INTER-DISTRICT FLOW TRANSFERS: HEALTH AND ECONOMIC IMPACTS

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Business Studies

in

Economics

at Massey University, Albany, New Zealand.

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ABSTRACT

As part of the introduction of the New Zealand Public Health and Disabilities Act in 2000, the introduction of the Population Based Funding Formula led to a change in the flow of funds for transfer patients. Prior to the PBFF, for the years 2000-2003, healthcare events were contracted on a fee-for-service basis and thus were borne by the DHB of treatment. From 2003 onwards, the cost of transfer patients followed the transfer back to their DHB of domicile. This study replicates and extends work done by Shin (2013) in assessing the impacts of this change in funding flows on the level of transfer and patient health outcomes. I use OLS and logistic modelling to empirically assess these effects and draw conclusions as to the effectiveness of the policy change and any potential efficiencies that are gained. I find evidence of a focus in the probability of transfers after the change in funding, where the overall probability of transfer decreases and the probability of transfer to tertiary DHBs increases. Additionally, patient outcomes demonstrate a concentration effect whereby after the policy is implemented, the pool of transfers is less diluted by low severity patient transfers and thus displays poorer health outcomes on average for the transfer group. The concentration of health outcomes suggests that the transfer decision is being considered more carefully now that costs are aligned to the DHB of domicile. A novel addition to this research is the analysis of regional DHB pairs. The analysis of five secondary-to-tertiary transfer flows provides insight into the necessity of a decentralised healthcare system in New Zealand and is mostly consistent with the analysis at the national level. Overall, the introduction of Inter-District Flow transfer funding has increased the efficiency of the transfer mechanism and enabled a more streamlined redistribution of funds to tertiary providers. This is an important finding because it reinforces the necessity of the transfer mechanism, specialist providers and local provision in a healthcare system such as New Zealand's.

ACKNOWLEDGEMENTS

I would like to thank my supervisors Professor Christoph Schumacher and Dr Matt Roskruge for their support through the research process. I have learned continuously, most often through challenges and uncertainty, and I thank you for your seemingly endless patience. Thank you to my mum for her eye for detail and my dad for his knack for well-timed tea making and both for their love and support. Thank you to Nicky and Karen from Auckland and Waitemata DHBs for sharing your experiences. To Flynn, Bridget, Jess, Ji-Eun, Kim, Anthony, Abby, Yasmine, David and Caitlin, thank you for lending an ear in times of stress. Thank you to Dr Brendan Moyle and Dr Liping Zou for your curiosity in my research. A special thank you Associate Professor Russell Gregory-Allen for being the shadow supervisor I didn't know I needed.

Statistics New Zealand Disclaimer

The results in this thesis are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI), managed by Statistics New Zealand.

The opinions, findings, recommendations, and conclusions expressed in this thesis are those of the author, not Statistics NZ.

Access to the anonymised data used in this study was provided by Statistics NZ under the security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this thesis have been confidentialised to protect these groups from identification and to keep their data safe.

Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

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1. INTRODUCTION

Inter-hospital transfers are linked with increased hospital costs, reductions in patient health outcomes, reductions in hospital performance and increased administration time. However, in a small, sparsely populated country, they become a necessity. Low frequency services with high complication levels that demand medical expertise, such as renal transplants or spinal injury, are prohibitively expensive if located in each of New Zealand's 20 District Health Boards (DHBs). For this reason, tertiary hospitals are well established in the main DHB centres of Auckland, Waikato, Wellington and Christchurch. These hospitals specialise in services that the rest of the country can utilise on a transfer basis.

The introduction of the New Zealand Public Health and Disability Act (NZPHDA) 2000 brought a raft of changes to the New Zealand health system. One change is the funding of transfer patients from a temporary fee-for-service contracted system, between 2000-2003, to a permanent, population-based capitation system from 2003 onwards. The temporary contracted period caused a proverbial "free-for-all" with respect to inter-district flow (IDF) transfers because patient costs were borne by the hospital of treatment. As part of the introduction of the Population Based Funding Formula (PBFF), a set of prices for IDFs were introduced that charged the District of Domicile rather than the District of Service. As a result, one study in 2013 observes a decrease in the level of IDFs and overall adverse effects on patient health outcomes (Shin, 2013). The purpose of this paper is to replicate and extend this finding to investigate the impacts of the change in transfer pricing procedures. Specifically, I will analyse the national impact of transfer cost on mortality, readmission and length of stay, and extend the analysis to five regional impact studies.

To conduct this research, a sample of 4.4 million healthcare events over eight years is analysed from Statistics New Zealand's Integrated Data Infrastructure. A common problem with analysis of policy changes in healthcare is controlling for unobserved variables that affect the causality of the underlying relationship. This paper mimics the research methodology in Shin (2013). Where this methodology differs is taking a more specific approach to replicate results. The first point of difference is the identification of DHB pairings. There are five clear DHB pairs in which patient transfers occur almost exclusively in one direction. Patient transfers commonly occur

from secondary providers to tertiary providers flowing from low resource to high resource facilities (direct flow). As such, these pairs are comprised of a secondary sender and a tertiary receiver. The reverse flow (indirect flow) of patients from the tertiary DHB to the secondary DHB is less than 2% of the level of transfer compared to that of the direct flow. An indirect flow still occurs due to the need for transfers to palliative care and sending patients to facilities closer to family and support networks when specialist care has been completed. By narrowing the focus of this study to regional DHB pairs with a one-way flow of patients, it may be possible to control for unobservable variables more effectively. *Cost weight* is included in each regression as a measure of hospital cost as well as a full set of control variables for demographic and social effects.

This research is investigative in nature, owing to the conflicting mechanisms which influence patient transfer discussed below. Health outcomes can have profound economic impacts with increased readmissions and complications from inadequate care costing taxpayers and increasing hospital workloads. There are three likely outcomes: (1) the policy change increases patient transfer to tertiary hospitals and there is no evidence of adverse patient outcomes, (2) the policy change decreases patient transfer to tertiary hospitals and there is evidence of adverse patient outcomes, (3) no evidence of a change in transfer or patient health outcomes. Outcome (1) implies that the policy change has worked effectively to align financial incentives with patient care and suggests that introducing an explicit set of transfer prices reduces unnecessary transfer. Outcome (2) implies that the policy change has unintended adverse effects that should be recognised and resolved. This scenario implies that the cost of transfer is so high as to discourage necessary transfer. Outcome (3) implies that the policy has no impact on the transfer decision, suggesting that cost does not affect the transfer decision or that the previous costing system was already efficient in design. With a more focussed study of DHBs and individual diagnosis analysis, I may be able to better identify effects of transfer on patient health outcomes.

My findings mostly confirm hypothesised outcome (1). I find that after the change in transfer funding the probability of overall transfer decreases, but probability of transfer to a tertiary DHB increases. This demonstrates a focussing of the transfer decision to those patients who are most in need of specialist services. This encourages a more efficient flow of funds to

specialist providers and reduces the probability of unnecessary transfer. The health outcomes analysed deteriorate after the policy change, however there is notable variation in these results. This can be attributed to a relative increase in the probability of severe patient transfer as a result of the focussing effect discussed above.

The rest of this thesis is organised as follows: Section 2 briefly reviews the history of the New Zealand health system with emphasis on institutional units, funding mechanisms and transfer policy. Section 3 describes the literature related to this study. Section 4 describes the data used and how it has been processed. Section 5 presents the methodology and econometric framework for this study. The National results and discussion are presented in Section 6, followed by the DHB pairs in Section 7 and Robustness Checks in Section 8. Conclusions in Section 9 and recommendations and limitations are outlined in Section 10. A list of key terms and definitions can be found in the index.

2. New Zealand Health System Background

2. 1 Introduction

Since the development of the General Medical Service benefits in 1941, New Zealand healthcare has operated on a dual public-private provision basis. Primary care is predominantly private while most hospital care in New Zealand is publicly funded through the general tax portfolio *VoteHealth*. This public funding removes patient selection thus reducing the reputation effect that commonly occurs in competing hospitals. This characteristic sets New Zealand apart from the US healthcare model and a Bismarckian framework such as Germany's. On the provider side, there is no scope for patient refusal. When a patient presents for care, regardless of funding or geographic location, the hospital is obliged to provide treatment.

2.2 Early Developments and the Quasi-Market Approach

There has been a constant raft of changes in health policy since the 1970s (Quin, 2009). Due to medical advancements leading up to the 1970s and the full funding of the hospital system by the New Zealand government, there were large increases in waiting lists leading to wide spread dissatisfaction. 1983 saw the introduction of fourteen Area Health Boards (AHBs) and New Zealand's first attempt at decentralisation. This coincided with the first attempt at using a population-based capitation system, calculated using a PBFF.

Only ten years later, policy changed again with the establishment of four Regional Health Authorities (RHAs). Meanwhile, the AHBs multiplied into 23 Crown Health Enterprises (CHEs). The intention of this change was to introduce competition among CHEs for cost-efficiency purposes and after a few years of adjustment to the contracting format, Ashton, Cumming and McLean (2004) found that this approach focussed healthcare provision toward cost control. This was arguably the main aim of this round of policy changes. Around the same time, the Department of Health was replaced by the Ministry of Health (MoH). Four years later, in 1997, the four RHAs merged to create one national purchasing agency called the Health Funding Authority (HFA) and the CHEs became not-for-profit Hospital Health Services (HHSs) in a move toward collaboration rather than competition. Throughout these changes there was a distinct split between service purchasing and provision. This period of competition from 1993 is viewed

by many as a step in the wrong direction (Ashton, Mays, & Devlin, 2005). Three reasons for the perceived failure of this system were put forward by Ashton and McLean (2001): weak budget constraints, the absence of competitive pressure, and, that resource decisions were made by doctors rather than funding managers.

A study by Pearce and Dorling (2006) shows that large geographic inequalities in health emerged between 1980 to 2001. Although there were overall declines in mortality, large geographical discrepancies in health improvements arose. Mechanisms for this increase in inequality include income inequality, ethnic distribution, migration patterns and access to healthcare. The latter was addressed in 2000, with the New Zealand Public Health and Disability Act. Twenty-one DHBs were established as a second attempt at decentralisation and the healthcare purchaser and provider functions were combined. For the duration of the changeover the PBFF was discontinued and services were provided on a Fee-for-Service basis; a renovated PBFF was introduced in 2003 (Penno, Audas, & Gauld, 2012).

2.3 Current System (2001 onward)

The current health system is organised into twenty DHBs as the Southland and Otago DHBs merged in May 2010. Figure 1 shows the boundaries for each of the twenty DHBS. This decentralised layout allows for locally tailored care but can reduce collaboration between units as communication becomes more fractured (Tenbensel, Mays, & Cumming, 2011). This is particularly evident in the variation of software used by DHBs, as Van Kesteren, Fowler, and Bates (2017) point out. This can have detrimental effects on the data provided to the MoH when

Figure 1 District Health Board location boundaries map

Source: Ministry of Health (2017b)

setting National Prices. DHBs vary in size with populations between 30,000 and 500,000. They also vary in service capacity and number of service providers. Canterbury DHB has fourteen service providers ranging from high-level tertiary hospitals to small health centres, while five of the twenty DHBs only have one service provider within the district. Four DHBs have a high-level tertiary hospital with another two DHBs housing "borderline" tertiary hospitals. Tertiary hospitals provide specialist services, such as National Services, or frequently transferred services. A national service is the specialisation of a service that is too expensive or infrequent to provide locally such as solid organ transplant and paediatric rheumatology. When funding is initially allocated to DHBs, a portion of this funding is then returned to the MoH and redistributed to the selected service provider/s of the national service. Service provision for National Services is conducted on a contract basis between the selected DHB and the MoH. These services are not subject to IDF payments as the funding has already been separately allocated and is accounted for by the National Cost Calculation and Pricing Programme (Ministry of Health, 2013, p. 82). This provides an additional framework to the transfer system. A flow diagram of the New Zealand healthcare system is displayed in Appendix 1.

Each DHB has up to eleven members, four of which can be chosen by the Minister of Health for reasons such as skill, experience or for fairer representation of members of the district. Elected members are chosen by public vote of the population of their district and they then serve a term of three years which can be repeated twice for a total of nine years in the position. Board meetings are held in view of the public and all discourse is disclosed. From their introduction in 2000, the DHBs have exceeded expectations. There is a clear link between the size of the DHB's population and the level of engagement. Smaller DHBs were able to involve their local population to a much greater degree from the beginning where larger DHBs took three to four years to achieve the same level of engagement (Mays, Cumming, & Tenbensel, 2007).

Although the reforms in 2000 moved away from a competitive system, there are still concerns regarding the level of autonomy provided to DHBs. A study done by Ashton suggests that although the change improved regional equality, the MoH constrains the decision-making ability of the DHBs to a set of "National health and disability strategies" (2008, p. 110). They find that DHBs have maintained a strong cost-focus despite the shift away from a competitive

framework and that combining the purchasing and provision activities has led to a bias toward purchaser provision of services. This first finding is echoed in research done by Coster, Mays, Scott, and Cumming using document analysis and key interviews to analyse the traction of Health Needs Assessment (HNA) in District Strategic Planning processes. They find that the DHBs were not making full use of the HNA tool and had little need to. Much of the funding they received was already earmarked and what little was leftover was directed by central government into "the Government's priority objectives" regardless of whether these aligned with local need (2009, p. 284).

