 603	164 504	81 862	134 950
Research income	27 804	41 706	103 347	332 567	59 775	171 347	50 424	79 438

There are some implicit assumptions in using current income data to scale a capital stock. One is that research and teaching have a similar level of capital intensity. Another is that current income split has not changed too much over time, as the capital stock reflects past decisions. Further research could test these assumptions. This example assumes that these assumptions are reasonable.

Output: equivalent full-time students (EFTS)

Input: teaching capital (as calculated below)

Productivity measure 2 (P2): EFTS per thousand dollars of teaching capital

Calculation:

teaching weight = (Government tuition funding + Student fees & charges) /
(Government tuition funding + Student fees & charges + Research income)

teaching capital = PPE * teaching cost weight

P2 = EFTS / teaching capital

For AUT:

teaching weight = (146937+ 168174) / (146937+ 168174+ 27804) = 0.919

teaching capital = 773626 * 0.919 = 710899

P2 = 19916 / 710899 = 0.028

Table C.4 shows P2 for the universities. The adjustment makes a significant difference for the research-intensive universities, especially Lincoln and Auckland. P2 also has significant dispersion, with Waikato more than twice as productive as Canterbury.

Table C.4 Second cut: research-adjusted capital stock productivity, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Teaching weight (%)	91.9%	55.7%	75.7%	64.9%	79.2%	69.7%	75.4%	77.4%
Teaching capital ($000)	710 899	103 613	794 089	1 579 514	828 663	1 073 858	308 445	615 531
EFTS per $000 teaching capital	0.028	0.030	0.024	0.020	0.015	0.017	0.032	0.028

A further limitation

Not all property, plant and equipment is equal. In particular, it gets depleted at different rates over time. Accountants call this depletion as 'depreciation' and use different rates of depreciation for different classes of assets. Should the makeup of PPE vary significantly between universities then a failure to include depreciation could make universities whose assets are depreciating more quickly than those of their peers appear more productive.

Third cut: using capital flows rather than stocks

Chapter 5 explains that you should use flows for capital inputs. One way to calculate capital flows is to add depreciation and a capital charge. Depreciation is already in the financial dataset (Table C.5).

Table C.5 University depreciation, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Depreciation ($000)	38 931	7 721	49 560	115 141	44 588	57 883	21 512	41 384

For historical and political reasons, the government does not impose a capital charge on universities. The rate that applied to other state sector entities in 2016 was 7%. This rate is a reasonable choice for this analysis.

You should use the same capital charge rate for every entity in a cross-entity comparison, otherwise the differences in rate could cause differences in measured productivity.

Output: equivalent full-time students (EFTS)

Input: teaching capital flow (as calculated below)

Productivity measure 3 (P3): EFTS per $000 of teaching capital flow

Calculation:

teaching capital flow = teaching capital * capital charge rate + depreciation

P3 = EFTS / teaching capital flow

For AUT:

teaching capital flow = 710899 * 0.07 + 38931 = 88694

P3 = 19916 / 88694 = 0.22

Table C.6 shows P3 for the universities. This adjustment made little difference to the relative rankings of the universities.

Table C.6 Third cut: research-adjusted capital flow productivity, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Teaching capital flow ($000)	88 694	14 974	105 146	225 707	102 594	133 053	43 103	84 471
EFTS per $000 of teaching capital flow	0.22	0.21	0.18	0.14	0.12	0.14	0.23	0.21

Yet another limitation

EFTS are a convenient unit that adjust for part-time and part-year students. However, some courses – and therefore EFTS – cost more to deliver than others. For example, the volume of PPE required to deliver an engineering, medicine or music EFTS is likely to be higher than that for a commerce or literature ETFS. A university that specialised in capital-intensive courses would appear less productive (at least by measures P1, P2 and P3) than its peers.

Fourth cut: a casemix approach to differentiated teaching outputs

The second and third cuts (P2 and P3) involved adjustments to inputs. This cut demonstrates an adjustment to outputs.

Casemix is a technique to quality adjust outputs based on the quality of the input (for co-produced services) and/or the nature of the service performed. Ideally, this example would make both types of adjustments. However, the TEC dataset does not contain on input quality information.[6] It does contain data that should be correlated with teaching costs, and this can be used as a proxy for course complexity.

