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PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

# Understanding Health Sector Productivity

## Research Note 2017/08

## December 2017

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**The New Zealand Productivity Commission Research Note 2017/08: Understanding Health Sector Productivity**

Te Kōmihana Whai Hua o Aotearoa[1]

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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–formed 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. Information on the Productivity Commission can be found on www.productivity.govt.nz or by contacting +64 4 903 5150.

[1] The Commission that pursues abundance for New Zealand

# Abstract

Any health sector productivity measures need to account for changes in the environment facing providers. Using data on hospital inpatients this research note shows that discharges are ageing and day patients are accounting for a growing share of hospital activity. For example, since 2002 the mean age (at admission) of inpatients has increased by about 3.4 months a year and the median by about 7.1 months a year. Yet we do not know if these results tell us something about the changing demands on the health system (e.g., "healthy (or unhealthy) ageing"), about the interaction between hospital care and other parts of the health system (such as primary and residential care), or about some combination of these factors. To fully understand changes in the health environment, and thus develop productivity measures, more system wide data are required. This note thus goes on to outline some key sources of data in the New Zealand health system. This discussion reinforces the potential of utilising existing data. It also highlights the need for transparency regarding the limitations of the data and approaches. This is not an argument for not measuring productivity. Data systems tend to improve the more you use them and the better use of data is an important step in providing the care needed for patients.

Box 1 **Productivity measurement case studies**

This case study supplements the New Zealand Productivity Commission's draft inquiry report *Measuring and improving state sector productivity*. The terms of reference for the inquiry ask the Productivity Commission to provide guidance and recommendations on:

- how to measure productivity in "core" public services (health, education, justice, social support) at the sector and service level;
- what role productivity measures should play in public sector performance frameworks; and
- how to develop the culture, capability and systems needed within government agencies to measure, understand and improve productivity.

This paper is one of a series of case studies illustrating how to measure state sector productivity, and how to overcome measurement difficulties. The Commission's website provides access to the full suite of case studies.

Readers should not view any of the case studies as a definitive description of productivity in the relevant state sector agency. Rather, the case studies aim to demonstrate different aspects of productivity measurement. The Commission hopes the results of the studies will stimulate further discussion about what is driving the identified productivity trends, how productivity measurement could be improved, and how productivity measures could be incorporated into the wider performance frameworks of state sector organisations.

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# 1 Overview

The Government has asked the Productivity Commission to undertake an inquiry into how the New Zealand State sector can effectively measure and improve productivity in core public services. This includes advice on how to measure efficiency of the health sector, at both a sector and at a service level.[2] This research note provides background material on the Productivity Commission's work on health sector productivity so far. This is a work in progress. This note has three parts: part one (the overview) provides a summary of the material in the note; part two discusses the age and complexity of hospital inpatients; and part three discusses the state of data in the health sector (with a focus on DHB provided and purchased services). This is a continuing project and the material in this note will form the basis for further research on health sector productivity in 2018.

New Zealand's state services often rank highly in international comparisons. Yet, as Statistics New Zealand has estimated, between 1996 and 2015 increases in outputs of the state sector have largely been driven by increasing inputs. In health, average growth in output of 3.9% reflected input growth of 3.0% with labour productivity contributing 0.9% (Statistics New Zealand, 2017a). This sector includes hospitals, medical and other healthcare services, and residential care services and social assistance. It also includes providers in both the state and private sectors, with the private sector accounting for 57% of industry GDP (production measure) in 2016.

Measuring the productivity of state services is complex and the Statistics New Zealand data do not account for things like changes in the quality of outputs or in the environment facing producers. Yet when seen in the context of the Treasury's work on the long-term fiscal outlook they still provide food for thought. (For background on the Treasury's long term fiscal model see Appendix A.) Not only will the demand for key public services increase but we can also expect growth in the aggregate labour force to slow.[3] The implication is that public sector managers can expect their services to face greater demand as input growth becomes more constrained, and so they are going to need to increasingly focus on lifting productivity.

Better measurement is an important step in lifting productivity, particularly in the state sector where many of the drivers of productivity growth in the measured sector (such as the reallocation of labour and capital due to firm entry and exit) apply weakly or not at all. Yet a stock response to the idea of measuring state sector productivity is that it is too hard or that there is something unique about state services that make this impossible.[4] But this is an out of date view. There have been years of work by national statisticians and others developing techniques for measuring services in the non-measured sector.[5] Nonetheless there is still a need to develop metrics that provide practical insights (Productivity Commission, 2017a and 2017b). Indeed, as Lau, Lonti and Schiltz (2017, p. 182) noted:

> To date, the lack of measures to appropriately capture public sector productivity building on, and going beyond, the System of National Accounts, has meant that major policy decisions are being taken without adequate understanding of their implications for the economy as a whole.

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[2] Note that this note uses the term health sector to broadly refer to what Statistics New Zealand define as the health industry. Statistics New Zealand data on National Accounts provides data on industries by 16 ANZSIC06 codes. Industries can be categorised as measured sector and non-measured sector (OO, PP, and QO sectors). Note industry classification not ownership is what counts in these codes and these classifications include market and non-market output.

[3] To illustrate the implications of a change in state sector productivity for the long term fiscal outlook, if the assumed health sector productivity in the long term fiscal model was to increase by half a percentage point (0.5%) then projected expenditure would fall from $137.205 billion in 2059/60 to $114.650 billion. This implies providing the same level of services at a 16.4% lower cost.

[4] For a discussion on the particular challenges in measuring state sector productivity (including the lack of market clearing prices) see Gemmell, Nolan and Scobie (2017).

[5] State sector industries (education and training, health and social care, central government administration and local government administration), along with owner occupied housing, make up what Statistics New Zealand refer to as the non-measured sector. Based on a production measure of GDP state sector output as percentage of total industry output was 15.8% in 2015.

## 1.1 Why health sector productivity?

There are many reasons for an interest in the productivity of the health sector. The sector is not only a major area of government expenditure and a major employer, but is important for living standards and economic growth (Atkinson, 2005). Productivity growth in the private sector relies on a healthy, well-educated population, whose efforts depend on good physical and social infrastructure. Given this, it seems reasonable to focus on the productivity of services like healthcare.

Fortunately, this is an area where – both internationally and within New Zealand – *relatively* good progress has been made in the measurement of state sector productivity. Lau, Lonti and Schiltz (2017) showed that among OECD countries health was the part of the state sector where governments were most likely to measure productivity, although even in this case the majority (20 of 32 countries) had not introduced measures. In New Zealand, District Health Boards (DHBs) regularly measure their productivity over a range of services and this includes benchmarking exercises (DHB, 2017). The Health Roundtable also undertakes valuable benchmarking work.

The concept of productivity can be misunderstood. It is an indicator of the output produced for a given set of resources (inputs). It is about making the best possible use of resources like funding and labour (not necessarily increasing hours of work or cutting budgets) and if measured properly should account for changes in the quality of care. Indeed, that is why the Productivity Commission has begun its research on health sector productivity with this work on potential changes in the environment facing providers. Nonetheless, a comprehensive performance framework for the health sector should include productivity as one dimension. For an example of a health system performance framework being developed by DHBs see Appendix B (DHB, 2017).

Improving productivity (the effectiveness with which inputs are transformed into outputs or activities) is a key step towards improving the final outcomes of the health sector. It is not possible to achieve the best possible health outcomes for New Zealanders unless health services are productive. It may, for instance, be possible to decide on what outcomes are desired and to even predict the likely contribution of particular outputs to these outcomes. But unless the health system can effectively convert the resources available into outputs it will be unlikely to maximise desired outcomes.

To put this more technically, a health system 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.[6] But this also works in the other direction, as Richardson (2012, p. 276) has 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 ensure allocative and dynamic efficiency are central to optimising the performance of the health system.

## 1.2 History of productivity measurement in the New Zealand health sector

Since 2013 Statistics New Zealand has annual published estimates of productivity for the education and training, and health care and social assistance industries. Their estimates go back to 1996. As well as these "national accounts" measures there have been a number of other attempts to measure productivity in the health sector. A review of 15 examples of attempts to measure productivity by national health sector organisations over the past 20 years can be found in Knopf (2017). The main categories of studies and the issues associated with them are summarised in Table 1.