2.4 Population Based Funding Formula

Funding in New Zealand is provided mainly though general tax and is distributed using the PBFF (Penno et al., 2012). This is a form of capitation funding, with each resident allocated funding based on age, gender, ethnicity and a measure of socioeconomic depravation (Quintiles 1-5). Funding per capita is provided based on census information, thus the migratory nature of residents and infrequency of census data can complicate service provision. To account for portions of the population that, historically, tend to demand more healthcare, adjusters are included. The adjusters add funding to DHBs based on unmet need, ruralness, overseas visitors and tertiary provision. The tertiary adjuster is directly linked to the IDF transfer discussed later in this section. Given the demographic distribution across New Zealand, funding allocations tend to be unevenly distributed. Urban/city areas, where incomes are higher and socioeconomic depravation is lower, tend to receive less PBFF funding while small and rural areas tend to receive higher levels of funding and adjustments (Shin, 2013). This allocation is then amplified as the low-funded districts tend to house specialist and tertiary healthcare providers while the high-funded districts tend to have fewer and less-equipped healthcare providers. This highlights the need for redistribution through IDF payments.

Diagnosis Related Groupings (DRG) are the smallest unit of measurement used to group health events into a diagnosis group for data recording and input cost purposes. This data then provides the basis of the weighting system used by a DHB to assign funding for a healthcare event given the overall funding provided by the MoH. In the current version of the Australian Refined DRG system (v7.0) there are 771 DRGs and 406 Adjacent DRGs. The version used in

this research is the base version 3.0, as this data has been recorded consistently throughout the sample period. There are 1,140 DRGs defined in v3.0. Although New Zealand utilises the Australian system, there are similar DRG-Casemix systems used in England, Canada, Ireland and the Netherlands (Rains & Thompson, 2015). Section 3.5 further discusses DRG coarseness, one of the main drawbacks of DRGs as a unit of measurement.

2.5 Inter-District Flow Transfers

Section 7.1.3 of the Operational Policy Framework defines the criteria for an IDF as follows:

> *An IDF occurs when:*
>
> a. *an eligible person receives treatment*
>
> ***and***
>
> b. *the DHB of Service is not the DHB of Domicile for that person.*

Ministry of Health (2013, p. 73)

There are two main sub-groups of IDFs. The first occurs when a patient is out of their District of Domicile (DoD) at the time of a medical emergency and is therefore treated in a different District of Service (DoS). An example of this is an individual from Auckland going to Christchurch on holiday, breaking an arm and receiving treatment at Christchurch Hospital rather than being flown back to Auckland to receive treatment at Auckland Hospital. Auckland DHB records this as an IDF and this healthcare event is added to the gross outflow of transfers for end of period payment, as set out by the National Cost Collection Pricing program (NCCP) (Ministry of Health NHB Capital and Operating, 2014, p. 11). The second is an *intentional* transfer from the DoD to a different DoS based on the need for specialist or extensive treatment, of which the DoD is not capable. An example of this might be a patient from Whangarei who presents with severe brain trauma at Whangarei Hospital. The hospital is not equipped to treat this patient and refers them to Auckland Hospital for treatment. Whangarei Hospital then records this as an IDF and adds it to gross outflow just as in the former case. The OPF sets out clearly that DHBs providing specialist services are mandated to provide care equally across DHBs, accepting transfers regardless of demographics, origin or wealth (Ministry of Health, 2013, p. 82).

The calculation of funding allocations is done in advance based on historical transfer patterns between DHBs. Hypothetically, each DHB in New Zealand has an expected flow of patients with the 19 other DHBs. As per Section 7.2.4 of the Operating Policy Framework, the arrangements between DHBs can follow a standard contract outlined by the MoH or these guidelines can be overruled by individual DHB agreements (Ministry of Health, 2013, p. 79). The actual IDFs are then confirmed with a lag of up to two years. This causes significant issues with "wash up" payments to adjust for the difference between predicted and actual patient flows. The National Minimum Data Set (NMDS) IDF values for the agreed period are provided to the DoD and DoS and it is the responsibility of the respective DHBs to review the volumes within two weeks. The DHBs decide if additional payment is needed or if predicted volumes were overestimated. Finally, DHB IDF volumes are aggregated nationally and the net flows are transferred to each DHB. A lot of the uncertainty surrounding the discrepancy between predicted flow and actual flow of transfers is borne by the receiver who is left to chase up payment over a short time frame and ensure that *ex-ante* agreed upon flows are set at reasonable levels (Ashton 2007).

2. 6 Changes Since the New Zealand Public Health and Disability Act 2000

Since the 2001 reforms, changes have been made to target the efficiency and value for money of the new system; such as a move toward performance measurement (Perkins & Seddon, 2006). These changes, implemented from 2008, saw the establishment of overarching institutions aimed at clinical engagement, productivity improvement and service access. Although achieving these goals, the new administrations were seen to be introducing unnecessary bureaucracy and complicating communication and collaboration between DHBs (Gauld, 2012). Adjacent to the changes made to public secondary healthcare, in 2001 reforms were introduced to the primary healthcare sector with an aim to gain full public provision. These changes lasted only thirteen months. The existing primary providers fought against the new policy and instead worked to adapt the Primary Health Organisation structure so that it magnified the existing hold private providers had in the market (Gauld, 2008). These primary care changes protected the high costs of private care and redirected healthcare demand to public providers, placing stress on newly capped budgets. We are still today feeling these negative effects of a mostly private primary system (Ministry of Health, 2017a).

Even with all the policy changes there are still those that argue that underlying service provision has remained stable throughout. Devlin, Maynard, and Mays (2001) believe that the 2000 reform takes New Zealand back to the pre-competitive system where AHBs worked in a similar decentralised fashion. In a later paper with Ashton and Mays, Devlin goes further to say that structural, legal and distributional changes did not affect healthcare provision at all (2005). As an end user of the system, payment choice between private insurance or public free healthcare remains the same, free healthcare is still funded by general tax and outpatient services are still free. Doctors and nurses are still remunerated in the same way and the division of labour between them remains largely unchanged. Newly defined purchasing authorities continue to use existing contracts with service providers due to need for the existing services. Any expected efficiencies from mixed private/public provision and potential technological development have not yet occurred. Given the time elapsed since this analysis, I aim to evaluate one small segment of these changes to identify any material differences in the provision of healthcare services for transfer patients in New Zealand.

3. Literature Review

This study combines areas of previous research spanning hospital transfers, transfer patient outcomes, hospital specialisation, payment systems and DRG coarseness. It ties these areas of research together as I analyse DHB hospital transfers to specialist facilities and the associated cost and health outcomes from the policy change to IDF payment. In each of the following subsections I analyse a portion of the literature and its relevance to the current research question.

The foundation of my work is Shin's doctoral thesis (2013). In one of three essays, she explores the IDF transfer mechanism and its effect on patient flows between the DHBs. Shin argues that the PBFF weights funding more heavily to poorer, lower socioeconomic areas where there is less likely to be a tertiary hospital. Conversely, tertiary hospitals are more likely to be located in richer, higher socioeconomic areas. The funding should be redistributed to fund tertiary hospitals when patients are transferred from the higher funded, poorer areas to the tertiary DHB. If attaching an explicit cost to patient transfer decreases the incentive to send patients to tertiaries, then this redistribution of funds will not occur. This will mean tertiaries, with specialist human and physical capital may not be able to cover the higher costs they incur running their facilities. Overall IDFs decreased after the policy change, more notably among patients with high Complexity Comorbidity Levels (CCL). This is not necessarily due to the implementation of priced-transfer, as IDFs are made up of both transfers between hospitals and patients treated while naturally outside of their DoD. However, there is a selective pattern of mid-range complexity transfers after the policy change. Thus, fatal and highly severe patients are still transferred to the tertiary DHB, while serious but non-fatal incidents are more likely to be retained by the secondary DHB. Shin argues that a combination of increases in readmission rates and decreases in length of stay suggest premature discharge of transfer patients and more frequent readmission. However, there is no clear pattern in mortality throughout the period analysed.

Regarding the period under investigation, Shin acknowledges a subsequent round of policy changes in 2008 and their influence on the analysis, as well as a robustness check excluding 1999-2000 as this was under the old Hospital and Health Services framework. Shin concludes

that the evidence of moderate to high CCL cases being retained at secondary DHBs indicates that necessary transfers are not taking place. Furthermore, that the reduction in transfer suggests that the anticipated redistribution of funds from secondary to tertiary DHBs does not occur to the anticipated extent. I elaborate on this work in three ways. Firstly, I introduce a regional study to better understand isolated flows of patients from secondary to tertiary facilities. This will help to understand whether the overall national pattern is reflected at a regional level. I also modify the control variables used, where Shin uses regional income and unemployment statistics, I apply individual educational achievement. And finally, I modify the time period analysed to exclude the previous HFA structure and the future 2008 policy changes.

3.1 Transfer Process and Decision Making

Most countries or individual hospitals have a process for effective patient transfer. The American College of Emergency Physicians suggests that most patient transfer should be standardised. Where possible, agreements should be made between sending and receiving hospitals for specialised care that allows routine transfer to take place. Prior to transfer, key staff should be identified as responsible for the transfer, patient information should be clearly communicated to the receiver and the receiving hospital should confirm acceptance of the transfer (American College of Emergency Physicians, 1997). As the level of transfers in New Zealand is necessary for the redistribution of funds, the procedural aspect of transfer management plays a key role in encouraging transfers. Interviews at three US community hospitals investigating the transfer process concluded that there are four key stages of transfer. (1) Identifying patients eligible for transfer, (2) finding destination hospitals, (3) agreement of transfer and, (4) carrying out the transfer. Key mechanisms to expedite this process include triage and transfer skill of staff, implementing protocol for frequent transfer diagnoses and informal arrangements with key referring sites. A key challenge identified that is especially pertinent for the current study is the opacity surrounding borderline cases. Staff found that cases in which the referring physician believes transfer was appropriate, but the receiving physician did not were particularly time-consuming and detrimental to patient health (Bosk, Veinot, & Iwashnya, 2011). This is reflected in the New Zealand setting through CCL assignment. Borderline transfer cases may occur when the patient's case is treatable using the

facilities at the secondary hospital, but a high CCL could convince the referring physician to recommend transfer to a tertiary hospital. To this end, Warren, Fromm, Orr, Rotella, and Horst (2004) believe that over and above regulation around transfer, set transfer processes for each diagnosis will improve the safety and health outcomes of the patients. In the study of critical care patients, they find effective transfer plans are often reviewed and staff are trained in transfer processes. Meanwhile in Sydney the same theme of clear and standardised transfer is reflected in a colour-coded system indicating the level of need for transfer. Over three months staff were trained to use the colour-coded system resulting in a 14% decrease in inappropriate transfer. By using treatment, age, physiology and diagnosis as parameters for the transfer decision, clinical staff were able to determine how, when and by whom patients should be transferred (Lee, Lum, Beehan, & Hillman, 1996).

An example in the UK focusses on the practical aspects of transfer including transport, staff and equipment. In a postal survey sent to UK emergency departments (56% return rate) just under half of Emergency Department staff responded that they were unaware of critical care transfer guidelines even though these have been developed in the UK alongside networks for transfer. Although the study is limited to emergency departments, it suggests that the transfer system designed in the UK is under-utilised with the exception of paediatrics where access to transfer resources is readily available (Stevenson, Fiddler, Craig, & Gray, 2005). Although not part of the transfer decision-making process, these factors indicate that transferring a patient from one healthcare provider to another is not a decision taken lightly. One study of the Kansas University Medical Centre looks at the use of a transfer centre to streamline the process at a *receiving* specialist hospital. This method outsources the transfer process to a central call centre where there is team of people devoted to organising and accepting transfers. They communicate with the relevant departments within the hospital and ensure that the patients receive the best possible care. This avoids taking up physician time and delaying patient transfer due to cooperation issues (Strickler, Amor, & McLellan, 2003). In New Zealand such arrangements are organised at the DHB level, with transfer agreements adapted to suit the specific pair of DHBs in question (Ministry of Health, 2013). To this end, the analysis of regional pairs will more accurately reflect any efficiencies to be gained from standardising transfers or creating a predetermined network of transfer hospitals.