The per-EFTS subsidy paid by government to universities for domestic students is partly based on an estimated cost of teaching the course to which it applies. Domestic student fees are regulated by government but vary at least in part on expected teaching cost. International student fees are market prices and so can be expected to reflect teaching costs.

This example uses government subsidies for teaching, and domestic and international student fees, as proxies for the complexity of courses taught by a university. These proxies are converted to casemix weights. Using these as part of a capital productivity measure makes some implicit assumptions, including that a more (or less) complex course, measured this way, needs more (or less) of both capital and labour.

The calculation of casemix weights requires additional data from the TEC dataset; specifically, domestic student EFTS as a proportion of total EFTS, the average fee and subsidy for a domestic EFTS, and the average fee for an international EFTS. Table C.7 includes these data. The calculation steps also use the average domestic EFTS fee & subsidy across all universities ($16,024) and the average international EFTS fee across all universities ($23,851).

Output: casemix-adjusted EFTS

Input: teaching capital flow

Productivity measure 4 (P4): casemix-adjusted EFTS per $000 of teaching capital flow

Calculation:

domestic price weight = (single-university average domestic EFTS fee & subsidy / all-university average)

international price weight = (single-university average international EFTS fee / all-university average)

casemix weight = (domestic EFTS * domestic price weight) +
(1 – domestic EFTS) * international price weight

[6] Some countries (eg, Australia) have a standardized entrance examination for university. The scores of students admitted could be used as a direct measure of input quality. Alternatively, the cutoff score applied might make a reasonable proxy.

casemix-adjusted EFTS = EFTS * casemix weight

P4 = casemix-adjusted EFTS / teaching capital flow

For AUT:

domestic price weight = (13753 / 16024) = 0.86

international price weight = (23632 / 23851) = 0.99

casemix weight = (0.845 * 0.86) + (1 – 0.845) * 0.99 = 0.88

casemix-adjusted EFTS = 19916 * 0.88 = 17526

P4 = 17526 / 88694 = 0.20

Table C.7 shows the P4 calculations.

Table C.7 Fourth cut: casemix- and research-adjusted capital flow productivity, 2016

	AUT	Lincoln	Massey	Auckland	Canterbury	Otago	Waikato	VUW
Domestic EFTS (%)	84.5%	80.1%	85.0%	87.6%	91.1%	91.7%	84.6%	90.3%
Av. domestic student fee & subsidy ($)	13 753	15 301	15 539	18 046	16 835	19 962	14 408	14 349
Domestic price weight	0.86	0.95	0.97	1.13	1.05	1.25	0.90	0.90
Av. international student fee ($)	23 632	21 397	22 575	28 369	25 078	28 591	20 585	20 583
International price weight	0.99	0.90	0.95	1.19	1.05	1.20	0.86	0.86
Casemix weight	0.88	0.94	0.97	1.13	1.05	1.24	0.89	0.89
Casemix-adjusted EFTS per $000 of teaching capital flow	0.20	0.20	0.17	0.16	0.13	0.17	0.20	0.18

Auckland (with a medical school) and Otago (with medical and dentistry schools) get the highest casemix weight. Canterbury (with engineering) comes next. Casemix weighting narrows, but does not eliminate, the capital productivity dispersion. Canterbury remains the poorest performer. AUT, Lincoln and Waikato remain the highest performers.

Check

There are many ways to further refine and improve this analysis, including the following:

- Universities may lease physical assets for teaching purposes, in addition to the assets they own. The capital input measure should ideally treat leased assets on an equivalent basis to owned assets. You should add rents and leases paid to capital flows. For consistency, you should also add rates and other costs of owning assets to capital flows.[7]
- Apparently poor performance in capital productivity may reflect different ratios of capital to other inputs (labour and/or consumables), rather than poor overall performance. A problem identified through study of a partial measure should spur deeper and wider investigation.
- The TEC dataset includes labour, measured in full-time equivalents, split into teaching and research inputs. You could calculate a labour productivity measure using this data.