[6] As the Productivity Commission (2017a) noted: technical efficiency is concerned with the optimal method of producing outputs. This is closely related to the concept of productive efficiency, which is to produce outputs at minimum cost. Allocative efficiency is concerned with the optimal distribution of resources to produce the right set of outputs. Dynamic efficiency is concerned with the structures, behaviours and incentives which create improvements in technical and allocative efficiency over time. In other words, technical efficiency relates to the distance from a production possibility frontier, allocative efficiency relates to movements along the frontier, and dynamic efficiency relates to growth in the frontier over time.

Knopf (2017) noted that it was not possible to use a time-sequence topology to document these examples as "no progression in measurement over time was identifiable" (p. 3). As she went on to argue (p. 5):

> Attempts to measure efficiency/productivity in the health sector have been tough going. There are data gaps, missing paradigms, and communication issues. The analytical capacity and capability across the sector appears to be in short supply. Measures that are part of operational processes appear more enduring but that could be expected. Meaningful succinct measures to populate performance frameworks have been elusive.

The experience of productivity measurement was contrasted with the development of Health Targets (Knopf, 2017, pp. 5-6). As Knopf argued the reasons for the relative support for health targets included technical constraints, perceptions of key stakeholders, and generic expectations around public sector monitoring frameworks. In particular, productivity measures were seen as not being meaningful or even "negatively or intuitively wrong" or creating the wrong incentives. It was thus noted that there is "scope for the Productivity Commission to advise on meaningful measures of efficiency and productivity (including developing the productivity story) that would be useful to the health sector" (2017, p. 6). Likewise, DHBs have noted the challenges posed by the lack of agreement on methodologies for measuring productivity and of longitudinal comparisons (DHB, 2017).

**Table 1 Examples of health sector productivity studies**

| Type of Study | Issues Identified |
|---|---|
| National Pricing Framework | Operationally driven but few in sector have skills to engage with (DEA) model |
| Conceptually Measuring Productivity | Hindered by tendency to measure what there is data for |
| Targets | Appear to have been supported and the infrastructure supporting targets is key |
| Benchmarking | To be useful also needs capacity to explain why variation exists |
| Monitoring Reports | Held back by gaps in understanding on potential indicators |

*Source:* Based on Knopf (2017)

## 1.3 The changing health sector environment

As discussed above measuring the productivity of state services can be complex. This note focuses on one dimension of this complexity: changes in the environment that the sector works within. There are several dimensions to this. The first dimension is changes in the casemix in different parts of the health system over time (see section 2.1 for a discussion of the casemix data used in this note). These changes can reflect factors such as:

- population ageing: e.g., since 2002 the mean age (at admission) of inpatients has increased by about 3.4 months a year and the median by about 7.1 months a year. To put this in context, between 2002 and 2014 the median age of the estimated residential population increased by around 2.7 months a year;[7] and
- the complexity of events: e.g., using average cost weights as a proxy for (economic) complexity, while overall cost weights for hospital inpatients fell this reflected a greater proportion of people being treated as day patients. There was little change in the average cost weights for the inpatient and day patient categories. (See Section 2.1 and Footnote 8 for a discussion of the use of cost weights as a proxy for complexity.)

[7] Note that population ageing can also be reflected in the age of the health workforce. For a general discussion of workforce ageing issues see Koopman-Boyden et al. (2014).

Another dimension is changing models of care. Models of care may evolve as:

- technological changes allow treatment of previously untreatable diseases;
- conditions that once required hospital care are able to be treated in other settings (such as primary care); and
- a need for minimum safe size and to manage costs can lead to specialist and other services being concentrated in larger settings (which can be reflected in scale effects or economies of scope).

It is also useful to note that an observed change in productivity may reflect a change in public policy rather than choices made by managers. Changes in resourcing impact on the health sector environment. This resourcing dimension is not discussed in this note. The focus here is on changes in the age and casemix of patients. These changes are unlikely to be automatically captured in productivity estimates (in contrast, resourcing decisions are likely to be reflected in measures of inputs) and are a key dimension of understanding quality change.

Yet it is hard to know if, for example, changes in casemix of hospital inpatients tells us something about the demands facing the sector (e.g., "healthy (or unhealthy) aging"), about the interaction between hospital care and other parts of the health system (such as primary and residential care), or about some combination of these factors. To fully understand changes in the health sector environment, and thus develop sector productivity measures, system-wide data are required. Indeed, DHBs have highlighted gauging performance in mental health, primary care, residential care, and community pharmacy as some key areas for further inquiry (DHB, 2017) (see Box 2).

Box 2 **Suggested areas for productivity case studies**

The issues paper for the State Sector Productivity Inquiry (Productivity Commission, 2017b) included a question regarding which public sectors/services the Productivity Commission should focus on as case studies for developing productivity measures. In response, DHBs noted (DHB, 2017) that the health system could benefit from an impartial look at:

- Age related residential care/interRAI: interRAI is a patient led assessment across different care settings which identifies patient risks and vulnerabilities. It covers a small population cohort (generally aged over 65, requiring DHB support) but these data could have a broader application in informing sector measurement and funding.
- Care Capacity and Demand Management (CCDM) Programme: local measures have been developed but a consistent national approach to measures would be beneficial.
- Community pharmacy: DHBs are currently considering a more integrated model in this area.
- DHB innovation: local DHB innovations could have wider application across the sector.
- Hospital episodes of care: particularly how an episode of care should be defined.
- Mental health: this is a key government priority and is funded on an input basis. Having guidance on consistently measuring outputs would be of system benefit.
- Primary care: there is a view that information flows are less than ideal. Having advice that identifies any gaps would be useful for the sector as a whole.

## 1.4 Improving data collection

Valuable data already exists in the health system (DHB, 2017). It is possible to go a long way in measuring productivity by increasing the utilisation of existing data. As DHBs have noted, 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" (DHB, 2017). Greater utilisation of these data should be the focus rather than requiring the collection of new data (which comes at a cost). This includes thinking about data access, standards, and linking, e.g., whether the right people have access to the right data.

Further, many of the challenges of measuring productivity in the health sector can be addressed with practices already in use in the sector (e.g., the use of service weights (see Footnote 13), tertiary adjustors, overhead allocation methodology, etc.). There are also existing methodologies for enabling comparisons between DHBs for medical and surgical activities (e.g., the role delineation model (see DHB, 2017)). But there are still significant limits in the data available:

- hospital data (both inpatients and outpatients) tends to be most readily available (and utilised for productivity studies) but only provide a partial view of the sector. To fully understand trends in the health system more system-wide data are required;
- while some data on outcomes in other health services (e.g., primary care) can be found in the Integrated Data Infrastructure (IDI) this database contains little data on inputs. Thus while this data infrastructure can help illustrate the relationship between outputs and outcomes it is less strong on the policy levers that can drive the production of outputs (which, in turn, affect outcomes);
- coverage of systems like the IDI is limited and there are significant pockets of data where there are opportunities for greater integration and improving access. As DHBs (DHB, 2017) and others (Downs, 2017) have noted, access to primary care data is a challenge, especially data that would inform better outcome-based analysis; and
- integrating data is likely to be easiest where there is consistency in data standards and systems. While some practices in use (e.g., common costing standards) could potentially provide a good basis for developing productivity metrics their execution across providers could be more consistent.

These points reinforce the importance of utilising existing data. They also highlight the need for transparency regarding the limitations of the data and approaches. This is not an argument for not measuring productivity. Data systems tend to improve the more you use them. As the New Zealand Nurses Organisation (2017) has noted the better use of data is an important step in providing the care needed for patients.

# 2 Age and complexity of hospital inpatients

A raw measure of productivity – the ratio of inputs to outputs – is not particularly useful by itself, rather it is meaningful as part of a comparison (Statistics New Zealand (2010) in Productivity Commission (2017b, p, 5)). In making these comparisons it is important to account for differences that organisations face in their production environments or how such environments may change over time. For hospitals, key aspects of their environment are the age profile of the population and the complexity of treatments. This chapter addresses these two issues using data on hospital inpatients.

As DHBs have noted (DHB, 2017), the outputs of the health sector are "wide and varied, reflecting the complex service settings that DHBs operate in." DHBs also identified that within each service setting there are multiple possible measures for the activities provided.