It is important to distinguish the difference between protocols outlining the transfer of patients physically between healthcare providers and the decision to transfer the patient in the first place. This is often much more challenging and not as easily standardised. In the United States more than half of transfer decisions were initiated by the patient. Patients are not always able to observe the same metrics as physicians and academics when assessing facility suitability for the level of care needed. Where the latter will assess specialised care, hospital volume or teaching status, patients focus on more subjective metrics like communication by physicians, perceived medical error and past experiences. This leads to a negative view of smaller non-specialist hospitals. Patients may believe tertiary centres are of a higher quality due to expertise and volume of patients, regardless of whether it is necessary for the treatment of their diagnosis (Dy, Rubin, & Lehmann, 2005). In New Zealand patient choice does not influence the transfer decision, and as many of these papers suggest, the referring physician is solely responsible for transfer. Green, Showstack, Rennie and Goldman (2005) investigate the determinants of transfer in a study of transfer patients in California. They conclude that insurance status, age, sex and race largely explain the inequality of opportunity for transfer. Individuals with poor insurance are more often admitted to publicly-owned hospitals, at 67% of total admissions, while only 14% of privately-owned hospital admissions were poor payers. On average 85% of hospital admissions are good payers, suggesting that those with high levels of insurance are more likely to receive treatment. There is a clear disincentive, especially for private for-profit hospitals to accept transfers with low levels of insurance as they are not likely to be reimbursed for what is already a higher-cost patient.

The transfer of patients in New Zealand is entirely up to the judgement of the physician relative to the care needed for the patient with no scope for wealth to affect the level or location of treatment. There is no standardised protocol as to which hospital a patient is referred to, and many of the DHBs have unique agreements with one another regarding patient transfers (Ministry of Health, 2013). Furthermore, the public funding of the New Zealand health care system removes any bias caused by insurance provision and wealth. Overall this ensures a more equitable distribution of transfers. From a physician's stand point the main reason for transfer is that the patient can receive superior care at another facility, care that is not able to be provided locally due to time, resource or physician skill constraints. This manifests as a sizeable transfer bias to tertiary and specialist hospitals.

3.2 Transfer Effects

Being transferred affects a patient's health outcomes but also the cost and performance measures of the hospital at which they are treated. Due to the systematic transfer of patients to more capable care facilities, these facilities routinely experience higher costs per case and performance-based metrics suffer. The earliest academic example of this is a 1988 study of Medicare patients in the United States where they find a 37.5% higher cost on average for transfer patients compared to routine admissions (Jencks & Bobula, 1988). Since then others have noticed the same cost effects. Using Veterans Affairs beneficiaries, Pietz, Byrne, Daw and Petersen (2007) explores the same increased costs among transfers in a capitation based system. Compared to routinely admitted patients, transfers produce a loss of US$1231 to the tertiary centre, a figure that doubles for referrals. Closer to home, Shin's first doctoral essay identifies a reduction in performance measures for tertiary DHBs in the New Zealand capitation system; higher complexity of transfer, a 22 day increase in length of stay and a 5% increase in mortality for transfer patients (2013). This places an increased burden on the healthcare system as patients stay longer and are readmitted more often. I investigate whether there is cause to believe that the introduction of IDF payments has resulted in a worsening of patient outcomes or an increase in unnecessary transfers that may result in increased healthcare costs.

Increased costs associated with transfer patients are explicitly linked with resource use. One study shows transfer status is the best predictor of resource use in the university hospital at the University of Michigan consistently over a four-year period. Transfers are 18% more likely to be length of stay outliers and 6.9% more likely to suffer in-hospital death (Bernard, Hayward, Rosevear, McMahon, & Chun, 1996). Another study finds the same inferior health outcomes for transfer patients in academic medical centres across America where transfers are 2.3% more likely to die within 48 hours of admission and their average length of stay is 60% longer than routine admissions (Sokol-Hessner, White, Davis, Herzig, & Hohmann, 2016). This is not to say that transfers are treated differently to routine admissions but rather that these cases are worse to begin with and, as such, necessitate transfer. This phenomenon is recounted by Rosenberg, Hofer, Strachan, Watts, and Hayward (2003) who find that length of stay is 41% longer, odds of death 2.2 times higher and severity measures are significantly worse for transfers. Further, the concentration of transfer patients at selected hospitals where advanced

treatment is available meant that these hospitals suffered from poorer quality standards as reflected in their patient outcome statistics. This conclusion is supported by a large scale study carried out recently using the 2009 US Nationwide Inpatient Sample identified 1,397,712 transfers of a total 33,089,923 patients and compared transfer and routine patient health outcomes. Transfers had double the risk-adjusted inpatient mortality, and average length of stay of 13.3 days compared to 4.2 days and a much higher probability of in-hospital adverse events (Hernandez-Boussard, Davies, McDonald, & Wang, 2017). The paper recommends that a measurement of transfer status needs to be included in the performance standards of a hospital if quality is to be assessed accurately. In the United States benchmarking based on hospital quality plays an important role in competitiveness with an insurer-based system and a large number of privately funded hospitals. In New Zealand the concern is not regarding the selection effect of quality benchmarking but rather the funding associated with both financial and non-financial measurements of quality by the MoH (Ministry of Health, 2018a). It is for this reason that I chose to include *length of stay*, *30-day mortality* and *readmission* as outcome measures. As transfers differ markedly from routine admissions, changes in health outcomes tell us about the tangible impacts of the policy change.

Finally, it is worth noting that these effects are also observed in a range of common, case specific situations. A study in 1999 looked at the characteristics of heart attack patients that were transferred to acute care hospitals in Michigan from 1994-1995 (Mehta, Stalhandske, McCargar, Ruane, & Eagle, 1999). Interestingly, their findings show the opposite effects from all the other papers. They identify the specific characteristics of transfer patients and find wealthier, less sick patients are more often transferred. They also find that patients with higher comorbidity are not transferred. This more naturally fits with the explanation linked to patient-driven transfer and, as such does not apply to the New Zealand context. It does however provide an interesting comparison and arguably suggests the New Zealand system works more effectively to ensure the provision of service to those who need it most rather than those who can most easily afford it. Two alternative studies look at specific diagnoses and transfer effects. One studies a Medicaid population looking at children in critical care and the other a tertiary care centre looking at hip fracture transfer. Both find that transfer patients use more resources, incur worse patient outcomes and reflect badly on hospital quality ratings (Odetola, Davis, Cohn, & Clark, 2009; Wiggers, Guitton, Smith, Vrahas, & Ring, 2011). These are cases

where complications are common and comorbidities are likely due to very young or very old age, and in turn specialist treatment is necessary. Specialisation therefore is closely linked with proclivity for transfer. This forms the motivation for my robustness checks in circulatory disease (see Section 8).

3.3 SPECIALISATION

Specialisation is characterised by having the physical and human capital necessary to treat a specific diagnosis or group of diagnoses. Logically, these types of hospitals are often centrally located in large cities that are easy to access as part of a network of hospitals. In this research, the three tertiary DHBs (Auckland, Waikato and Capital&Coast) are indeed in main cities with central locations and larger populations. The nature of these cities makes the hospitals within them natural choices for tertiary services. National Medicare claims from 2005 suggest that 40.7% of variation in hospital location can be explained by hospital characteristics such as surgical and medical capability as well as size, physical resources and medical school affiliations (Iwashnya, Christie, Moody, Kahn, & Asch, 2009).

Dudley, Johansen, Brand, Rennie, and Milstein (2000) argue that high volume hospitals are systematically better than low volume hospitals with improved mortality outcomes across a range of studies they review. In their observational study, referring patients with more severe cases of a specific diagnosis to a high-volume hospital has the potential to avoid a "significant number of deaths". From a policy position, a selective referral programme that sorts patients into high severity and low severity cases and then allocates them to high-volume and low volume hospitals respectively may help to improve outcomes overall. The obvious criticism of this conclusion is that referral from the low volume hospital gives that hospital no chance to practice or improve. The diagnoses discussed in the paper are all cases treatable at either the low or high volume hospitals, the difference being that the high-volume hospitals display improved outcomes. However, a more thorough study on orthopaedic surgery in Medicare patients shows that even after adjusting for patient characteristics and frequency of surgery, specialist hospitals outperformed "standard" hospitals. This controls for the high-volume argument of "practice makes perfect" and instead suggests that alternative factors such as level of support care or increased resource influences patient outcomes. The study splits

hospitals into quintiles, where the highest fifth is most specialised and the lowest fifth is least specialised, and the odds of adjusted mortality are 1.60 times worse in the lowest fifth compared with the highest (Hagen,Vaughan-Sarrazin, & Cram, 2010). A drawback of Hagen's study is the use of Medicare data which limits the population of study almost entirely to individuals over the age of 65. Clark and Huckman (2012) use the National Inpatient Sample to analyse healthcare spillovers and complementarities in cardiovascular care. They find that there are significant benefits to associated areas of treatment when a hospital specialises in a selected treatment. This introduces the concept of related diversification which they believe is more beneficial than a hospital that pigeonholes into only one healthcare service. This is evident in their results as the *related areas of treatment* variable is statistically significant and negatively correlated with mortality rate. This bodes well for tertiary hospitals throughout New Zealand. They not only provide specialist services but also maintain the services of a "regular" hospital. Clark argues that this would make them better at these services as well as the specialist services they provide.

The link between efficiency and specialisation is displayed again in an Italian study assessing the introduction of DRGs and a prospective payment system. In a notably technical paper, the provision of healthcare is modelled using a distance function approach with stochastic frontier techniques. The study concludes that there is scope for further economies of scale. This is largely due to overstaffing and the potential for reallocation of resources which is particularly evident in private hospitals (Daidone & D'Amico, 2009). The New Zealand system is currently divided; it is a decentralised system of healthcare provision but provision for severe and complex illness is central. This paper makes the argument for the centralisation of specialist care. However, there is enough literature to suggest that worse patient outcomes and higher costs would make transfer patients an unappealing prospect for a specialist hospital. Indeed, papers by Gordon and Rosenthal (1996) and Shin, Schumacher, and Feess (2017) argue that those hospitals that are geared toward specialist treatment are not appropriately compensated. Shin et al. (2017) suggests this is because tertiary hospitals receive the most complicated cases as well as the highest volume of cases. A negative correlation between tertiary hospitals and case funding illustrates lower average funding for high-skill providers. While Gordon and Rosenthal (1996) conclude that the higher severity of transfer patients, if not adjusted for, could discourage tertiary providers from accepting transfers altogether. This

is similarly the case for this research. Prior to the policy change, funds were not being fairly allocated or reallocated to the hospitals at which transfer patients were being treated. It brings us to a discussion on payment incentives and behaviour.

3.4 Payment Behaviour

In New Zealand tertiary providers treat not only more complicated cases with costs above the average in a given cost weight but also tend to treat more patients than secondary providers. The IDF system reallocates the regional funding to these tertiary providers, but does so on a national pricing level with a fixed dollar amount allocated for the treatment of a given DRG. This skews payment behaviour in favour of secondary DHBs who have lower cost cases (Shin et al., 2017). The actual calculation process used for the allocation of funds in New Zealand is still relatively unclear. The main analysis is made up of four cost weight factors: age, sex, deprivation and ethnicity. Followed by three adjusters: rural, unmet need and overseas. Census data is used to process these factors for five different areas of health: Personal Health Other, Personal Health Primary, Mental Health, Health of Older People and Psycho-geriatric Services; and funding is then allocated regionally. Penno et al., (2012) review this calculation process and, in particular, note that Maori population funding is often underestimated when compared to actual costs of health provision and that even after ten years using the PBFF, half of the DHBs across the country are still running deficits. This indicates that there is significant inaccuracy in the allocation of funds to areas where it is needed most.

A population-based method of funding is not unique to New Zealand, there are also examples in the United Kingdom and Canada. In 1994, a review of the British funding method revealed, similarly to New Zealand, that funds were not being allocated to the geographic locations where they were needed the most. Carr-Hill et al. (1994) use the definition of healthcare supply versus health use to isolate the effects of supply on the use of healthcare. If we evaluate the healthcare use, or pure demand for healthcare, the distribution of NHS funds changes significantly in favour of poorer geographic areas. A drawback of the British study is its use of small area analysis. This limits the applicability of the formula to wider country-level funding distributions.

Canada on the other hand has been through a substantial overhaul of its healthcare system since the early 1990's. The structure, issues and aims of the Canadian healthcare system are very similar to New Zealand's. Weaver's masters research describes a widespread search for solutions to high expenditure in the healthcare sector with all provinces, except Ontario, adopting some form of regionalisation approach. The study of British Columbia's move to a regional method of healthcare funding and decision making suggests that restructuring runs the risk of reorganising the method of provision without solving any of the underlying issues with the pre-1990s system. Weaver finds no significant change in expenditure but his analysis shows promising improvements in four out of five "problem areas" in British Columbia (Weaver, 2006). Ontario's exception to regionalisation was studied in detail in 2000 where the idea of capitation funding was more closely analysed by Bedard. Using a funding formula and sensitivity analysis he concluded that minor adjustments to the formula significantly change the distribution of funding and it is therefore unclear which formula, under which conditions, would be considered fair or equitable (Bedard, Dorland, Gregory, & Roberts, 2000). The most common method of funding in Canada prior to the 1990's reforms is historic utilisation. A major flaw with this approach is a lack of control for demographics and lags in data provision for accurate funding allocation. Three regions of Canada: Saskatchewan, Quebec and Alberta adopted fully-fledged population needs-based funding formula (PNBF). Newfoundland and Laborador adopted a partial PNBF within the regions of the province. In all cases, a clear synergy is created linking the use of PNBF and the regionalisation process (McIntosh, 2010). Similarly, in New Zealand the switch to the PBFF is linked with the decentralisation of healthcare purchasing and provision to the 20 DHBs. Compared with Canada, a key difference is the simple structure of the New Zealand system, under which the entire country follows the same structure as a single province in Canada.