Interested readers should consult Gemmell, Nolan and Scobie (2017). It provides an extensive analysis of quality adjusted productivity of New Zealand tertiary education providers.

[7] Should a university lease out assets it owns, then rent and lease income should be subtracted from capital flows. Rates etc. for these assets should be excluded from capital flows.

References

Accent & RAND Europe. (2010). *Review of Stated Preference and Willingness to Pay Methods.* Retrieved 13 September 2017 from http://webarchive.nationalarchives.gov.uk/+/http:/www.competition-commission.org.uk/our_role/analysis/summary_and_report_combined.pdf

Atkinson, T. (2005). *Atkinson review: final report. Measurement of government output and productivity for the national accounts.* Retrieved 7 July 2017 from www.ons.gov.uk/ons/guide-method/method-quality/specific/public-sector-methodology/articles/atkinson-review-final-report.pdf

Baumol, W. B., & Bowen, W. G. (1966). *Performing Arts, the Economic Dilemma: A Study of Problems Common to Theatre, Opera, Music and Dance*. The University of Michigan. MIT Press.

Black, S. (1998). Measuring the value of better schools. Federal Reserve Bank of New York. *Economic Policy Review*. *4*(1), 87–94.

Bouckaert, G. & Van de Walle, S. (2003). Quality of Public Service Delivery and Trust in Government. In: *Governing Networks*: EGPA Yearbook, Ed. Ari Salminen. Amsterdam: IOS Press.

Boyle, R. (2006). *Measuring public sector productivity: Lessons from international experience.* CPMR Discussion Paper, no. 35. Retrieved 14 September 2017 from www.ipa.ie/_fileUpload/Documents/CPMR_DP_35_Measuring_Public_Sector_Productivity_Lessons_from_International_Experience.pdf

Coglianese, C. (2012). Measuring Regulatory Performance: evaluating the impact of regulation and regulatory policy, expert paper 1, Paris: OECD. Retrieved 26 July 2018 from www.oecd.org/gov/regulatory-policy/1_coglianese%20web.pdf

Cannon, S., Danielsen, B., & Harrison, D. (2015). School vouchers and home prices: Premiums in school districts lacking public schools. Journal of Housing Research, *24*(1):1-20.

Cooley, W.W. (1983). Improving the performance of an educational system. *Educational Researcher*, *12*(6), 4-12.

Controller and Auditor-General. (2017). *Investing in tertiary education assets*. Retrieved 24 July 2018 from www.oag.govt.nz/2017/tei-assets

Conway, P. (2016). *Achieving New Zealand's productivity potential*. New Zealand Productivity Commission Research Paper 2016/1, Wellington: NZPC.

Data Futures Partnership. (2017). *A path to social licence: Guidelines for trusted data use.* Wellington: Data Futures Partnership. Retrieved 6 September 2017 from https://trusteddata.co.nz/wp-content/uploads/2017/08/Summary-Guidelines.pdf

District Health Boards New Zealand (2010). Hospital Quality and Productivity Interim Report: June 2009 to July 2010. Retrieved 27 July 2018 from www.parliament.nz/resource/0000160165

District Health Boards (2015). *Hospital Quality and Productivity: Report to December 2015*. Wellington: Technical Advisory Services Limited.

Diewert, W. (2017). *Productivity measurement in the public sector: theory and practice.* Discussion paper 17-01. Vancouver, Canada: University of British Columbia. Retrieved 7 September 2017 from http://econ.sites.olt.ubc.ca/files/2017/02/pdf_paper_erwin-diewert-17-01-TheoryandPractice.pdf

Djellal, F., & Gallouj, F. (2008). *Measuring and improving productivity in services: issues, strategies and challenges.* Cheltenham, United Kingdom: Edward Elgar.

Downs, A. (2017). *From theory to practice: The promise of primary care in New Zealand*. Retrieved 20 November 2017 from www.fulbright.org.nz/wp-content/uploads/2017/09/DOWNS-From-Theory-to-Practice-The-Promise-of-Primary-Care-in-New-Zealand-.pdf

Dunleavy, P. (2015). Public sector productivity: puzzles, conundrums, dilemmas and their solutions. In J. Wanna, H-A Lee, & S. Yates (Eds.) *Managing under austerity, delivering under pressure* (pp. 25–42). Canberra, Australia: ANU Press.