**Table 2 Core outputs for different service settings**

| Community | Primary Setting | Ambulatory Setting | Hospital Setting |
|---|---|---|---|
| Length of stay | Enrolment | Attendance | Discharge |
| Discharge | Items dispensed | Tests | Length of stay |
| Home support | Attendances | Treatment type | Case weight |
| | Consultations | Clinical measurement | Operating theatre procedures |
| | Treatments | | |

*Source:* DHB (2017)

This research note focusses on the hospital setting (particularly the age of patients and the complexity of procedures). As noted below this only provides a partial view of the sector. However, even with this limitation, analysis along these lines can be a useful starting point in understanding key features of the health sector's environment. These features include:

- the ageing demographics of hospital patients, reflecting changes in the general population;
- burdens of chronic conditions such as arthritis, diabetes, and cancers growing (Ministry of Health, 2016b);
- the health system undergoing technological change, with new technologies allowing treatment of previously untreatable diseases and previously treatable conditions to be treated differently; and
- the health sector itself changing, with moves towards more preventative and community based care (Ministry of Health, 2016b). It has been suggested that as treatments which would once have required hospital care are treated in primary care, activities that still require hospital care become on average more complex.

Work along the lines in this note can also provide context for measures of health system productivity. In particular:

- aggregate productivity measures (based on unadjusted volumes of outputs and inputs) may not differentiate between the adoption of new, better, but more complex treatments and a decline in productivity; and
- measures of complexity, alongside those of productivity offer a greater level of insight into what is happening inside the health system.

## 2.1 Method and data

The data for this analysis were sourced from the National Minimum Data Set (NMDS). This dataset covers publicly funded hospital inpatient activity. The key features of this dataset are summarised in Table 3. For completeness Table 3 also includes material on the National Non-Admitted Patient Collection (NNPAC), which covers publicly funded hospital outpatient and emergency department activity.

**Table 3 NMDS and NNPAC Datasets**

| NMDS | NNPAC |
|---|---|
| Covers publicly funded hospital inpatient activity | Covers publicly funded hospital outpatient and emergency department activity |
| Focusses on clinical coding | Focusses on recording attendance |
| Classified into DRGs | Non DRG, classified into Purchasing Units |
| Around 40% of hospital events | Around 60% of hospital events |
| Key fields: length of stay, age, gender, ethnicity, cost weights (WIES), event type, facility | Key fields: age, gender, ethnicity, volume, purchase unit code, event type, service code, attendance, facility |

*Sources:* NMDS, NNPAC, authors' calculations

The dataset used is the complete, uncleaned NMDS dataset so that results give an overview of the whole dataset. Consequently, the trends shown may be different from those seen in cleaned subsets of the data, such as case mix funded events.

For the purposes of this note age refers to the age of patient at time of admittance to hospital. Age is a useful indicator of changes in hospitals' environment as:

- older patients can require more resources than younger patients for similar treatments. For example, the risk of certain complications and recovery times can be higher. This is reflected in cost weights generally increasing with age, although this increase is not strictly monotonic with there being some high cost weights associated with neonatal care; and
- an older demographic has a greater disease burden than younger demographics (Ministry of Health, 2016b). As such, an aging population can be expected to lead to more activity treating diseases which are more complex than the average disease.

Complexity is defined in relation to resource intensity; particularly length of stay and cost weights. It is acknowledged that these factors are not completely synonymous with medical complexity (e.g., when relatively simple medically procedures require long periods of inpatient care). However, changes in resource intensity can be used to generate a preliminary view on changes in medical complexity.[8] These two factors are discussed in more detail below.

In this note Length of Stay is calculated as the number of midnights spent in hospital, or the date of discharge minus the day of admittance. More formally this should also exclude leave days, but the data to do this were not available for this note. Nonetheless, length of stay is useful as a complementary indicator and proxy for complexity as longer lengths of stay can be expected to generally lead to higher resource use.

Cost Weight refers to the casemix assigned weight. Cost weights are a measure of the resources consumed for a discharge. As more complicated procedures can be expected to consume more

[8] In the NMDS the Patient Clinical Complexity Level (PCCL) can indicate the incidence of complications and comorbidities. The PCCL is based on Complication and Comorbidity Levels (CCL) for each of the diagnostic codes. (An inpatient episode can have multiple diagnostic codes.) The CCL values are integer and vary from 0 (least complex) to 4 (most complex) for surgical and neonatal episodes and from 0 to 3 for medical episodes. As the Casemix Project Group (2015) noted in the 2013/14 admitted patient data that is casemix funded about 30% of events had some form of complication (e.g., a PCCL greater than 0).Preliminary analysis showed that across all NMDS events, the distribution of events by PCCL showed no substantial change between 2002 and 2014. Consequently, no further work on CCL or PCCL codes was included in this analysis.

resources, cost weights can be used to compare the resource intensity of different hospital outputs. Cost weights are calculated such that they reflect resource consumption of activities, relative to other activities in the same year.

Importantly, the cost weights used in this analysis are backdated, so that events for all years are weighted with the same edition of the cost weights (WIESNZ14). This means that the cost weighting treats past years as having the same level of technology as the current year. This is equivalent to using a fixed base price deflator and means that it is effectively assumed that any changes in values are purely the result of compositional changes (e.g., switching between more and less costly events). In other words, this does not explicitly account for changes in model of care or technology.

Box 3 **Casemix, diagnostic related groups (DRGs), and WIES**

The casemix system is the basis for 28-29% of DHB funding in New Zealand. The casemix system has two parts: a clinical coding classification used to group events; and a cost weighting system applied to these groupings. These parts of the casemix system are discussed below.

The first step is to turn patients' clinical records into clinical codes. The clinical coding classification contains almost 24,000 codes and can indicate:

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

Given the volume of clinical codes, similar events with comparable resource use are assigned to Diagnostic Related Groups (DRGs). DRGs 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 (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. In New Zealand a version of WIES has been adapted (WIESNZ) and is updated annually. For data in this note the cost weights are based on WIESNZ14 and the DRG system used is AR_DRG v6.0x. The clinical coding classification is ICD-10-AM/ACHI 8th edition. The clinical coding classifications are updated every four years.

*Source*: Casemix Project Group, 2015

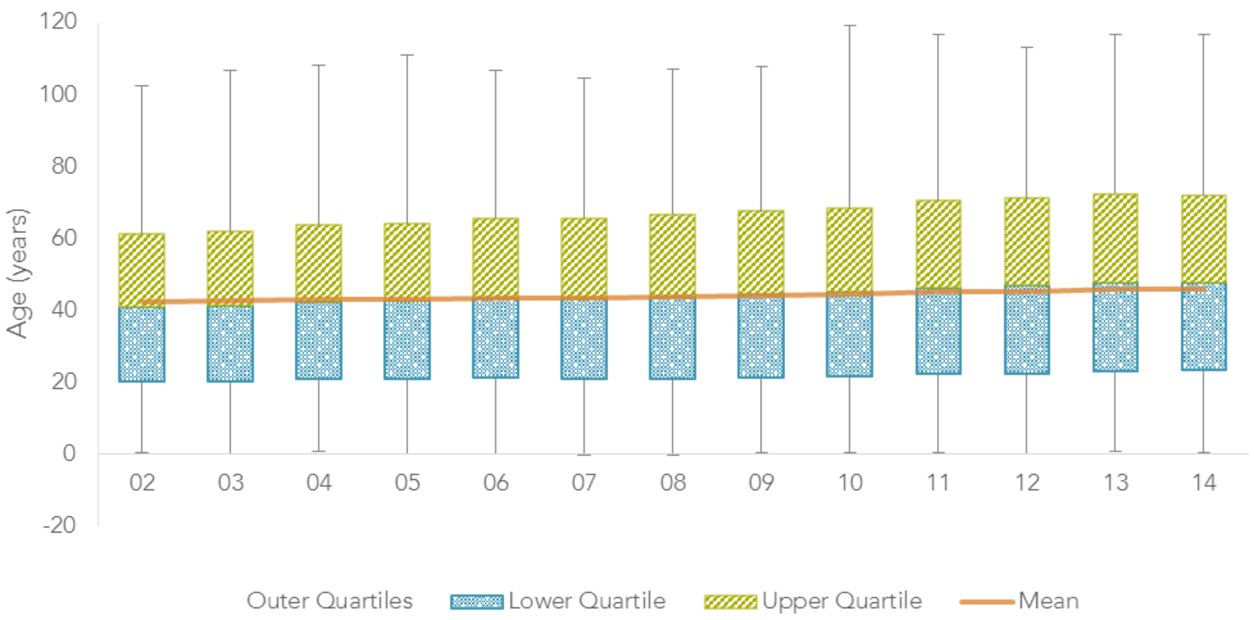
## 2.2 Results

Figure 1 and Table 4 show how the age of the inpatient population has changed between 2002 and 2014. This figure shows that both median and mean ages displayed a strong upward trend. The mean age rose from 42.4 to 45.8, a trend increase of 0.28 years annually, the median age rose from 40.8 to 47.8, a trend increase of 0.58 years annually, and quartile measures rose less than the median at 3.34 and 2.30 years respectively.