This simplicity is further emphasised when comparing New Zealand healthcare with Germany. In a literature review of the differences in healthcare planning, one major difference is the central planning approach of the MoH compared to Germany's fragmented planning in a federal structure (Ettelt, Fazekas, Mays, & Nolte, 2012). As with the Canadian comparison, the size of New Zealand both in population and geography make healthcare provision by a central authority more straightforward. That's not to say that payment behaviour in Germany is dysfunctional. A study on anaesthesia services looking at the impact of transfer pricing finds

that efficiency improved after the introduction of a transfer pricing mechanism. The surgical unit of a German University Hospital implemented transfer pricing for anaesthesia services. As anaesthesia services are particularly labour intensive, the researchers used the labour margin of the anaesthesiologist to define a measure of efficiency on both the part of the surgeon and the anaesthesiologist. Assuming each actor has the financial interests of their unit as a priority each will try to maximise their own payment portion. They found that both the surgeon and the anaesthesiologist improved efficiency after the transfer mechanism was implemented (Kuntz, 2005). This reflects the ability of payment structure to significantly affect the behaviour of health care providers. This includes the use of capped budgets. Germany turned away from hospital reimbursement and toward capped hospital budgets in the 1990's. One small hospital provided data from 1989 to 2003 allowing researchers to analyse the capping of budgets in 1993 and the subsequent tightening of these budgets in 1996. They find that the frequency of high-severity patients decreases by a mean of 2.57% post-1996. This implies that this hospital actively sought out lower risk patients, with the authors suggesting a mix of risk-selection activity and better matching of provider ability and patient illness. It illustrates a common point in capitation systems: a focus on cost reduction through low-cost resource selection and low-severity patient selection (Ernst & Szczesny, 2008).

The final examples of payment behaviour come from the United States. Similar to the capping behaviour observed in Germany, a study of hospitals in Washington reveals that there is an incentive to overstate expected volume increases or understate expected volume decreases. The 1970's Washington State system placed an upper bound on hospital budgets, such that revenue should equal total patient volume in turn equalling total cost. Hospitals then submit their expected volumes to the Washington State Hospital Commission for the coming year. Blanchard, Chow, and Noreen (1986) suggest that lingering fixed costs may go some way to explaining the results rather than the incentives stated above. However, this is fundamentally an agency problem where hospitals choose to act in their own interests, maximising private profits as opposed to decreasing state-wide healthcare costs. In 1988, an exogenous policy change modified the prices for 40% of DRGs across the United States implying that certain DRGs became more profitable than others. Using Medicare data, Dafny concludes that hospitals responded to these DRG changes by "upcoding" patients to more profitable DRGs and away from less profitable ones. Reassuringly, they find no significant effects on admission

levels or treatment policies suggesting that hospitals did not actively seek out high-paying DRG cases (Dafny, 2005). This paper highlights the flexibility of DRGs and a unit of diagnosis, monitoring and cost. As the DRG is the smallest unit we use to differentiate between illnesses and allocate costs to treat them there is concern that they can be manipulated and, as other papers reflect, are susceptible to "coarseness".

3.5 DRG Coarseness

Payments associated with a DRG is an average cost of the procedure across a wide sample of cases. As such, there is scope for more expensive cases within a diagnosis as well as less expensive cases within the diagnosis. One way for hospitals to reduce cost and increase profits is to specialise in a DRG for which they have relatively low costs of production. A second option is to only accept patients within a specific DRG whose costs lie below the average cost within that DRG. Dranove (1987) finds extensive differences in casemix for a DRG with 16% of DRG standard deviations exceeding their averages across three Chicago hospitals. He models the hospital and regulator choices under the two options above and finds that the optimal system of rate setting occurs with a larger number of more narrowly-defined DRGs. A more recent study of Medicare patients suggests that this issue has not been resolved, with half of the variation in costs explained by inter-DRG differences and the other half explained by intra-DRG differences (Lynk, 2001). The attraction of more expensive patients within a DRG to more specialised hospitals reinforces work by Shin et al. (2017) as well as the transfer effects discussed above. In New Zealand, Rouse, Arulambalam, Correa, and Ullman (2010) use 67 cardiac DRGs to define secondary from tertiary DRGs using a complexity proxy. They also note the difficulty stemming from the coarseness of DRG classifications and the variation this creates in hospital reimbursements.

This research relies on the identification of changing transfer behaviour subject to changes in costing. This costing is done based on DRG classifications. As such, it is important to understand that the coarseness of even the smallest unit of costing may affect the clarity of the outcomes in this study. In an attempt to refine some of these outcomes, Section 8 discusses robustness checks of three DRG subsamples to investigate whether costing patterns are consistent within

a DRG. This is particularly important, as highlighted in the papers above, for specialist hospitals who, on average, deal with patient DRGs above average cost.

4. Data Description

The data used for this analysis is managed by Statistics New Zealand (SNZ) in the Integrated Data Infrastructure (IDI). I use subsets of three different datasets stored within the IDI: Publicly Funded Hospital Discharges, Mortality Registrations and Ministry of Education (MoE) Completions. Overall there are 4,431,183 observations over 1,472,037 patients and 48 facilities for the period between the 30th of June 2000 and the 1st of July 2008. Prior to the year 2000, the original capitation system was in force and the health system was organised under the Health Funding Authority. This was temporarily suspended in favour of contracted healthcare provision until the 1st of July 2003. The end date for the period analysed is determined by a subsequent set of policy changes that took place in the second half of 2008 (Gauld, 2012). The previous study by Shin extends the data to 2011 and these additional policy changes may influence the transfer cost effects.

The IDI allows me to track an individual across datasets. In this sense, I am able to observe their medical information such as admission dates, DHB of domicile and service, diagnoses and demographic statistics while matching this to mortality and education information. All data are de-identified and recoded using a unique identifier that matches across the datasets. The data contained in the IDI is more expansive in its coverage but less comprehensive than the original datasets held with the respective agencies. This study uses data originally from the Ministry of Health's National Minimum Data Set and Mortality Collection and the MoE's Completion dataset. Due to data confidentiality rules set out by SNZ, all data values are rounded to base 3 and identifying values are suppressed. Only publicly-provided inpatient hospital events are analysed. I further restrict the sample to adults over the age of 18 with a length of stay less than 90 days to account for outlier values.

Before analysis, several additional steps were taken to prepare the data for use. The variables for month and year of birth and death are kept separately in the IDI. In order to create *birth date* and *death date* variables I added birth and death day variables all equal to 15 and then generated *birth date* and *death date* variables which are specific only to a monthly value in order to ensure confidentiality within the data. A measure of transfer between DHBs is missing

in the IDI data. This has been recreated by recoding the facility of service as the DHB in which the facility is located. This is then used as a *DHB of service* variable. From here, I can define an IDF variable based on patient treatment where the DoS differs from their DoD. Inter-District Transfers are a small subset of IDFs, approximately 2%. Therefore, to define the transfer subset I conditioned the IDF variable on admission source. This variable indicates whether a specific admission is a routine admission or a transfer. If we combine this with those patients being seen while outside their DoD this then provides a clean dummy variable for *transfer*.

Two of the three dependent variables are not defined within the IDI data. *30-day mortality* can be defined using the patient *death date* variable in the Mortality Register and the patient *event end date* in the Publicly Funded Hospital Discharges, subtracting one from the other and conditioning the variable to less than 30 days. A similar process is used to define the three *readmission* variables. Here, I use event start date and event end date from the Publicly Funded Hospital Discharges data to define a dummy where any readmission greater than zero and less than 30, 45 or 60 respectively, is equal to 1 and otherwise 0. An added complication for the readmission variable is matching the beginning and ending dates across the same individual. This is done by sorting the data by individual and then in chronological order. Then, the difference is computed as per Equation 1:

$$readmissiongap = startdate_r - enddaate_a \quad (1)$$

Where r is the current event for which the patient is admitted and a is the original admission. This calculates the gap between admissions. These gaps are then refined to only include gaps of <30, <45 and <60 days, respectively. Readmission is not a cost-driven quality measure in New Zealand as each hospital event is independently funded. However, the MoH provides a series of non-financial performance measures with the intention of quality improvement while maintaining productivity and efficiency (Robinson & Kerse, 2012). Measure OS8 is *Acute Readmissions*. Here, they indicate that hospital events occurring within 28 days of discharge are classed as readmission events (Ministry of Health, 2018a). In order to avoid this period, providers may intentionally extend readmission decisions. By including *45*- and *60-day readmission* we may pick up an increase in readmissions that is not observed within the 30-day period. This may form an interesting side note to the main analysis. A downside of these

additional measures is that we would expect the cause of readmission to be less associated with the hospital admission the longer the time to readmission. Unlike readmission, *30-day mortality* and *length of stay* (LOS) are commonly used as measures of hospital quality[1].

The variables used for the analysis of *transfer, length of stay, mortality* and *readmission* are listed and described in Table 1. The three dependent variables are described first and all independent variables and intermediate variables are then described.

Table 1 List of variables used for empirical analysis

Variable Name	Description	Source
	Dependent Variables	
Length of Stay	Length of Stay (LOS) in a facility in days.	SNZ IDI – Publicly Funded Hospital Discharges Data
30-Day Mortality	Binary variable equal to 1 if the patient dies within 30 days of discharge and zero otherwise.	SNZ IDI – Publicly Funded Hospital Discharges Data and Mortality Registrations Data
30-, 45- and 60-day Readmission	Binary variable equal to 1 if the patient is readmitted within a given number of days after discharge and zero otherwise. Variation in day measurement explained below.	SNZ IDI – Publicly Funded Hospital Discharges Data
Independent Variables		
Admission Source Code	A code used to describe the nature of admission (routine or transfer) for a hospital inpatient health event.	SNZ IDI – Publicly Funded Hospital Discharges Data
Birth date	The date a person was born. Generated from birth month and birth year variables in the data with a given average birth date.	SNZ IDI – Publicly Funded Hospital Discharges Data
Sex	The person's biological sex at the time of the healthcare event.	SNZ IDI – Publicly Funded Hospital Discharges Data
Ethnicity	Ethnicity is the ethnic group or groups people identify with or feel they belong to. Thus, ethnicity is self-perceived and people can belong to more than one ethnic group. Where more than one	SNZ IDI – Publicly Funded Hospital Discharges Data

[1] Carretta, Chukmaitov, Tang, and Shin (2013), Hernandez-Boussard et al. (2017), Bernard et al (1996), Gordon and Rosenthal (1996), Rosenberg et al. (2003), Sokol-Hessner et al. (2016), Odetola et al. (2009), Wiggers et al. (2011), Lynk (2001), Iwashnya et al. (2011), Lyman (2010) and Clark and Huckman (2012).

	ethnic group is reported in the ethnic core fields, the SNZ prioritisation algorithm is used to report only a single ethnicity.	
DHB of Domicile	The 3-digit code of the District Health Board responsible for the domicile in which the patient is a resident.	SNZ IDI – Publicly Funded Hospital Discharges Data
DHB of Service	The 3-digit code of the District Health Board responsible for the domicile in which the patient is treated.	SNZ IDI – Publicly Funded Hospital Discharges Data
Transfer	Dummy variable equal to 1 if both the patient's DOD is different from their DOS and the admission source code indicates transfer.	SNZ IDI – Publicly Funded Hospital Discharges Data
Qualification Award Category Code	27 categories of educational achievement, aggregated into five dummy variables for this study; post-graduate, under-graduate, high-school, vocation and no education.	SNZ IDI – MoE Completion Data
Event Start Date	The date on which the healthcare event began.	SNZ IDI – Publicly Funded Hospital Discharges Data
Event End Date	The date on which the healthcare event ended.	SNZ IDI – Publicly Funded Hospital Discharges Data
DRG 3.1 Reference	Diagnosis-related group code produced by version 3.1 of AN-DRG Grouper.	SNZ IDI – Publicly Funded Hospital Discharges Data
CCL Code	Complication/co-morbidity class level. This comes out of the DRG grouper programme and identifies the clinical severity within the DRG code. Split into five dummy variables for this study; CCL0, CCL1, CCL2, CCL3 and CCL4.	SNZ IDI – Publicly Funded Hospital Discharges Data
Tertiary	A dummy variable equal to 1 if the DHB has at least one tertiary provider and otherwise equal to 0.	SNZ IDI – Publicly Funded Hospital Discharges Data *DHB of Service* Classification from Shin (2013)
MDC	The Major Diagnostic Category (MDC) is a category generally based on a medical classification that is associated with a particular medical speciality. MDCs are assigned by the DRG grouper program.	SNZ IDI – Publicly Funded Hospital Discharges Data
MDC Type	A code denoting which version of a grouper a Major Diagnostic Category (MDC) code belongs to.	SNZ IDI – Publicly Funded Hospital Discharges Data
Cost Weight	A calculated value designed to weight a base rate payment.	SNZ IDI – Publicly Funded Hospital Discharges Data

Death Date	The date a person died. Generated from death month and death year variables in the data with a given average death date.	SNZ IDI - *Mortality Registrations Data*

Complication Comorbidity Level

The complication and comorbidity level (CCL) is a measure of the costliness of a health care event. It is a single value attributed to a diagnosis that reflects the chance of other diagnoses held by the patient affecting the current diagnosis. This takes a value between 0 and 4 as outlined in Table 2. When other diagnoses affect current treatment this may complicate the treatment process or prohibit standard treatment procedure, instead requiring expertise or specialist resources. It is then clear that a strong relationship occurs between an increasing likelihood of transfer and an increasing CCL. CCLs are unique to the diagnosis given, for example, a complication that may affect resource consumption for a heart attack may not complicate treatment for a broken arm.