Dunleavy, P. (2016). *Public sector productivity – Measurement challenges, performance information and prospects for improvement.* Paper to the Annual Meeting of the OECD Senior Budget Officers' Network. Paris, France: OECD.

Dunleavy, P., & Carrera, P. (2013). *Growing the productivity of government services.* Cheltenham, United Kingdom: Edward Elgar.

Gabbitas, O., & Jeffs, C. (2008). *Assessing productivity in the delivery of public hospital services in Australia: Some experimental estimates.* Paper presented at the 30th Australian Health Economics Conference. Adelaide, Australia.

Gemmell, N., Nolan, P., & Scobie, G. (2017a). *Estimating quality-adjusted productivity in tertiary education: Methods and evidence for New Zealand*. Wellington: Victoria University of Wellington Chair in Public Finance and New Zealand Productivity Commission.

Gemmell, N., Nolan, P., & Scobie, G. (2017b). *Public sector productivity: Quality adjusting sector-level data on New Zealand schools*. Wellington: New Zealand Productivity Commission.

Genet, T., & Hayward, M. (2017). *Productivity measurement case study: Police.* New Zealand Productivity Commission Research Note 2017/09. Wellington: New Zealand Productivity Commission.

Gibson, J., & Boe-Gibson, G. (2014). *Capitalizing performance of 'free' schools and the difficulty of reforming school attendance boundaries*. Working Paper 8/14, Department of Economics, University of Waikato. Hamilton: University of Waikato.

Gill, D., Kengema, L., & Laking, R. (2011). Information that managers use: results from the managing for organisational performance survey. In Gill, D. (Ed.), *The iron cage recreated: the performance management of state organisations in New Zealand* (pp. 375–402). Wellington: Institute of Policy Studies.

Gill, D., & Schmidt, T. (2011). Organisational performance management: Concepts and themes, in Gill D. (ed.), *The iron cage recreated: The performance management of state organisations in New Zealand*. Wellington: Institute of Policy Studies.

Goodridge, P. (2007). Index numbers. *Economic & Labour Market Review*, *1*(3), 54–57.

Green, N. (2017). *Productivity measurement case study: early childhood education.* New Zealand Productivity Commission Research Note 2017/05. Wellington: New Zealand Productivity Commission.

Insights MSD [iMSD] (2017). *Service delivery cost allocation model for individual outputs: 2017 version.* Wellington: Ministry of Social Development.

Janssen, J. (2018). The start of a conversation on the value of New Zealand's financial/physical capital. *Living standards series discussion paper*. Wellington: New Zealand Treasury.

Knopf, E. (2017). *History of efficiency measurement by the New Zealand public health sector: post 2000.* Wellington: New Zealand Productivity Commission.

Laking, R. (2008). New Zealand public management in action: a case study of organisational performance, *International Public Management Review*, *9*(1), pp. 76-93.

Lau, E., Lonti, S., & Schultz, R. (2017). Challenges in the measurement of public sector productivity in OECD countries. *International Productivity Monitor, 32,* 180–95.

Le Grand, J. (2007). *The other invisible hand: Delivering public services through choice and competition*. Princeton, NJ, United States: Princeton University Press.

London Economics & DIW Econ. (2017). *Review of international best practice in the production of productivity statistics*. Retrieved 26 July 2018 from www.ons.gov.uk/file?uri=/economy/economicoutputandproductivity/productivitymeasures/articles/reviewofinternationalbestpracticeintheproductionofproductivitystatistics/2018-02-07/productivityinternational.pdf

Lovell, C., & Baker (2005). Experimental estimates of productivity change in the non-market sector: Preliminary evidence from government services. Internal research memorandum. Canberra: Australian Government Productivity Commission.

MacGibbon, N. (2010). Exogenous versus Endogenous Rates of Return (Statistics New Zealand Working Paper No 10–03). Retrieved 26 July 2018 from http://archive.stats.govt.nz/methods/research-papers/working-papers-original/exogenous-vs-endogenous-working-paper-10-03.aspx

Mansell, J., Laking, R., Matheson, B., & Light, R. (n.d.). *Data commons blueprint: A high trust, lower cost alternative to enable data integration and reuse*. Retrieved 9 December 2017 from http://datacommons.org.nz

Marshall, M. (2009). Applying quality improvement approaches to healthcare. *British Medical Journal*, 339(7725), 819-20.