Figure 2 shows the trends for the length of stay. The median stayed constant at 1, i.e., half of all events remained at less than 2 days and the mean length of stay fell from 6.6 days to 3.9 days from 2002 to

2014. As Treasury (2017) noted, "longer stays tend to reduce patient wellbeing and increase cost." Further analysis could, however, consider any interaction between average length of stay and readmission rates.

**Figure 1 Age of Inpatient Events, 2002-2014**




*Source:* NMDS, authors' calculations

*Note:* Age is calculated as days between date of birth and date of admittance divided by 365.25

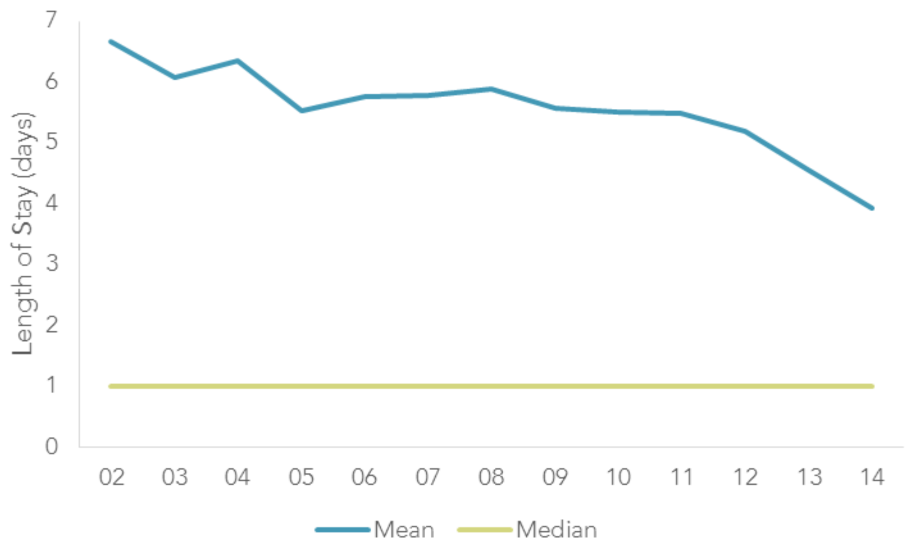
**Table 4 Age of Inpatient Events, 2002-2014**

| Year | Mean | Median |
|---|---|---|
| 2002 | 42.41 | 40.77 |
| 2003 | 42.57 | 41.17 |
| 2004 | 43.18 | 42.37 |
| 2005 | 43.19 | 42.66 |
| 2006 | 43.55 | 43.39 |
| 2007 | 43.55 | 43.43 |
| 208 | 43.75 | 43.83 |
| 2009 | 44.05 | 44.45 |
| 2010 | 44.42 | 45.14 |
| 2011 | 45.05 | 46.34 |
| 2012 | 45.30 | 46.90 |
| 2013 | 45.79 | 47.80 |
| 2014 | 45.81 | 47.82 |

*Source:* NMDS, authors' calculations

*Note:* Age is calculated as days between date of birth and date of admittance divided by 365.25

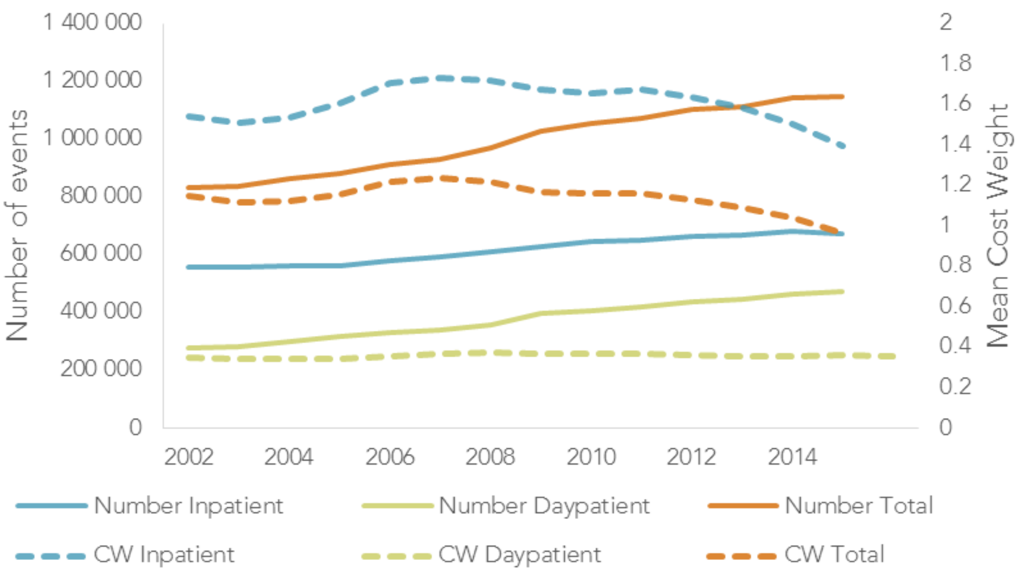
**Figure 2 Length of Stay of Inpatient Events, 2002-2014**




*Source:* NMDS, authors' calculations

*Note:* Individual length of stay entries are calculated as whole days. Consequently the mean is the average of integer values

**Figure 3 Cost Weighted Outputs of Inpatient and Day Patient events, 2002-2014**




Source: NMDS; authors' calculations

*Note:* Day patients are inpatients with length of stay of 0

Figure 3 breaks down cost weighted discharges by inpatients and day patients. Between 2002 and 2015 the average cost weights for inpatients fell from 1.54 to 1.50. The average cost weights for day patients grew from 0.35 to 0.36 over the same period. The number of patients discharged increased from 776,100 to 1,072,000 (an increase of 38%), composed of:

- inpatients, whose numbers rose from 556,000 to 679,000 (a 22% increase); and
- day patients, whose numbers rose from 276,000 to 464,000 (a 68% increase).

Overall, average cost weights fell from 1.14 to 0.96 (a fall of 9%), reflecting the faster growth in the volume of day patients.

## 2.3 Discussion

Although the data used for this note provide only a very partial view of the health system they still raise a number of findings which are important for contextualising measures of health sector productivity. These findings are discussed below. They cover issues relating to understanding compositional changes, the interactions between variables, the definition of complexity, and the healthy ageing hypothesis.

### Understanding compositional changes

Figure 3 showed that average cost weights fell overall, largely driven by a compositional shift in hospital events towards same day events. This compositional shift could be the result of genuine growth in same day events, e.g., greater production of elective surgeries. Alternatively a declining length of stay, as shown in Figure 2, could reflect patients that were previously treated as inpatients now being discharged within a day of arrival due to, for example, new technology or approaches to care. Most likely a combination of the two factors is occurring, although the balance is unknown. Similar questions can be asked for length of stay. For example, how much of the change of length of stay can be attributed to improvements in treatments leading to reduced waiting times, and how much to changes in the composition of treatment towards more day surgeries?

### Interaction between variables

WIES cost weights are based on an assumption that similar treatments with differing lengths of stay will have differing resource costs, with the two being proportional. Yet when comparing inpatient events across time the relationship between length of stay and cost weights may break down, especially given the changes in length of stay observed in Figure 2. A declining length of stay could be a desirable outcome for patients and be consistent with increased productivity, but as it leads to fewer resources being consumed relative to past years then cost weights could show a decline in output levels, potentially lowering measured productivity. Analysis into whether shorter length of stays have increased the volume of output would be helpful in determining the effect of declining length of stay on measured productivity and complexity.