Table 2 Description of complexity and comorbidity levels

CCL Value	Description
0	No evidence of complication/comorbidity
1	Minor complication/comorbidity
2	Moderate complication/comorbidity
3	Severe complication/comorbidity
4	Catastrophic complication/comorbidity

Source: Adapted from Rains and Thompson (2015, p. 11)

Ethnicity

When filling out official documents in New Zealand, ethnicity classifications permit an individual to select more than one ethnicity. Prioritised ethnicity is a method used by SNZ in order to record a single ethnicity value when more than one have been entered. *Prioritised ethnicity* is a more straightforward variable when using the data practically but can result in reduced representation of diversity (Statistics New Zealand, 2006). I chose to use *prioritised ethnicity* as this is what is used for the calculation of the PBFF, in which ethnicity is a major factor in the funding calculation (Penno et al., 2012, p. 20). The drawback that should be noted

going into this analysis is a potential under-representation or simplification of individual ethnicity. The table of prioritisation and the groupings used is included in Appendix 2. An example carried out using Census data from 2001 suggests a 15.8% underestimation of the Pacific population and loss of multiple ethnicities especially for individuals aged 19 years and younger, as a result of parents from different ethnic backgrounds (Statistics New Zealand, 2006). This simplification potentially reduces the power of the *pacific* control dummy as social and economic factors disproportionately negatively affect pacific people's health access and health outcomes (Reid, 2012). Inability to correctly identify the pacific population could underestimate these impacts.

INCOME

I have not included a measure of individual income as the Inland Revenue (IR) data did not merge accurately with the Public Hospitals and Mortality datasets. We assume a strong correlation between income and education from the prior discussion and as such QACC should be a sufficient socioeconomic control. This is a limitation of this research discussed in more detail in Sections 6.2 and 10.

EDUCATION

I include the control variable *Qualification Award Category Code* (QACC) to account for individual variance in income and health as this is the most robust variable available within the datasets. The codes and their divisions into four dummy variables are displayed in Table 3. There is evidence that the correlation between education, health and income is positive and significant and therefore that including education should contribute to the analysis of transfer health outcomes (Lleras-Muney, 2005). Education level is available for approximately half the data set and is measured in five dummy groups: *postgraduate, undergraduate, high school, vocation* and *no education* as a base group. I would expect to observe an improvement in healthcare outcomes as education level increases. In Section 8, a subsample test is performed on the national sample for only those individuals for which we have recorded QACC information. This confirms whether the lack of full education data compromises the main analysis.

Table 3 Qualification Award Category Code categories and separations into dummy variable categories

Post-Graduate	1	Higher doctorate
	10	PhD and other doctorates
	11	Masters
	12	Bachelors with honours
	13	Post-graduate diplomas
	14	Post-graduate certificates
Under-Graduate	20	Bachelors
	21	Graduate diploma/certificate
	25	Certificate of proficiency (credit to a Degree)
	30	Professional association diploma
	31	National diploma/national certificate levels 5-7
	32	New Zealand diploma
	33	Diploma/certificate issued by TEO levels 5-7
High-School	34	Advanced trade certificate
	35	New Zealand certificate/technicians certificate
	36	National certificate level 4 and other level 4 certificates
	37	Certificate of proficiency (credit to a Diploma)
	40	Professional association certificate
	41	National certificate levels 1-3
	46	Certificate issued by TEO levels 1-3
Vocation	43	Trade certificate level 4
	60	Licence
	90	Certificate of personal interest
	96	STAR
	97	Programmes of study taught under contract
	98	Programmes of study made up of selected unit standards
	99	Community education programmes

Regional Pairs

Section 7 focusses on the analysis of five regional DHB pairs. The rationale being that transfer agreements that exist between neighbouring secondary-to-tertiary DHBs have a high frequency of transfers and thus a large sample size. These will be the cleanest pairs from which to analyse changes. Transfer statistics for each regional pair are described in Table 4 while the summary statistics for the regional pairs can be found in Appendix 3.

The pairs selected for analysis in this study are those with the highest volume of transfer from the secondary DHB to the tertiary DHB. Table 4 and the Map in Figure 2 show Northland to Auckland (1) has the highest volume of transfers with 4,041 transfers across the 8 year sample period, followed by Lakes to Waikato (3), Midcentral to Capital&Coast (5), Taiarawhiti to Waikato (4) and finally Taranaki to Waikato (2). Along with these flows, the reverse flow is calculated for each pair to check whether patients were indeed being transferred from secondary to tertiary or whether this high volume was occurring in both directions. Transfers flowing in the tertiary to secondary direction were less than 2% of the secondary-to-tertiary volume. These statistics are not included here as they breach the confidentiality standards set by SNZ.

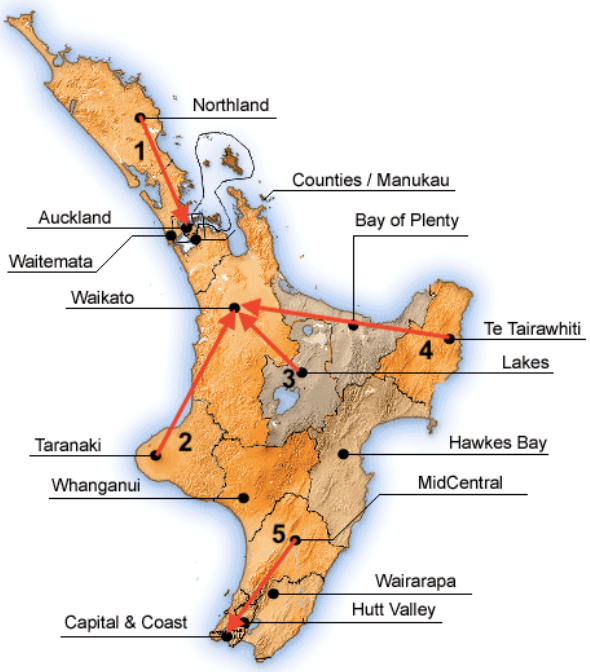

Figure 2 Map of the North Island of New Zealand depicting the flow of transfer from secondary to tertiary DHBs for five regional DHB pairs

Note: Adapted from Ministry of Health (2018b)

Table 4 Breakdown of healthcare event statistics by nature of admission

	Routine (%)	Transfer (%)	Total
National	4366887 (98.6%)	64242 (1.4%)	4,431,129
Northland-Auckland	189069 (98.0%)	4041 (2.0%)	193,110
Taranaki-Waikato	110298 (99.6%)	447 (0.4%)	110745
Lakes-Waikato	125157 (98.8%)	1530 (1.2%)	126687
Taiarawhiti-Waikato	60264 (99.1%)	558 (0.9%)	60822
Midcentral-Capital&Coast	154470 (99.1%)	1470 (0.9%)	155940

All pairs are from the North Island of New Zealand. The South Island is not included for four reasons. (1) Populations across the island are sparse and scattered over large geographically-isolated areas. (2) Dunedin Hospital is unique in its role as the teaching hospital associated with the University of Otago. While Canterbury DHB houses Christchurch Hospital which is another tertiary hospital. Both dominate the region equally in terms of transfer with low volumes

flowing to each. (3) The 2010 and 2011 Christchurch earthquakes disrupt the collection of data from this region. Although this data does not coincide with the occurrence of the earthquakes the lag of transfer data especially is a concern. (4) The northern segment of the South Island around Nelson and Picton is just as likely to feed into the Wellington DHB as it is to be transferred down to Canterbury. Although this argument could be made for Waikato and Auckland or Waikato and Wellington, analysis of a single island may provide insight into these tertiary DHB interactions.

A study of 1.4 billion individuals in the US looking at factors affecting small area variation in life expectancy identifies societal and behavioural factors that impact on life expectancy. This research finds a significant negative correlation between longevity and smoking and positive effects of immigrants, college graduates and government spending on longevity (Chetty et al., 2016). Although living a long life does not equate to living a healthy life, I can link the social factors in this study to the regional pairs used for this research. The secondary districts in the regional analysis are more rural, less resource rich and in some cases geographically challenging to access. McIntyre, MacIver, and Sooman (1993) argue that rather than acting as a control in health outcome studies, the physical environment plays a significant role in influencing the health outcomes of its residents. A lack of facilities, access to services, old or broken resources and poorly kept public spaces discourages health promoting activities. Given the differences in regions studied, these environmental factors may help to explain part of the variation in health outcomes when compared across the five pairs. Any observed differences would reinforce the need for a decentralised approach and local healthcare provision.

Two studies go so far as to say that differences between tertiary and secondary facilities should prompt transfer of patients based on need rather than location, regardless of the facilities available. This would mean all patients above a specific severity threshold are sent to the specialist provider as a standardised protocol rather than a decision made on a case-by-case basis. Given the high volume of flows between certain DHB pairs, this seems to be occurring in an understated way in New Zealand. IDF levels are currently set using standardised or personalised agreements between each DHB. The exception being that low severity patients are still treated at the tertiary hospitals alongside the high severity patients, where these

studies would suggest they are sent to the secondary facilities (Dudley et al., 2000; Iwashnya et al., 2009).

Table 5 provides the descriptive statistics of the variables used in the empirical analysis. Length of stay is in days, age is in years, and cost weight is a value centred at 1 (larger for higher cost cases and smaller for lower cost cases). Otherwise, all variables are expressed as binaries. The maximum age and maximum and minimum cost weight are suppressed due to the confidentiality regulations of SNZ. The Panel I sets out the full data set, Panel II displays data from prior to policy implementation and Panel II summarises data after the policy implementation. Dates of these periods are given in the heading of each panel.

Table 5 Descriptive statistics of variables used in the empirical analysis

	Mean	Std. Dev.	Min	Max
I. Full Dataset 30/06/2000-01/07/2008 N=4,431,129				
Length of Stay	2.993	4.981	0	90
30-day Mortality	0.020	0.139	0	1
30-day Readmission	0.145	0.353	0	1
45-day Readmission	0.175	0.380	0	1
60-day Readmission	0.197	0.398	0	1
National Transfers	0.014	0.120	0	1
Post-2003	0.684	0.465	0	1
Tertiary	0.555	0.497	0	1
CCL 0	0.221	0.415	0	1
CCL 1	0.513	0.500	0	1
CCL 2	0.182	0.385	0	1
CCL 3	0.068	0.252	0	1
CCL 4	0.016	0.126	0	1
Gender (female)	0.595	0.491	0	1
NZ European	0.598	0.490	0	1
Maori	0.156	0.363	0	1
Pacific	0.062	0.241	0	1
Asian	0.047	0.213	0	1
Other	0.137	0.344	0	1
Age at Admission	52.114	21.205	18	S
Cost Weight	1.007	1.444	S	S
Post Graduate	0.021	0.142	0	1
Under Graduate	0.084	0.278	0	1
High School	0.172	0.378	0	1
Vocation	0.001	0.033	0	1
No Education	0.721	0.448	0	1

II. Pre-Policy Change 30/06/2000-01/07/2003 N=1,399,494				
Length of Stay	3.179	5.213	0	90
30-day Mortality	0.022	0.148	0	1
30-day Readmission	0.150	0.357	0	1
45-day Readmission	0.181	0.385	0	1
60-day Readmission	0.205	0.404	0	1
National Transfers	0.017	0.128	0	1
Post-2003	0.000	0.000	0	0
Tertiary	0.485	0.500	0	1
CCL 0	0.233	0.423	0	1
CCL 1	0.483	0.500	0	1
CCL 2	0.194	0.396	0	1
CCL 3	0.072	0.258	0	1
CCL 4	0.018	0.132	0	1
Gender (female)	0.553	0.497	0	1
NZ European	0.625	0.484	0	1
Maori	0.143	0.350	0	1
Pacific	0.052	0.222	0	1
Asian	0.035	0.184	0	1
Other	0.145	0.352	0	1
Age at Admission	54.113	20.885	18	S
Cost Weight	1.046	1.470	S	S
Post Graduate	0.017	0.130	0	1
Under Graduate	0.066	0.249	0	1
High School	0.139	0.346	0	1
Vocation	0.001	0.033	0	1
No Education	0.776	0.417	0	1

III. Post-Policy Change 01/07/2003-01/07/2008 N=3,029,574				
Length of Stay	2.907	4.867	0	90
30-day Mortality	0.019	0.135	0	1
30-day Readmission	0.143	0.351	0	1
45-day Readmission	0.172	0.377	0	1
60-day Readmission	0.194	0.395	0	1
National Transfers	0.013	0.115	0	1
Post-2003	1.000	0.000	1	1
Tertiary	0.588	0.492	0	1
CCL 0	0.215	0.411	0	1
CCL 1	0.527	0.499	0	1
CCL 2	0.176	0.381	0	1
CCL 3	0.067	0.249	0	1
CCL 4	0.015	0.123	0	1
Gender (female)	0.614	0.487	0	1
NZ European	0.585	0.493	0	1
Maori	0.162	0.369	0	1
Pacific	0.066	0.249	0	1

Asian	0.053	0.224	0	1
Other	0.134	0.340	0	1
Age at Admission	51.191	21.288	18	S
Cost Weight	0.988	1.431	S	S
Post Graduate	0.022	0.147	0	1
Under Graduate	0.093	0.290	0	1
High School	0.188	0.391	0	1
Vocation	0.001	0.034	0	1
No Education	0.696	0.460	0	1

Table 6 displays the frequency and proportions of total admissions throughout the eight year period analysed within each of the twenty DHBs. The largest three DHBs are all part of the wider Auckland region making up 33.7% of total admissions. This is followed closely by the other two large tertiary DHBs Canterbury and Waikato.