Ministry of Justice. (2017). *Annual Report: 1 July 2016 to 30 June 2017.* Retrieved 26 July 2018 from www.justice.govt.nz/assets/Documents/Publications/moj-2016-17-annual-report-screen.pdf

Ministry of Social Development. (2017). Privacy, human rights and ethics framework (unpublished internal document).

Moore, S., & Hayward, M. (2017). *Productivity measurement case study: Ministry of Social Development.* New Zealand Productivity Commission Research Note 2017/07. Wellington: New Zealand Productivity Commission.

New Zealand Treasury. (1994). *Improving output costing: guidelines and examples.* Retrieved 21 September 2017 from www.treasury.govt.nz/publications/guidance/reporting/outputcosting/outputcosting.pdf

New Zealand Treasury. (1996). *Putting it together: an explanatory guide to the New Zealand public sector financial management system.* Retrieved 21 September 2017 from www.treasury.govt.nz/publications/guidance/publicfinance/pit/

New Zealand Treasury. (2011). *Putting it together: an explanatory guide to New Zealand's state sector financial management system.* Retrieved 27 July 2018 from www.treasury.govt.nz/publications/guide/putting-it-together-explanatory-guide-new-zealands-state-sector-financial-management-system-html

New Zealand Treasury. (2015). *Guide to social cost benefit analysis.* Retrieved 9 December 2017 from www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/guide/cba-guide-jul15.pdf

NZPC. (2014). *Regulatory institutions and practices.* Wellington: New Zealand Productivity Commission. Retrieved 1 July 2018 from www.productivity.govt.nz/sites/default/files/regulatory-institutions-and-practices-final-report.pdf

NZPC (2015). *More effective social services.* Wellington: New Zealand Productivity Commission. Retrieved 3 June 2018 from www.productivity.govt.nz/sites/default/files/social-services-final-report-main.pdf

NZPC. (2017). *New models of tertiary education.* Wellington: New Zealand Productivity Commission. Retrieved 24 June 2018 from www.productivity.govt.nz/sites/default/files/New%20models%20of%20tertiary%20education%20FINAL.pdf

O'Mahony, M., & Stevens, P. (2009). Output and productivity growth in the education sector: Comparisons for the US and UK. *Journal of Productivity Analysis*, 31:177–94.

OECD. (2001a). *Measuring productivity (OECD Manual).* Retrieved 20 November 2017 from www.oecd.org/std/productivity-stats/2352458.pdf

OECD. (2001b). *Specifying outputs in the public sector.* Paris, France: OECD.

OECD. (2009). *Measuring capital (OECD Manual).* Retrieved 9 December 2017 from www.oecd.org/publications/measuring-capital-oecd-manual-2009-9789264068476-en.htm

OECD. (2016). *Engaging public employees for a high-performing civil service.* Paris, France: OECD.

Office of National Statistics. (2007). *The ONS productivity handbook: A statistical overview and guide*. Hampshire, United Kingdom: Palgrave Macmillan.

Office of National Statistics. (2012). *Public service productivity estimates: Education.* Retrieved 1 September 2017 from www.ons.gov.uk/economy/economicoutputandproductivity/publicservicesproductivity

Office of the Deputy Prime Minister (UK). (2005). *Measurement of output and productivity of the fire and rescue service. A conceptual framework.* Retrieved 7 September 2017 from http://webarchive.nationalarchives.gov.uk/20070507024724/http://www.communities.gov.uk/pub/810/MeasurementofOutputandProductivityoftheFireandRescueServicePDF565Kb_id1123810.pdf

Parker D., Waller K., Xu H. (2013). Private and public services: productivity and performance migration, *International Journal of Productivity and Performance Management*, *62*(6) 652-664.

Pickens, D. (2017). *Efficiency and performance in the New Zealand state sector: Reflections of senior state sector leaders*. Wellington, New Zealand: New Zealand Productivity Commission.