### The definition of complexity

Using cost weights as a measure of economic complexity requires assuming that hospitals are allocatively efficient. This, in turn, requires assuming that an event with a higher cost weight uses greater resources than an event with a lower cost weight and that hospitals would not provide resource intensive treatments if less resource intensive and equally effective alternatives were available. However:

- cost weights say little of the medical complexity of the procedures provided. While DRGs are split into patient complexity (see Box 3), low cost weighted events may still be medically complex or utilise complex technologies with short length of stay;
- factors important to patients, such as recovery times, are an important feature of hospital effectiveness but may conflict with hospital maximising the allocation of their economic resources.[9]

### The healthy ageing hypothesis

There could be value in understanding the relationship between population aging and the age of discharges. Does a change in the age of inpatient discharge tell us something about the "healthy aging" hypothesis, or is the interaction between hospitals and other parts of the health system driving this result? To resolve these issues or otherwise extend this analysis further work is needed (see, for example, Footnote 8 on the potential use of measures of Patient Clinical Complexity Level (PCCL)). Such analysis would give a greater understanding of complexity, and could:

- explore complexity for inpatients at a disaggregated level such as individual DRGs;

[9] This could be seen as an example of the general challenge of estimating value add for non-market ouput. As Atkinson (2005, p. 40) noted: "The problem in the case of non-market output is that there is no transaction from which the price or quantity can be observed. First, there is no revealed preference by consumers, but, second, neither can the costs of supplying a marginal unit be taken as a measure of the individual or collective benefit. There is no reason to suppose that government output is supplied to the point where the benefit from a marginal unit is equal to the marginal cost of supply."

- expand coverage to all hospital events by looking at outpatient and emergency department hospital events in the NNPAC; and
- explore complexity outside of hospitals by looking at events in primary or residential care.

# 3 Health sector data

The section above illustrated both the potential and the limitations of hospital inpatient data. While the data used in this note illustrate a number of important findings to fully understand changes in the health sector environment, and thus develop health sector productivity measures, more system wide data are required. The rest of this note thus discusses the current state of play of health sector data in New Zealand.

## 3.1 The importance of information flows

Before discussing the New Zealand health data it is useful to consider some of the key findings of a major review on data issues, including in the health sector, by the Australian Productivity Commission. As the Australian Productivity Commission (2017, p. 91) has noted while information has always played an important part in the health system its role has become more pivotal following the end of the era of paper records. This new era is categorised by digitalisation of data, new ways of transmitting information to clinicians and patients (e.g., smartphones), and approaches to convert data into knowledge and practice.

But, as they also noted, as with other innovations in the health sector the diffusion of processes for collecting and using data has been gradual:

> Part of this is the familiar story of the barriers posed by customary practices, the poor capabilities in administrators, clinicians and patients to use this new resource, and legitimate concerns about the investment costs associated with new technologies. But part also reflects regulatory barriers (such as ethical clearance, privacy requirements for data use, and rules about sharing) and administrative practices (like incompatible data definitions) (Australian Productivity Commission, 2017, p. 91).

And this can lead to a real worsening (or at least missed opportunities for improving) health outcomes. For example, poor information flows can raise the risks of:

- conflicting treatments;
- duplication of effort;
- suboptimal outcomes;
- inconvenience for patients; and
- excessive costs (Australian Productivity Commission, 2017, p. 92).

Indeed, the Australian Productivity Commission cited a clinician who remarked that it is:

> ironic, given that our profession takes so much pride in the ability to tell the story in a succinct and systematic way, that we are so tolerant of platforms that obscure rather than illuminate the important points in a patient's history" (Australian Productivity Commission, 2017, p. 94).

And as a concrete example of the potential costs they noted the costs due to the absence of electronic coordination of dispensing of controlled drugs. The absence of a system for reconciling prescriptions issues by clinicians with the purchase of drugs from dispensers means that it is difficult to identify people who are not filling their scripts (Australian Productivity Commission, 2017, p. 93).

## 3.2 Wiring up health data

As noted above there is a sizeable literature that investigates the productivity of the New Zealand health system. But there are inconsistencies across studies and a lack of a shared understanding over what counts as evidence. The authors thus prepared a "wiring diagram" that aims to illustrate key sources of data in the health sector (with a focus on DHB provided and purchased services) that could potentially be used as the basis for productivity measures (see Appendix C). Rather than governance relationships this emphasises the flow of data (which often track financial flows) in the sector.

The diagram can be read in the following way. At the top of the diagram is the Health System Vote. This Vote is split between National Services and the funding package for District Health Boards (DHBs). There are 20 DHBs, which have been established based on geographic location (van Kesteren, 2014, p. 66). Some of the funds for National Services are top sliced from the DHB Funding Package. There are also a range of other funding sources (shown to the right of the Health Vote).[10]

Crown funding to DHBs is distributed through a Population Based Funding approach, which distributes funds according to the relative needs of populations and the costs of providing health services to meet those needs. Population based funding is calculated using a formula based on (a) cost weights and (b) adjusters (Penno, Audas, and Gauld, 2012; van Kesteren, 2014, p. 67). Cost weights represent the expected costs per person of a DHB population and are modelled using historical expenditure and four demographic characteristics. Adjusters are designed to compensate DHBs for unavoidable differences in costs associated with the provision/funding of services to their respective populations.

DHBs can choose to provide health services through their "provider arm" or to purchase services from other providers within the district (their "funder arm"). DHBs may also purchase services from other DHB's providers through inter-district flows (IDFs). IDFs can occur for hospital inpatient services, outpatient services, primary care, community pharmacy, community labs, mental health, and NGO services. In 2013-14 IDFs accounted for about 10 per cent of total national DHB funding (DHB, 2015b). There are two types of IDFs: acute (e.g., when a person is subject to an unexpected illness of accident when away from their usual district of residence); and arranged (within a week) or elective (can be longer dated).[11] Understanding IDFs is especially important when assessing the relative performance of individual decision-making units (e.g., individual DHBs).[12]

The Ministry of Health distributes funds to DHBs through the Crown Funding Agreement (CFA). The CFA is an output agreement between the Crown (via the Ministry of Health) and DHBs. The CFA incorporates:

- the Operational Policy Framework (OPF): This is a set of business rules, policy and guideline principles that outline the functions of DHBs; and
- the Service Coverage Schedule (SCS). This sets out the national minima for the range and nature of health services to be funded by DHBs. For some services the SCS also covers subsidies and user charges, as well as specific quality and audit requirements.

All DHBs are required to prepare accountability and planning documents, including an Annual Plan, a Statement of Intent, and a Regional Plan. Each DHB has a Planning and Funding Unit (PFU) which chooses to provide health services or purchase services from multiple other providers. DHBs are also required to report their costs split into prevention, early detection/management,

[10] The health system's funding comes mainly from Vote Health, which totalled just over $16.142 billion in 2016/17. Around three-quarters of the Vote is allocated to the DHB funding package, with the majority of the remaining public funding (approximately 19 percent) funding national services, such as disability support services, public health services, specific screening programmes, mental health services, elective services, Well Child and primary maternity services, Māori health services and postgraduate clinical education and training. About 1 percent of the Vote is allocated to running the Ministry of Health. Other funding sources include the Accident Compensation Corporation (ACC), other government agencies, local government, and private sources such as insurance and out-of-pocket payments.

[11] In relation to acute IDFs, as DHB shared services noted these "are largely outside the control of DHBs, and are predictable in aggregate." In relation to arranged IDFs, DHB shared services also noted these flows "represent long-established clinical relationships and referral patterns; each speciality has its own idiosyncratic patterns, based on history, service supply decisions and pragmatism" (DHB, 2015).

[12] IDFs are not directly recorded in NMDS or NNPAC but, as DHB (2015b) noted, they can be derived by comparing: DHB of Domicile (DoD) (the DHB whose service area includes the place of domicile of the patient); DHB of Service (DoS) (the DHB providing the service); and DHB of Facility (DoF) (the DHB that owns/manages the physical structure where the service is carried out). Local patients are largely those where the DOD matches the DoS. IDFs are patients who receive hospital service provided by a DHB that does not normally provide service for the patient's domicile (i.e., DoD does not equal DoS) (DHB, 2015b). Exceptions to this approach include: overseas patients (given a domicile code that reflects their overseas status and considered as local patients); private facility attendance (excluded from IDF analysis) unless it is directly funded by a DHB; and mental health patients (excluded from IDF analysis).

assessment/treatment, and rehabilitation and support (DHB, 2017). These different cost bases can be particularly relevant when case weighting activities (DHB, 2017).