Table 6 Frequency and percentage of healthcare events by DHB

	Frequency	Percent
Waitemata	537,855	12.1%
Counties Manukau	489,729	11.1%
Auckland	464,139	10.5%
Canterbury	437,403	9.9%
Waikato	374,037	8.4%
Southern	272,871	6.2%
Bay of Plenty	241,917	5.5%
Capital and Coast	209,040	4.7%
Northland	202,617	4.6%
Hawkes Bay	165,252	3.7%
Midcentral	165,171	3.7%
Nelson Marlborough	141,219	3.2%
Hutt	138,354	3.1%
Lakes	132,894	3.0%
Taranaki	119,052	2.7%
Whanganui	92,991	2.1%
South Canterbury	69,549	1.6%
Taiarawhiti	63,813	1.4%
Wairarapa	53,571	1.2%
West Coast	35,283	0.8%
No DoD	24,375	0.6%
Total	4,431,132	

5. METHODOLOGY

This analysis thoroughly investigates the pattern of transfer patients and associated health outcomes over the period of the policy change. I focus on the level of transfers and its effects on health outcomes both at a national level and a regionally paired level. Figure 3 maps out the regression analyses performed. Each box contains regressions in a matrix-style layout. The six regressions are in the left column and sample restrictions in the right column. The regressions are described in more detail below.

The main analysis (emphasised in bold) is split into two sections in this research. The full sample analysis of national transfers against the six regressions is carried out in Section 6. This closely replicates the methodology used by Shin (2013) in her second essay. The data used is the same while the original study sourced it from the Ministry of Health and this study sources the data from SNZ. Furthermore the original study is carried out to 2011 while the current study stops at 2008. Finally, the original study used regional income and unemployment data as control variables compared to the use of MoE data in the current study. While the six outcomes are analysed for the five regional pairs in Section 7. The analysis of regional pairs is a novel aspect of this research. By narrowing the focus to DHB pairs with a one-way flow of transfer patients (from secondary DHB to tertiary DHB), it may be possible to reduce variation further and identify regional trends given the unique characteristics of the Auckland, Waikato and Capital&Coast DHBs.

The regression analysis software used in this analysis is Stata version 15. The *transfer*, *mortality* and *readmission* regressions are logit regressions while ordinary least squares regression is used for the length of stay analysis. I use robust standard errors to account for possible heteroskedasticity.

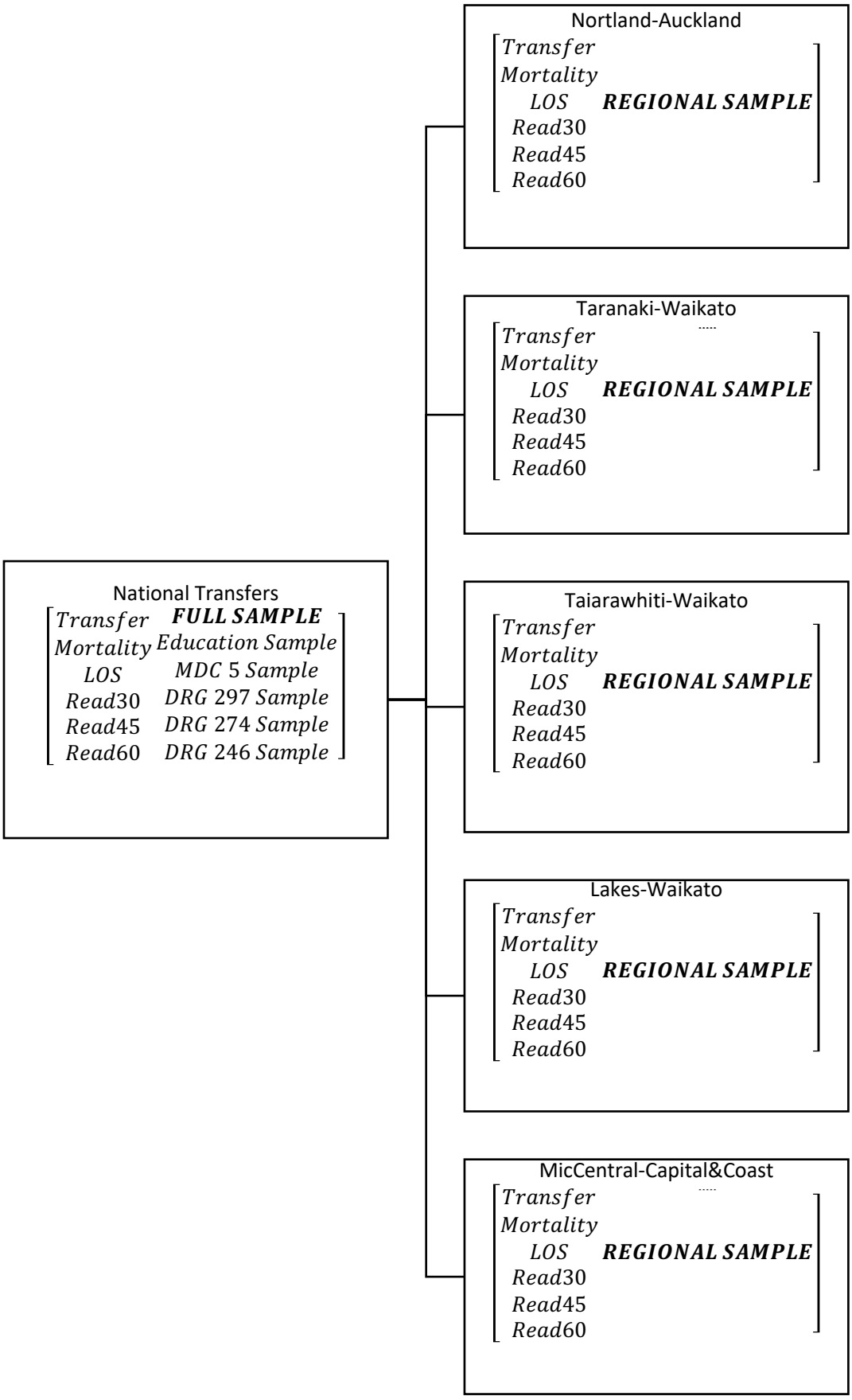

Figure 3 Tree diagram illustrating the samples used and dependent variables analysed in Sections 6-8

Equation 2 analyses the effects of the policy change on the overall level of transfers between DHBs. This is expressed as:

$$TRANSFER_{it} = \beta_0 + \beta_1 POST + \beta_2 TERT_i + \beta_3 TERT_i \times POST + \Sigma_{i=1}^{4} \beta_{i+3} CCL_i + \Sigma_{i=1}^{4} \beta_{i+7} CCL_i \times POST + \beta_{12} costweight + \beta_{13} X_{it} + \varepsilon_{it} \quad (2)$$

where $TRANSFER_{it}$ is a dummy variable equal to 1 if the patient was transferred by their DoD to and alternate DoS or 0 otherwise. $POST_t$ is a dummy variable equal to 1 if the healthcare event occurred after 30th June 2003 or 0 otherwise. $TERT_i$ is a dummy variable equal to 1 if the DoS is a tertiary DHB and otherwise equal 0. The tertiary classification is the same as that used in Shin (2013). CCL is a dummy variable for the complexity and comorbidity level where j=1,2,3 or 4. Here the lowest complexity category is the base group of analysis (CCL 0). I expect to observe an increase in probability of transfer as CCL increases, as more complicated cases are more likely to be transferred. The $TERT_i \times POST_t$ interaction term allows me to analyse the changes in transfer before and after the policy change for the group of DHBs most likely to be affected. As explained in Section 3, tertiary healthcare providers are more likely to receive transfers due to resource availability and specialisation. Shin finds that $\beta_3 < 0$ after the policy change which suggest that as transfers became more expensive, the tertiary DHBs were less likely to receive patients from outside their DoD. The $CCL_{ij} \times POST_t$ interaction terms allow me to differentiate the effect of transfer by level of medical difficulty before and after the policy change. Relative to the most straightforward cases, more complex cases should increase the likelihood of transfer. If the introduction of the policy discourages transfer, this may be evident at higher levels of complexity. In Shin's study this is reflected with negative signs on these coefficients. $Costweight$ is a measure of the resource use of the patient. The higher the cost weight, the more complex the cases. I would expect to observe a positive relationship between *cost weight* and *transfer*. As discussed in Section 3, studies find ample evidence of increased length of stay, mortality and resource use for transfer patients as they tend to have treatments of higher complexity or severity. X_i is a list of control variables such as sex, age, ethnicity and education.

For the regional pairs, the equation is modified to drop the tertiary component as the pair is made up completely of secondary to tertiary patient flows. The resulting Equation 3 is expressed as:

$$TRANSFER_{it} = \beta_0 + \beta_1 POST + \Sigma_{i=1}^{4}\beta_{i+1} CCL_i + \Sigma_{i=1}^{4}\beta_{i+5} CCL_i \times POST + \beta_{10} costweight + \beta_{11} costweight_i \times POST_t + \beta_{12} X_{it} + \varepsilon_{it} \quad (3)$$

An interaction term is added to assess the changes in $costweight$ before and after the policy change for transfer patients. If secondary providers withhold less complicated cases post-reform we would expect to see an increase in $costweight$ for transfers due to increased concentration of high-cost, high-complexity patients.

Equation 4 analyses the effects of the policy change on patient *mortality* outcomes. This is expressed as:

$$MORT_{it} = \beta_0 + \beta_1 YEAR_t + \beta_2 TRANSFER_i + \beta_3 TRANSFER_i \times YEAR_t + \beta_{11} costweight + \beta_{12} X_{it} + \varepsilon_{it} \quad (4)$$

where $MORT_{it}$is a dummy variable, equal to 1 if the patient died within 30 days. $YEAR_t$ is a set of eight fixed effects. The $TRANSFER_i$ variable is equal to 1 if the patient has been transferred outside his or her DoD for the national analysis. For the regional analysis, $TRANSFER_i$ equals 1 if the patient has been transferred to the tertiary provider. The $TRANSFER_i \times YEAR_t$ interaction term allows me to analyse the specific health outcomes of the patients in that year. If the coefficient is positive for the years after the policy change this indicates that the mortality outcomes of the transferred patients are indeed worsening. This may indicate that the sending hospital is choosing to retain patients with less severe conditions, such that before the policy the mortality statistics were diluted by unnecessary transfers and after the policy mortality statistics worsen as transferred patients now only consist of more severe cases. All other variables in the regression equation are the same as those described in Equation 2.

Next, I analyse the effects of the policy change on patient *length of stay*. This is the only equation of the six that is run as an OLS model with a non-binary outcome. Equation 5 is expressed as:

$$LOS_{it} = \beta_0 + \beta_1 YEAR_t + \beta_2 TRANSFER_i + \beta_3 TRANSFER_i \times YEAR_t + \beta_{11} costweight + \beta_{12} X_{it} + \varepsilon_{it} \quad (5)$$

where LOS_{it} is the length of stay in days for each patient health event. We would expect that length of stay is positively correlated with transfer as the cases sent are often more complex cases requiring longer periods of health care. Using the marginal effects, I expect an increase in LOS after 2003, applying the same logic used in the case of the mortality health outcome. All other variables in the regression equation are the same as those described in Equation 2.