Pritchard, A. (2003). Understanding government output and productivity. *Economic Trends, 596,* 27–40.

Richardson, R. (2012). Seismic shifts in politics and policy. *Reform.* Retrieved 26 July 2018 from www.reform.uk/wp-content/uploads/2014/11/Seismic-shifts-in-politics-and-policy.pdf

Rouse, P., & Swales, R. (2006). Pricing public health care services using DEA: Methodology versus politics. *Annals of Operation Research*, 145:265–80.

Schreyer, P. (2010). *Towards measuring the volume output of education and health services: A handbook*. OECD Statistics Working Papers 2010/02. Paris, France: OECD. Retrieved 20 November 2017 from http://dx.doi.org/10.1787/5kmd34g1zk9x-en

Schreyer, P. (2012). Output, outcome and quality adjustment in measuring health and education services. *Review of Income and Wealth*, 58(2): 257–78.

Sharpe, A., Bradley, C., & Messinger, H. (2007). *The measurement of output and productivity in the health care sector in Canada: An overview*. CLS Research Report 2007–06. Ottawa: Centre for the Study of Living Standards.

Simpson, H. (2009). Productivity in Public Services. *Journal of Economic Surveys, 23*(2), 250–276.

Smith, C. (2018). *Treasury living standards dashboard: Monitoring intergenerational wellbeing*. Wellington: Kōtātā Insight.

SSC & New Zealand Treasury. (2008). *Performance measurement. Advice and examples on how to develop effective frameworks.* Wellington: SSC and New Zealand Treasury. Retrieved 7 July 2017 from www.ssc.govt.nz/upload/downloadable_files/performance-measurement.pdf

Statistics New Zealand. (2010). *Measuring government sector productivity in New Zealand: a feasibility study.* Retrieved 9 June 2017 from www.stats.govt.nz/browse_for_stats/economic_indicators/productivity/measuring-govt-productivity.aspx

Statistics New Zealand. (2013). *Education and health industry productivity, 1996–2011.* Retrieved 9 June 2017 from http://archive.stats.govt.nz/browse_for_stats/economic_indicators/productivity/education-health-industry-productivity-1996-2011.aspx

Statistics New Zealand. (2014). *Productivity statistics: sources and methods (10th edition).* Retrieved 5 December 2017 from http://archive.stats.govt.nz/browse_for_stats/economic_indicators/productivity/productivity-stats-sources-methods-tenth-ed.aspx

Statistics New Zealand. (2017a). *Productivity Statistics: 1978–2016.* Retrieved 9 June 2017 from www.stats.govt.nz/browse_for_stats/economic_indicators/productivity/ProductivityStatistics_HOTP78-16.aspx

Statistics New Zealand. (2017b). *Integrated Data Infrastructure.* Retrieved 5 December 2017 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/integrated-data-infrastructure.aspx

Statistics New Zealand. (n.d). *DataInfo*. Retrieved 27 July 2018 from http://datainfoplus.stats.govt.nz/item/nz.govt.stats/1d6724de-47ef-4b49-938a-ccddd9b98a9f/1/

SCRCSSP (Steering Committee for the Review of Commonwealth/State Service Provision) (1997). Data envelopment analysis: A technique for measuring the efficiency of government service delivery. Retrieved 28 November 2017 from www.pc.gov.au/research/supporting/data-envelopment-analysis/dea.pdf

Tavich, D. (2017). *Social sector productivity: A task perspective*. New Zealand Productivity Commission Research Note 2017/01. Wellington: New Zealand Productivity Commission.

Tipper, A. (2013). *Output and productivity in the education and health industries*. Paper presented at the 54th Conference of the New Zealand Association of Economists, Wellington.

Van Dooren, W., Bouckaert, G., & Halligan, J. (2015). *Performance management in the public sector.* Oxford, UK: Routledge.

Wakeman, S., & Le, T. (2015). *Measuring the innovative activity of New Zealand firms.* New Zealand Productivity Commission Working Paper, WP 2015/02. Retrieved 26 July 2018 from www.productivity.govt.nz/working-paper/measuring-the-innovative-activity-of-new-zealand-firms

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