For provider arm services there are two key national datasets: the National Minimum Dataset (NMDS) which covers inpatients; and the National Non-Admitted Patient Collection (NNPAC) which covers outpatients and emergency department service. These are described in greater detail above (see Table 3). However:

- these data are for events (discharges for NMDS and patients for NNPAC) and so do not provide information on a whole course of treatment (e.g., joining up activities in primary care and secondary care);
- inpatient data is adjusted for complexity (based on cost weights and so are a measure of "resource complexity") but outpatient data is not. Inpatients are assigned a diagnostic related group (DRG) based on their major diagnosis category, the types(s) of procedures required, and the level of complication. WIES weights are then assigned based on the DRG group, with an adjustment for length of stay;
- outpatient data is weighted with national prices from the National Cost Collection and Pricing Programme. NCCPP prices are calculated for the purpose of inter-district flows (where the DHB of domicile and of treatment differ) but DHBs do not have to use these national prices; and
- service weights have been developed as part of the Health System Performance Programme, which can be used to estimate measures for sub outputs, such as theatres, wards, and radiology. Service weights are based on components of the total costs – e.g., a class of labour costs – rather than the total cost that are in the WIES weights for casemix funding.[13]

The provider arm also contains rich operational data (e.g., through the Care Capacity Demand Management (CCDM) programme (DHB, 2017)). The majority (17 of 20) DHBs utilise a validated patient acuity system (TrendCare) which provides the data that drives the Staffing Methodology within the CCDM programme. The TrendCare system captures detailed information on patient complexity/acuity and the staffing hours needed to deliver the required care to these patients. However, there are some limits in terms of workforce and activity coverage for the CCDM programme and the TrendCare system (e.g., not operating theatres). TrendCare systems are also not integrated across DHBs. As DHBs have noted, there could be the opportunity to benchmark validated nursing and midwifery patient acuity data at a national level (DHB, 2017).

In relation to other agencies, data can be found in a number of places. In particular, for primary care:

- information on patients enrolled with Primary Health Organisations is contained in the Primary Health Organisation Enrolment (PHO) dataset. This (quarterly) dataset includes demographics, addresses, primary care funding streams, and patient identifiable information. Also included are when the patients were enrolled, when they were last seen, the practice type, and average fees paid;
- however, as Downs (2017) noted, little is known about what occurs during visits with the failure to collect primary care diagnosis codes or procedure codes. The Ministry of Health has been required to create a dataset of imputed GP consultations using data on prescriptions and laboratory tests;
- further, as Downs (2017) also noted, while almost all PHOs are involved in data collection these efforts are not standardised or integrated. While there is an effort to create a national primary care data warehouse, this needs to be consistent with efforts to support monitoring the performance of the sector; and

[13] As DHB (2015a) has noted service weights 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 entire hospital. Service weights enable the calculation of more accurate efficiency and productivity measures for sub outputs such as theatres, wards, radiology. This can be calculated as the cost weight of the service (e.g., the average service cost divided by the average cost of each episode) multiplied by the ratio of the average cost of the service for the purchasing unit over the average cost of the service.

- finally, while the system level measures framework (discussed below) highlight some key health outcomes, data will be reported at the Alliance level (collaborations of PHOs and DHBs) and Alliances will choose their contributory measures (Downs, 2017). Consequently the measures will not be necessarily comparable across the country.

For other services there are a range of datasets in Statistics New Zealand's Integrated Data Infrastructure (the IDI) which could be of value. These include: ACC Injury Claims, B4 School Check, Cancer Registrations, Chronic Condition/Significant Health Event Cohort, GMS Claims, Health Tracker, Laboratory Claims, Mortality, National Immunisation Register, National Needs Assessment and Service Coordination Information (SOCRATES), Pharmaceutical, Population Cohort Addresses, Population Cohort Demographics, and Programme for the Integration of Mental Health Data (PRIMHD). As DHBs have noted, the national mental health collection (PRIMHD) is especially important, but requires further understanding (DHB, 2017).

However, while the IDI contains potentially useful data on outputs (or activities) the challenge is to link these data to inputs. Fairly allocating inputs to outputs is a key issue in accurately measuring health sector productivity (DHB, 2017). Further, access to health datasets which have been subject to ad hoc loading (as opposed to full integration) is relatively restricted within the IDI.[14] In these cases access tends to be restricted to already existing datalab projects. This is a barrier to the use of these data in new projects. Note that all projects are subject to Statistics New Zealand confidentiality requirements (including the checking of work before release) and so this restriction does not provide additional benefit in terms of data security.

There are several places where data on inputs are collected. Health Workforce New Zealand (HWNZ) and District Health Boards' Shared Services have an overview of workforce issues. However, as with outputs, the data relating to hospital activity tends to be most comprehensive. It can also be useful to account for changes in the composition of the workforce (e.g., skill levels), so data like the Tertiary Education Commission data on qualifications could be of value. Data on employees' qualifications would be most useful when linked to employers (for an example of this approach see Maré, Le and Fabling (2017)). Another potential source of data on inputs is the common costing standards. To facilitate IDFs the National Cost Collection and Pricing Programme (NCCPP) sets National Prices. While DHBs are permitted to negotiate their own prices the goal is that DHBs will use National Prices and save resources (on price and volume negotiations). These National Prices are based on a set of DHB Costing Standards.

The Common Costing Standards (CCS) establish the requirements for recognising, measuring, and disclosing financial and non-financial information. They also set out specific rules to be used in DHBs' costing systems when they have a material impact (for definition of material impact see van Kesteren, 2014, note 14, p. 71). They are based on the principle that when determining the cost of a patient event it must be fully absorbed (i.e., including directs and indirect costs associated with patient events). There are several companion documents that underpin the CCS. These include:

- the Common Chart of Accounts: which provides a nationally consistent GL coding system for the recording of transactions by DHBs. This also supports common presentation, interpretation, and use of financial information produced by DHBs. This covers both DHB provider and funder roles;[15]

- full-time Equivalent Counting Specification: which sets out a framework for measuring staff resources. Three measures are accrued FTE, worked FTE, and contracted FTE; and

- other linking documents: the National Service Framework Data Dictionary; the Common Counting Standards; NSF Service Specification; and Operational Policy Framework (Kesteren, 2014, p. 82).

[14] See, for example, Statistics New Zealand (2017b), *Upcoming datasets for the IDI and LBD*.

[15] . The major categories are: 1000s, Revenue; 2000s, Expenditure; 2001, Personnel; 2002-2199, Medical Personnel; 2200-2399, Nursing Personnel; 2400-2599, Allied Health Personnel; 2600-2799, Support Personnel; 2800-2999, Management/Administration Personnel; 3000s, Outsourced Services; 4000s, Clinical Supplies; 5000s, Infrastructure & Non-Clinical Supplies; 6000s, Provider Payments (joint DHB/MoH use); 8000s, Internal Allocations; 9000s, Balance Sheet.

However, these standards have not been uniformly implemented across the country (only 13 DHBs use them).

Further, there are some publicly available sources of data on inputs. In particular:

- Household Labour Force Survey: this covers the civilian, non-institutionalised, usually-resident New Zealand population aged 15 or over. It collects data on the number of personnel, hours worked, salaries, and occupation. Issues in the survey include sampling error and the fact that compensation is restricted to wages and salaries and self-employed income (excludes other parts of employment-related compensation). There is no link to outputs;
- Linked Employer-Employee Data (LEED): this provides statistics on filled jobs, job flows, worker flows, mean and median earnings for continuing jobs and new hires, and total earnings. It is created by linking a longitudinal employer series from the Statistics NZ Business Frame to a longitudinal series of EMS payroll data from Inland Revenue. It does not contain any information relating to the number of hours worked for those earnings;
- Medical Council's workforce statistics: this covers all doctors in New Zealand and is collected annually as part of the renewal of practicing certificates. The information available includes: region, length of service, country of registration, age, sex, work type (e.g., primary care of house officer), vocational scope (e.g., anaesthesia, emergency, or ophthalmology), hours worked, and type of employer; and
- National Asset Management Plan (Capital Investment Committee) and Statistics New Zealand's measurement of capital productivity.