The effects of the policy change on patient readmissions are analysed using Equations 6-8. If healthcare providers have a tendency to delay readmission until the after the 30-day period, we would expect to see a jump in readmission results for Equations 7 and 8. Equation 6 is *30-day readmission* which is expressed as:

$$READ30_{it} = \beta_0 + \beta_1 YEAR_t + \beta_2 TRANSFER_i + \beta_3 TRANSFER_i \times YEAR_t + \beta_{11} costweight + \beta_{12} X_{it} + \varepsilon_{it} \quad (6)$$

where $READ30_{it}$ is a dummy variable equal to 1 if the patient is readmitted within 30 days of discharge from a health event or otherwise equal to 0. The interpretation of this regression can be complicated. Rumball-Smith and Sarfati caution the linkage of readmission and hospital quality (2012). Any increases in readmission rates for transfer patients may be put down to the same concentration effect explained in the mortality regression but is just as likely due to individual patient effects such as not following prescribed post-discharge care regimens. All other variables in the regression equation are the same as those described in Equation 2.

Equation 7 is *45-day readmission* which is expressed as:

$$READ45_{it} = \beta_0 + \beta_1 YEAR_t + \beta_2 TRANSFER_i + \beta_3 TRANSFER_i \times YEAR_t + \beta_{11} costweight + \beta_{12} X_{it} + \varepsilon_{it} \quad (7)$$

where $READ45_{it}$ is a dummy variable equal to 1 if the patient is readmitted within 45 days of discharge from a health event or otherwise equal to 0. All other variables in the regression equation are the same as those described in Equation 2.

Equation 8 is *60-day readmission* which is expressed as:

$$READ60_{it} = \beta_0 + \beta_1 YEAR_t + \beta_2 TRANSFER_i + \beta_3 TRANSFER_i \times YEAR_t + \beta_{11} costweight + \beta_{12} X_{it} + \varepsilon_{it} \quad (8)$$

where $READ60_{it}$ is a dummy variable equal to 1 if the patient is readmitted within 60 days of discharge from a health event or otherwise equal to 0. All other variables in the regression equation are the same as those described in Equation2.

Referring back to Figure 3, these six regressions are repeated for five regional-pair subsamples. The five subsamples are explained further in Section 7. The Figure 3 education, MDC and DRG robustness controls on the national sample are added as a robustness check to the main analysis in Section 8. The education subsample ensures that the missing values for education within the data do not bias the overall results, the MDC subsamples analyse a particularly high-volume diagnosis group to control for variation in conditions and as an extension of this, three DRGs within MDC category 5 are analysed.

6. National Analysis

6.1 Results

In this section I present the results of the empirical analysis of the national sample. The four key sets of results are laid out in Table 7 and each heading describes the type of data being presented. Table 8 compares the results of patient readmission across 30, 45 and 60 days. Note that the interaction terms from the logit models are not included in the coefficient section of the table. Interaction terms used in nonlinear models are complicated to interpret. For this purpose, I choose to follow the methodology laid out in Karaca-Mandic, Norton, and Dowd (2012) and in line with the interpretation and marginal analysis conducted by Shin (2013). This produces a series of marginal effects displayed in Table 7. I take the marginal effect of each year dummy (in the state equal to 1 and in the state equal to zero) with respect to the variable tertiary. Then the two marginal effects for each year are differenced to produce an average marginal effect for the given year conditional on the tertiary variable. For brevity, only the marginal effects of post and tertiary are analysed for transfer. The transfer analysis is restricted to a study of pre- and post-policy change using a dummy variable *post* that is equal to 1 if the healthcare event occurs after 1st July 2003. This is due to a collinearity issue between the 2006 and 2007 year dummies that occurred only in this section of the empirical study. The presence of collinearity prevents the use of marginal analysis. I carried out testing to investigate the cause of the collinearity, but I was unsuccessful. The model presented has been checked for collinearity and any possible heteroskedasticity.

Column (1) shows a large decrease in transfers after the policy change, significant to a 1 percent level. Interestingly, *tertiary* is insignificant on its own, but the *post-tertiary* interaction term shows a significant 2% increase in probability of transfers to tertiary DHBs after the change in transfer pricing. The decrease in overall transfers and increase in transfers to tertiary DHBs suggests a focussing of transfer efforts to only those necessary for higher level care. The hypothesised relationship between CCL and transfer is confirmed in the national sample with higher probability of transfer as CCL increases. All four CCL variables are significant at the 1 percent level. The marginal effects of CCL on transfer after the policy change are significant with a 0.7% decrease for CCL3 transfers and a 1.5% decrease in *CCL4* transfers after the policy

change. This is not consistent with the regional analysis where I find a mix of increases and decreases in high CCL transfers after the policy change.

Table 7 Effects of a policy change in transfer funding on Transfer, 30-day Mortality, 30-day Readmission and Length of Stay outcomes for the national sample

	(1) Transfer N=4,431,129	(2) 30-day Mortality N=4,431,129	(3) 30-day Readmission N=4,431,129	(4) Length of Stay N=4,431,129
2001		-0.0014	0.0060	-0.0851***
2002		-0.0199	0.0098	-0.1258***
2003		-0.0391**	-0.0027	-0.1048***
2004		-0.0421**	-0.0008	-0.1542***
2005		-0.0654***	0.0079	-0.2640***
2006		-0.0847***	0.0345***	-0.3072***
2007		-0.0768***	0.0389***	-0.3084***
Transfer		0.3361***	-0.5854***	-0.7264***
Cost weight	0.1713***	0.1222***	0.0380***	2.2760***
Post	-2.4877***			
Tertiary	-0.0146			
CCL1	0.4326***			
CCL2	0.4620***			
CCL3	1.0530***			
CCL4	1.4076***			
Interaction terms (Marginal Effects except for LOS)				
PostxTertiary	0.02***			
PostxCCL1	0.0001***			
PostxCCL2	0.0001***			
PostxCCL3	-0.0065***			
PostxCCL4	-0.0146***			
2001xTransfer		-0.0008	0.0016	0.0175
2002xTransfer		-0.0006	-0.0016	-0.2591*
2003xTransfer		-0.003*	-0.0012	-0.2974**
2004xTransfer		-0.005*	0.0001	-0.7198***
2005xTransfer		-0.0044**	0.0041	-1.1295***
2006xTransfer		-0.0077***	-0.0111***	-0.7473***
2007xTransfer		-0.0062***	-0.0229***	-0.6785***

At the same time as the changes for transfer funding were occurring in 2003, the first National Services were being established. The current National Services programme was then established in 2010 and incorporates all pre-existing nationally offered services (National Service Framework Library, 2018). The concurrent introduction of National Services and transfer pricing changes is one possible explanation for the decrease in high complexity

transfers after the policy change. Solid organ transplant services were the first national service provided under the DHB structure. They are high complexity cases often classed in CCL3 and CCL4. A National Services classification removes them from transfer status as these healthcare events are funded with an overarching national fund rather than individual DHB transfers.

The national *mortality* analysis in Column (2), shows an anticipated decline in *mortality* that improves throughout the period analysed. The lack of any significant difference in trend before and after 2003 suggests that the change in pricing had no clear impact on national mortality as a patient health outcome. This conclusion is reinforced by the stable decreases in *mortality* over the marginal effects of transfer patients in each year. The transfer patient *mortality* effects are much more modest with a less than 1% decrease in all years analysed. In line with the findings of other studies both in New Zealand and overseas, the likelihood of 30-day mortality increases if the patient is transferred as do the costs associated with these cases.

In Column (4) the increase in cost weight is especially prevalent for length of stay (2.3-day increase), intuitively due to the costs associated with increased time spent in a hospital facility. The decrease in length of stay for each year compared with the year 2000 base category suggests that for all patients, including transfers, hospitals efficiency is improving. Shin (2013) finds that a combination of increases in readmission and decreases in *length of stay* in the period post policy change suggests that patients are being discharged prematurely. For the significant values across these two sets of results in my analysis I observe no such phenomenon. Here there are significant decreases in both *readmission* and *mortality* with decrease in *length of stay* for transfers increasing in magnitude after the change in transfer pricing. This suggests that the increases in efficiency did not come at the cost of poorer quality care at the national level. The readmission marginal effect analysis is the least significant in Table 7. This could be due to the low volume of readmissions in general or due to volatility over a period of extensive policy changes in the health care sector.

One of the additional hypotheses put forward in this paper is the possible change in readmission outcomes dependent on how the readmission period is defined. Results for *30-, 45-* and *60-day readmission* are presented in Table 8. Comparing the statistically significant results, there are no obvious differences in the coefficients across the three groups. The *2006*

and *2007* interaction terms also show similar values suggesting that any readmissions are processed as care is needed with no influence from hospital performance measures. Due to the similarities in readmission outcomes across a range of time frames, I chose to perform the marginal analysis only on *30-day readmission* (see Column 3) so care should be taken in interpreting the interaction coefficients in Table 8. Surprisingly, the likelihood of *readmission* decreases when a patient is transferred. This effect grows stronger the longer the time frame with a decrease in probability of *readmission* of between 59% and 78% for transfer patients. If a patient needs advanced care and is transferred to a different DoS, lower readmission rates for transfers implies higher quality of care at these specialist facilities. This is consistent with the conclusions of Dudley et al. (2000) and Hagen et al. (2010) on enhanced care practices at specialised healthcare providers. A table of all national and subsample *readmission* results is provided in Appendix 4.

Table 8 Effects of a policy change in transfer funding on 30-, 45- and 60-day Readmission outcomes for the national sample

	(4) 30-day Readmission N=4,431,129	(5) 45-day Readmission N=4,431,129	(6) 60-day Readmission N=4,431,129
2001	0.006	0.0046	0.0036
2002	0.0098	0.0042	0.0025
2003	-0.0027	-0.0079	-0.0049
2004	-0.0008	-0.0084	-0.0102*
2005	0.0079	-0.0024	-0.0014
2006	0.0345***	0.0275***	0.0254***
2007	0.0389***	0.0363***	0.0409***
Transfer	-0.5854***	-0.714***	-0.78***
Cost weight	0.038***	0.0396***	0.0399***
Interaction Terms (logistic coefficients)			
2001xTransfer	0.0237	-0.0032	-0.0333
2002xTransfer	-0.0155	-0.035	-0.0725
2003xTransfer	-0.0169	-0.0509	-0.085
2004xTransfer	0.0005	-0.0165	-0.0564
2005xTransfer	0.0547	0.021	-0.0205
2006xTransfer	-0.1253*	-0.1599**	-0.1822***
2007xTransfer	-0.2954***	-0.3086***	-0.3333***

6.2 Discussion

The *post* effect is consistent with the findings in Shin (2013) however the effects are much stronger. This may suggest that the sample size used by Shin, which included a subsequent policy change, diluted the transfer effect of the policy change. Shin's health outcome studies do not completely align with my findings. The *year* dummies show a consistent negative effect, but the interaction terms display an increase in *mortality* coefficients for the years after the policy change. I find no such effects in my results. The outcomes of transfer patients for each of the health outcomes is consistent between the studies, with positive effects for both mortality and *length of stay* and negative effects for *readmission*.

Although the results for key variables between the two studies are consistent, there remains substantial variation in marginal effects and health outcomes. The immediate source of this variation is the data itself. The first study sources the data set directly from the Ministry of Health and has access to a larger sample size over a longer period. Accounting for just this variation may absolve the discrepancies. An alternate explanation is the level of external variation in health data. There are several factors that should be identified and controlled for such as medical developments, facility upgrades, changes in hospital staffing and regulation, diagnosis prevalence, aging populations and socioeconomic factors. Neither study is able to completely account for even the few factors mentioned above due to limitations, but the different methods used, and different variables chosen may explain the differences in results. For example, Shin chose to account for income and unemployment on a regional basis, taking a broad approach. As districts are smaller geographical units than regions, this is a rudimentary control. At the expense of income and employment I chose to fine tune my control and use individual education level, but I sacrificed data quality to do so, as education data was only available for half of the full sample.

In the secondary *readmission* analysis (Table 8) the results link lower likelihood of *readmission* with transfer patients. Although this is easy to interpret as a positive outcome, Rumball-Smith and Sarfati (2012) criticises the use of readmission as a measure of hospital efficiency in a study by Robinson and Kerse (2012). Robinson and Kerse investigate the nature of readmission in the elderly population of New Zealand. The study finds that Maori and Pacific populations are more likely to be readmitted within three months of a healthcare event, as are men, at-risk populations and the elderly. He suggests better care during the initial admission and additional

support programmes for the groups identified could lower these readmission rates. The key acknowledgement made in the paper, and reinforced in the later criticism, is the portion of readmissions that are preventable. Readmission is not only determined by quality of care during the initial admission but also the health history of the patient, age, socioeconomic factors, patient support system and financial position. Highlighting readmission as a performance measure or encouraging decreases in readmission past a reasonable level may result in adverse effects, such as prolonged initial length of stay or unnecessarily high costs for the initial admission. Therefore, this paper observes only the changes in readmission as a result of the introduction of transfer fees and does not infer any changes in hospital quality as a result of changes in readmission rates.

7. Regional Analysis

7.1 Results

The regional analysis comprises of five subsections, each devoted to an individual outcome compared across five regional DHB pairs. The discussion in this section is focussed on comparing the regional analysis with the results of the national sample in Section 6. The main finding of the regional analysis is the variation in results attributable to the idiosyncratic nature of healthcare at a local level.