Valuable data on dimensions of the quality of healthcare are collected by the Health Quality and Safety Commission (HQSC) (see, for example, HQSC (2017)). The HQSC compiles an Atlas of Healthcare Variation. This concentrates on individual conditions and clinical groups and highlights differences in practice and the improvements required to reduce unwarranted variation. The HSQC also produce a series of Quality and Safety Markers. These markers are a mix of process and outcome measures focused on driving improvement for four key safety priorities: falls, healthcare associated infections, surgical harm and medication safety. In relation to patient experience data the HQSC collect two sources of patient data: Adult Inpatient Survey (from August 2014); Primary Care Patient Experience Survey (being trialled in a small number of practices from February 2016).

For data on outcomes, the New Zealand Health Survey (NZHS) provides an annual view on the health and wellbeing of New Zealanders. The NZHS has been continuous since 2011 and had earlier waves in 1992/93, 1996/97, 2002/03, and 2003/07. It is a panel survey and produces (but is not limited to) a number of Tier 1 statistics, including: self-rated health; smoking (current); past-year drinking; hazardous drinking; obesity; mental health status (psychological distress); unmet need for GP due to cost; and unfilled prescription due to cost.

Health outcomes can also be reflected in a number of broader system level measures. These include:

- the DHB Non-Financial Monitoring Framework;
- Long Term Conditions Outcomes Framework;
- Health targets for DHBs and Primary Health Organisations; and
- Ministry of Health managed Better Public Service Targets.

The Ministry of Health has also introduced a number of system level measures (the SLM framework). District alliances (of DHBs and PHOs) are required to develop and implement plans to improve these headline outcomes. It is expected that this would include: sharing information about the utilisation of health services, select and monitor initiatives that will improve outcomes, and select additional contributory measures that reflect local priorities (Public Policy Institute, 2017). These measures include:

- ASH rates for 0-4 year olds;
- acute hospital bed days;
- patient experience of care;
- % of 6 week old babies living in a smoke free household; and
- amenable mortality rates.

## 3.3 Improving the collection and management of data

The Australian Productivity Commission's recent review (discussed in Section 3.1) also included a number of recommendations for improving information collection and management in health systems (pp. 95-98). Although there are obviously some important differences between the health systems in the two countries, many of the challenges regarding the collection and management of data appear strikingly similar. Their recommendations were:

- a coordinated approach to standardise definitions and terminology, including within primary care;
- collecting and linking data at the right level of granularity;
- ensuring that in procurement decisions future operability is not blocked by contract terms or software design;
- co-design of data systems by those who work with them, including training the medical workforce and administrators and demonstration of benefits to clinicians and patients (change data into information that can change behaviour or give people control); and
- not constraining the sharing of data for analytical purposes unless there are concerns about cybersecurity and privacy.

As the Australian Productivity Commission noted, reliable health data can lead to improved health outcomes, including through assisting providers to self-evaluate their relative performance. Yet this requires ensuring "the data are of the right quality, the setting in which the data have been collected is divulged, the risks of unintended negative outcomes from misinterpretation or mismeasurement is assessed and remedied, and the measurement of performance is regularly refined" (Australian Productivity Commission, 2017, p. 97). And, they went on to write, the "difficulty of accessing information forgoes opportunities for richer analysis, including of causal analysis of the factors that affect population health, benchmarks for performance at the regional level, and a greater capacity for testing the efficacy of some health promotion initiatives" (Australian Productivity Commission, 2017, pp. 100-101).

# References

Atkinson, T. (2005). *Atkinson Review: Final report. Measurement of Government Output and Productivity for the National Accounts.*

Australian Productivity Commission (2017). *Shifting the Dial: 5 Year Productivity Review*. Supporting Paper 5 – Integrated Care. Canberra: Australian Productivity Commission.

DHB (2105a). *Hospital Quality and Productivity: Report to December 2015*. Wellington: Central Region's Technical Advisory Services Limited (TAS).

_____ (2015b). *Understanding Inter-District Flows 2009 – 2014 for the Central Region*. Wellington: Central Region's Technical Advisory Services Limited (TAS).

_____ (2017). *The Productivity Commission's Inquiry: Measuring and Improving State Sector Productivity*. District Health Boards' Submission. Wellington: Central Region's Technical Advisory Services Limited (TAS).

Casemix Project Group. (2015). *The New Zealand Casemix System: An Overview*. Wellington: Ministry of Health.

Charles, Anna. (2017). *Developing accountable care systems: Lessons from Canterbury, New Zealand*. London: The Kings Fund.

Creedy, John & Scobie, Grant. (2015). *Debt Projections and Fiscal Sustainability with Feedback Effects*. New Zealand Treasury Working Paper 15/11. Wellington: The Treasury.

Downs, Amy. (2017). *From Theory to Practice: The Promise of Primary Care in New Zealand*. Ian Axford Fellowship Report. Wellington: Fulbright New Zealand.

Gemmell, Norman, Nolan, Patrick & Scobie, Grant (2017). *Public Sector Productivity: Quality Adjusting Sector-Level Data on New Zealand Schools*. Working Paper 2017-02. Wellington: New Zealand Productivity Commission.

HQSC (2017). *A window on the quality of New Zealand's health care*. Wellington: Health Quality and Safety Commission.

Knopf, Elizabeth (2017). *History of Efficiency Measurement by the New Zealand Health Sector Post 2000*. Wellington: New Zealand Productivity Commission.

Koopman-Boyden, Peggy, Cameron, Michael, Davey, Judith & Richardson, Margaret (2014). *Making active ageing a reality: maximising participation and contribution by older people*. Report to the Ministry of Business, Innovation and Employment. Hamilton: National Institute of Demographic and Economic Analysis.

Lau, E., Lonti, S. & Schiltz, R (2017). Challenges in the Measurement of Public Sector Productivity in OECD Countries. *International Productivity Monitor*, 32, 180-195.

Maré, Dave, Le, Trinh & Fabling, Richard (2017). *Productivity and the allocation of skills*. Motu Working Paper 17-04. Wellington: Motu Economic and Public Policy Research.

Ministry of Health. (2016a). *Annual Update of Key Results 2015/16: New Zealand Health Survey*. Wellington: Ministry of Health.

_____ (2016b). *New Zealand Health Strategy Future Direction*. Wellington: Ministry of Health.

New Zealand Nurses Organisation. (2017). *Factsheet: Trendcare and CCDM*. Wellington: New Zealand Nurses Organisation.

Peacock, Stuart, Chan, Chris, Mangolini, Melvino, & Johansen, Dale (2001). *Techniques for measuring* efficiency *in health services*. Staff Working Paper, Canberra: Australian Productivity Commission.

Penno, Erin, Audas, R, & Gauld, Robin. (2012). *The State of the Art? An Analysis of New Zealand's Population-Based Funding Formula for Health Services*. Dunedin: Centre for Health Systems, University of Otago.

Piscetek, Melissa & Bell, Matthew. (2016). *Demographic, Economic and Fiscal Assumptions and Modelling Methods in the 2016 Long-Term Fiscal Model. Background Paper for He Tirohanga Mokopuna: 2016 Statement on the Long-Term Fiscal Position*. Wellington: The Treasury.

Productivity Commission. (2017a). *Measuring and improving state sector productivity: Draft report.* Wellington: New Zealand Productivity Commission.

_____ (2017b). *Measuring and improving state sector productivity: Issues paper*. Wellington: New Zealand Productivity Commission.

Public Policy Institute (2017). *Measuring and Managing Health System Performance in New Zealand. Policy Briefing 5/2017*. Auckland: University of Auckland.

Richardson, Ruth (2012). Seismic shifts in politics and policy, in Seddon, Nick (ed.), *The Next 10 Years*. London: Reform.

Statistics New Zealand. (2010). M*easuring government sector productivity in New Zealand: a feasibility study*. Wellington: Statistics New Zealand.

_____ (2017a). *Productivity Statistics: 1978–2016*. Wellington: Statistics New Zealand.

_____ (2017b), *Upcoming datasets for the IDI and LBD (15 September 2017)*. Wellington: Statistics New Zealand.

Treasury (2017). *District Health Board Financial Performance 10 2016 and 2017 Plans*. Wellington: Treasury.

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

van Kesteren, Peter. (2014). Activity-Based Costing and Inter-District Flows in the New Zealand Public Health Sector. A thesis submitted to Victoria University of Wellington in fulfilment of the requirements for the degree of Master of Commerce.

# Appendix A State sector productivity and the Treasury's long term fiscal model

## Key features of the model

The discussion below focusses on one part of the Treasury's long term fiscal model (LTFM) and draws on a comprehensive and useful discussion of the model in Piscetek and Bell (2016). As they noted the model takes a three stage approach:

- Demographic projections are obtained;
- Demographic projections are combined with economic assumptions to derive the economic projections; and
- Demographic and economic projections and assumptions are combined with fiscal assumptions to estimate the fiscal projections. The fiscal projections are based on assumptions regarding revenue and expenditure. Expenditure is itself broken down into operating allowance controlled expenses, welfare expenditure, transport and communications expenditure, and debt financing.

In the 2016 LTFM the growth in individual expense categories (for operating allowance controlled expenses, e.g., excluding welfare, transport and communications, and debt financing) is estimated in one of two ways:

- Long-run stable percentages of GDP. Different expense categories are assumed to achieve their stable percentage of GDP at different rates and to then reach long-run stable ratios. These then grow in line with non-demographic growth in nominal GDP, which has both a non-demographic component (nominal wage growth) and a demographic component (labour force growth).
- Bottom-up driven expenditure (health and education).

The approach to bottom-up driven expenditure requires explanation, particularly as the approach to modelling this changed between 2013 and 2016.

### Bottom-up driven expenditure

The 2013 LTFM estimated the growth of bottom-up driven expenditure using the following approach:

$$g_t = \frac{(1+d_t)(1+n_t)(1+\pi_t)(1+l_t)}{(1+p_t)} - 1$$

Where *g* was the annual growth in expense type (in nominal dollars), *t* denoted the year that growth *g* occured, *d* was the recipient group, *n* was non-demographic volume growth, *π* was inflation, *l* was economy-wide productivity growth, and *p* was public sector productivity growth.

*π*, *l*, and *p* were assumed to be 2.0%, 1.5%, and 0.3% respectively. This was the same for all expense types.

*d* and *n* varied among expense categories. In relation to *n*, in health this (non-demographic growth) was set at 1.5% and in education this was set at 1.0%. All other expenses (e.g., law and order) covered by this approach were aggregated to lead to an estimate of 0.8%.

In relation to *d*, weighted demographic growth in health and education subgroups were calculated as:

Health spending was based on Ministry of Health data (cost weights) on health spending distributions by 5-year age group and gender. These cost weights were adjusted for "healthy ageing" (e.g., some account was made for the impact of growing longevity on the timing of health costs).

Education spending was based on summaries of data on ages and gender groups for students of all education areas, which guided the demographic growth components of various education expense classes.

For other expense types the growth in the working aged population (15 years and above) was applied to estimate *d*. In the 2013 model law and order was modelled on a weighted recipient base, but this growth driver was not applied to this expenditure category in the 2016 model.

In the 2016 model, bottom-up growth in health and education was estimated using the following approach:

$$g_t = (1+d_t)(1+\gamma\pi_t)(1+\delta l_t)-1$$

This equation aimed to capture three components of expenditure growth: demographic growth, price, and residual. The main changes from 2013 were that non-demographic volume growth and public sector productivity were replaced with elasticities on π and *l*. ***γ*** was an elasticity calculated from historical annual data and was the growth of the health or education subgroups of the CPI relative to the overall CPI (elasticity CPI to subgroup CPI). ***δ*** was an elasticity designed to capture the residual growth component (elasticity residual growth to labour productivity growth).

## Possible productivity-related questions

In the bottom-up growth approach, as ***δ*** is fixed over time then an increase in *l* would lead to a higher growth rate for spending. And if we hold measured sector productivity as fixed then an increase in state sector productivity would lead to higher total economy labour productivity. This would appear to lead to higher expenditure growth (given values of ***δ*** of 1.35 for health and 0.90 in education). Note that as a share of GDP the result may not be as clear, as real GDP equals the real GDP in the previous year multiplied by growth in total hours of work and labour productivity growth (so the denominator will increase too).

This can be shown by changing the assumed long-run labour productivity growth from 1.5% to 1.85%. This leads to debt as a percentage of GDP in the terminal year (2059/60) falling from 205.8% to 200.4%, but with health spending growing from $137.205 billion to $162.752 billion and education spending growing from $85.803 billion to $96.363 billion.

Yet work by John Creedy and Grant Scobie (2015) shows that a debt target of 20% of GDP by 2054 could be achieved without any real per capita reduction in spending by lifting the base level of total economy productivity growth from 1.5% to somewhere between 1.85% and 2.65% (depending on the timing of the productivity increase). Achieving this increase in productivity would need gains in the productivity of both public and private services. The Creedy and Scobie work also shows a future political economy problem, with the higher immediate productivity scenario leading to a higher rate of debt reduction until the 2030s and with debt then increasing later in the period.

In the 2016 LTFM it is also possible to introduce assumptions for productivity growth reducing health and education expenditure. So, for example, if health productivity was assumed to increase by 0.5% then projected expenditure would fall from $137.205 billion in the terminal year to $114.650 billion. This could be read as providing the same level of services at a 16.4% lower cost. Likewise, making the same assumption for education means that spending in 2059/60 is $74.650 billion not $85.803 billion, which is equivalent to a 13.1% reduction in cost. With both of these assumptions then debt as a share of GDP will be 158.0% of GDP rather than $205.8%.

# Appendix B Health system performance framework

DHBs have identified that the wealth of data that they can collectively bring together can support cross-sector approaches and ensure health intelligence is a part of government policy development (DHB, 2017). With this in mind, the 20 DHBs are leading a joint Health System Performance Insights programme. This has included developing a framework to enable a balanced view of performance covering all aspects of DHBs production models. The framework, which has been adopted and amended from the Australian Institute of Health and Welfare, is shown below.

| **Determinants of Health**<br>*Effects of a New Zealander's environment on their health* | | | |
|---|---|---|---|
| **Environmental factors**<br>*Physical, chemical and biological factors such as air, water and soil quality.* | **Community and socioeconomic**<br>*Community factors such as social capital, support services, and socioeconomic factors such as housing, education, employment, and income.* | **Health behaviours**<br>*Attitudes, beliefs, knowledge, and behaviours such as patterns of eating, physical activity, smoking, and alcohol consumption.* | **Biomedical factors**<br>*Genetic-related susceptibility to disease, and other factors such as blood pressure, cholesterol levels, and body weight.* |
| **Health Status**<br>*An overview of the health of New Zealanders* | | | |
| **Health conditions**<br>*Prevalence of disease, disorder, injury or trauma, or other health-related states.* | **Disability/Human function**<br>*Alterations to body structure or function (impairment), activity limitations and restrictions in participation.* | **Wellbeing**<br>*Measures of physical, mental, social and spiritual wellbeing of individuals.* | **Population**<br>*A measure of birth, life and mortality rates of the New Zealand population.* |
| **DHB Health Sector Performance**<br>*How efficiently does the DHB health sector perform?*<br>*(Primary, Community, Secondary, Tertiary)* | | | |
| **Effectiveness**<br>*Care, intervention, or action provided is relevant to the client's needs and based on established standards. Care, intervention or action achieves desired outcome.* | **Safety**<br>*The avoidance—or reduction to acceptable limits—of actual or potential harm from healthcare management or the environment in which healthcare is delivered.* | **Accessibility**<br>*People can obtain healthcare at the right place and right time irrespective of income, physical location and cultural background.* | **Responsiveness**<br>*Service is client oriented. Clients are treated with dignity and confidentiality and encouraged to participate in choices related to their care.* |
| **Resources**<br>*Achieving desired results with the most cost-effective use of resources.* | | | |
| **Sustainability**<br>*Resourcing and productivity to maintain the core system, new activities, and future demands.* | **Infrastructure**<br>*Capacity of the infrastructure to sustain the system.* | **Workforce**<br>*To optimise a workforce that can sustain and enhance the system.* | **Innovation**<br>*Innovate and respond to new ways of dealing with needs that will aid the health system in the long term.* |

# Appendix C Health sector data wiring diagram