Transfer

The general overarching result of the regional analysis is an increase in probability of *transfer* after the introduction of transfer pricing. This is shown with significance only in the Northland analysis in Column (7) of Table 9. As with the national sample, the likelihood of *transfer* increases as *CCL* increases. This is also reflected in the marginal effects of CCL after the policy change where likelihood of *transfer* is higher across all *CCL* levels but increases for higher severities. Across all five regions *cost weight* is significant to a 1 percent level with similar magnitudes of increase in the likelihood of *transfer* as *cost weight* increases. The combination of higher *CCL* and increasing *cost weight* is understandable as they both reflect complexity or severity of treatment.

Differences between the regions are either small or not statistically significant and therefore should be interpreted with caution. The coefficient magnitudes for the Northland sample are generally larger than the other four regions, and this could be due to the volume of observations for this region and the high level of specialist facilities available at Auckland Hospital. Four of the five regions experience an increase in transfer volumes after the policy change, however only Northland's is significant. Each of these pairs already incorporates the tertiary aspect as all transfers that occur between the sending and the receiving DHB are from a secondary to a tertiary. Furthermore, all regions exhibit an increasing likelihood of *transfer* with higher *CCL*.

Table 9 Effects of a policy change in transfer funding on Transfer outcomes for the regional samples

	(7) Northland-Auckland N=193,110	(8) Taiarawhiti-Waikato N=60,825	(9) Lakes-Waikato N=126,690	(10) Taranaki-Waikato N=110,748	(11) Midcentral-Capital&Coast N=115,943
Post	1.5046***	0.5456	-0.2534	0.2716	0.2669
CCL1	1.6458***	-0.0471	0.1728	0.6915*	1.4199***
CCL2	1.5815***	0.4306	0.5211**	0.6372	0.8007*
CCL3	2.1691***	0.8618*	1.2512***	1.3865***	1.3254***
CCL4	2.9979***	1.8406***	1.0027**	1.5421***	1.9220***
Cost weight	0.3253***	0.2723***	0.1928***	0.2837***	0.2193***
Marginal Effects of Interaction Terms					
PostxCCL1	0.0048***	0.0005***	0.003	0.0021***	0.0052***
PostxCCL2	0.0063***	0.0006**	0.0032	0.0001	0.0034***
PostxCCL3	0.0172***	-0.0007	-0.0049	-0.0006	0.0021*
PostxCCL4	0.0281***	-0.0222**	0.0069	-0.0012	0.0089*
PostxCost weight	0.0019***	0.0007***	0.0001***	0.0001***	0.0011***

Although not significant in all cases, the marginal effects across *CCL3* and *CCL4* after the policy change differ across the regions. In Column (8), the Taiarawhiti *CCL4* value is significant at the 5 percent level implying that after the introduction of transfer pricing there is a 2.2% reduction in the likelihood of high severity patients transferred from Taiarawhiti to Waikato. This is a counterintuitive result to both the hypothesis in Shin's work and those of this study. I would expect to see decreases in lower severity patients under these marginal interaction terms. The Northland (Column 7) and Midcentral (Column 11) results demonstrate the expected concentration of transfers to higher complexity cases with positive and larger *CCL3* and *CCL4* interaction terms than *CCL1* and *CCL2*. Results vary in magnitude with a 0.9% increase in Midcentral to a 2.8% increase Northland.

MORTALITY

In both the *mortality* and *readmission* regional regressions significance across variables of interest is weak. Although the overall sample sizes for the regions is high, the number of patients who die within 30 days or are readmitted within 30 days is very low. For those results in Table 10 that are significant, a decrease in *mortality* across the years analysed is observed. In Column (12), for the Northland sample, *Transfer* decreases the likelihood of *30-day mortality*.

Table 10 Effects of a policy change in transfer funding on 30-day Mortality outcomes for the regional samples

	(12) Northland-Auckland N=193,110	(13) Taiarawhiti-Waikato N=60,825	(14) Lakes-Waikato N=126,690	(15) Taranaki-Waikato N=110,748	(16) Midcentral-Capital&Coast N=115,943
2001	-0.0726	-0.1010	-0.0899	-0.0667	-0.0892
2002	-0.1743**	-0.2176	-0.0811	0.1020	-0.1105
2003	-0.1087	-0.3342**	-0.0022	0.1229	-0.1538*
2004	-0.2041**	-0.3495**	-0.0973	0.1542*	-0.2440***
2005	-0.3239***	-0.2062	-0.2007*	-0.0227	-0.2126**
2006	-0.3416***	-0.1377	-0.1305	0.2264**	-0.4484***
2007	-0.0911	-0.1784	-0.0976	-0.0991	-0.3772***
Transfer	-1.4243*	-0.8339	0.1752	-0.7254	0.5889
Cost weight	0.1163***	0.1270***	0.1386***	0.1117***	0.1297***
Marginal Effects of Interaction Terms					
2001xTransfer	-0.0079		0.0033	0.0137	-0.0057
2002xTransfer	-0.0001		0.0012	0.0566	-0.0333
2003xTransfer	0.0319**		0.0116	0.0606*	-0.0425**
2004xTransfer	0.0169**		-0.0032	0.0398*	-0.0307*
2005xTransfer	0.0163**		-0.0002		-0.0329**
2006xTransfer	0.0183**		-0.0073		-0.0338**
2007xTransfer	0.0179*		-0.0022	0.0121	-0.0178

Across Columns (12)-(16) *cost weight* is consistent and positive suggesting that as patient treatment becomes more expensive, and more complex, the likelihood of *30-day mortality* increases. Northland *mortality* marginal effects exhibit a concentration effect. After the policy change, likelihood of *30-day mortality* increases by 1.6%-3.2%. This implies that the likelihood of *30-day mortality* increases because only more serious cases are being sent. The transfer results suggest a larger increase in the likelihood of *CCL4* patients relative to *CCL0* as a result of the change in transfer funding, thus increasing the number of very severe transfers relative to overall transfers. The opposite occurs insignificantly in Column (14) for Lakes where, after the transfer pricing changes, there is an overall reduction in the likelihood of *mortality* compared to the year 2000. This may be attributed to localised improvements in healthcare practices or socioeconomic contributors. In the Midcentral analysis Column (16), the likelihood of *mortality* decreases consistently compared to 2000 with no apparent change in 2003.

LENGTH OF STAY

The *length of stay* analysis also demonstrates variation among districts in New Zealand, as outlined in Table 11. There is a decrease in *length of stay* compared to the base year, *2000* for Northland, Taiarawhiti, Lakes and Midcentral (Columns 17-20, respectively), although the magnitude of these decreases varies across the regions. Furthermore, Taranaki displays an increase in *length of stay* of 0.18 days in *2004*. For Midcentral, Northland and Taranaki *length of stay* decreases by two or more days for transfer patients. Although this does not align with the idea that more severe patients, who need longer hospital stays, are transferred it may reflect efficiency at the receiving hospital.

Table 11 Effects of a policy change in transfer funding on Length of Stay outcomes for the regional samples

	(17) Northland-Auckland N=193,110	(18) Taiarawhiti-Waikato N=60,825	(19) Lakes-Waikato N=126,690	(20) Taranaki-Waikato N=110,748	(21) Midcentral-Capital&Coast N=115,943
2001	-0.1208***	-0.0205	-0.1817***	0.0390	-0.1432**
2002	-0.1334***	-0.1895**	-0.4402***	-0.0302	-0.2086***
2003	-0.0707*	-0.2017***	-0.2576***	0.0222	-0.1861***
2004	-0.1230***	-0.1772**	-0.3293***	0.1765***	-0.4364***
2005	-0.2588***	-0.3647***	-0.5239***	0.1315**	-0.5679***
2006	-0.3272***	-0.4211***	-0.5382***	0.1400***	-0.6398***
2007	-0.3315***	-0.4913***	-0.4266***	0.1453***	-0.6269***
Transfer	-2.3940***	0.8875	-0.2964	-2.8204**	-5.3887***
Cost weight	2.0642***	2.7262***	2.4635***	2.2300***	2.2335***
Interaction Terms (OLS coefficients)					
2001xTransfer	0.6342	-1.7890	0.0767	0.1453	1.6792*
2002xTransfer	-0.4592	-0.4716	0.9670	-0.1300	0.6827
2003xTransfer	1.4317**	0.1970	1.9888***	1.6494	1.9090*
2004xTransfer	1.6580***	-2.6082	2.8541***	0.3534	0.5883
2005xTransfer	1.1400*	-2.4017	1.1715	1.8490	0.8795
2006xTransfer	1.5261**	-1.6210	1.4743**	2.7548	1.3361
2007xTransfer	1.9102***	-2.1761	-0.4355	0.2793	1.5322*

A concentration effect is once again observable in the Northland interaction terms, where after 2003 there is an increase in *length of stay* for transfers (1.4 days in 2003 up to 1.9 days in 2007). This could be caused by a relative increase in more severe patients that require longer hospital stays. The same effect can be weakly observed in the Lakes interaction terms. It should be noted that particularly for secondary to tertiary pair analysis such as this, the effects may have been much more pronounced if *length of stay* was not truncated at 90 days. Transfer patients tend to be *length of stay* outliers to extreme values and this is confirmed in the analysis

process. The positive relationship between *length of stay* and *cost weight* identified in the national analysis is reflected in the regional analysis. In all regions, a one unit increase in *cost weight* increases *length of stay* by 2 days. As highlighted before, this is due to the link between resource use and time spent in hospital.

30-DAY READMISSION

The significant marginal effects in the 30-day readmission analysis show a mix of outcomes for the regional pairs. On one hand, Midcentral (26) shows an increase in readmissions given that the patient is transferred for the later years while Taranaki (25) suggests that readmission decreases 8.8% and 9.3% for transfer patients in 2006-2007 respectively. Even for routinely admitted patients, likelihood of readmission fluctuates between regions and between years.

Table 12 Effects of a policy change in transfer funding on 30-day Readmission outcomes for the regional samples

	(22) Northland-Auckland N=193,110	(23) Taiarawhiti-Waikato N=60,825	(24) Lakes-Waikato N=126,690	(25) Taranaki-Waikato N=110,748	(26) Midcentral-Capital&Coast N=115,943
2001	-0.0085	-0.0414	.0509	0.0527	-0.0473
2002	0.0178	0.0378	0.1027**	0.0341	-0.0619
2003	0.0067	0.1080*	0.0398	0.0358	-0.1165***
2004	0.0064	0.0179	0.1308***	-0.0150	-0.1070***
2005	-0.0100	0.0147	0.1354***	-0.0953**	0.0562
2006	0.0103	0.0900	0.1453***	-0.0753*	0.0777*
2007	0.0604*	-0.0681	0.1815***	-0.1494***	0.1122***
Transfer	-1.2532***	-0.7968	-0.1241	-0.3059	-3.0802**
Cost weight	0.0555***	0.0416***	0.0443***	0.0252***	0.0449***
Marginal Effects of Interaction Terms					
2001xTransfer	0.0112	-0.02	-0.0205	-0.055	0.0053
2002xTransfer	0.0044	0.0239	-0.0164	-0.0656	0.0221
2003xTransfer	0.0176	-0.0168	0.0095		0.0282
2004xTransfer	0.0279	0.0292	-0.0657	-0.0465	0.0214
2005xTransfer	0.0296	0.0546	-0.0038	0.0634	-0.0103
2006xTransfer	0.0173	0.0583*	-0.0235	-0.0876**	0.0063*
2007xTransfer	0.0117	-0.0305	-0.0954	-0.0926***	0.0001*

As suggested by Rumball-Smith and Sarfati (2012) readmission of a patient is not necessarily reflective of the level of care provided while initially treated. The prevalence of readmission is more likely associated with the level of care post-discharge or the type of illness the patient is

diagnosed with. Further, the relationship between *transfer* and *readmission* shows little significance in these regressions possibly due to the nature of readmission for transfers. Specialist care at a hospital in another district may not be feasible for readmission.

Nonetheless, no clear change emerges as a result of the policy change in 2003. This suggests that a pricing mechanism shift for transfer patients has no measurable impact on the readmission rates of transfer patients. Further, I do not observe the same phenomenon found in Shin's work where a decreased length of stay is followed by increased readmission rates for transfer patients (2013). When comparing the *length of stay* and *readmission* outcomes for transfer patients in the regions, any significant results display increasing length of stay coupled with increasing readmission or decreasing length of stay coupled with decreasing readmission. This is more suggestive of a health-based explanation such as higher complexity cases requiring longer length of stay and increased probability of readmission as opposed to deliberate cost cutting behaviour by physicians.

45- AND 60-DAY READMISSION

The tables for regional *45-* and *60-day readmission* are presented in Appendix 5. The marginal effects of the interaction terms for these two sets of results were not calculated as they fall outside the scope of this study. A comparison with the 30-day readmission analysis reflects very little difference in the original coefficients and thus little value is added in computing and displaying these marginal effects as a main finding. The Northland analysis (Column 22) displays variation between the 30-day results and 45- and 60-day results for the year fixed effects. However, the variation occurs in 2002-2004 and 2006 suggesting that this is not due to the change in IDF fees. Expanding on the conclusion that the *30-, 45-* and *60-day readmission* results are highly similar, this suggests that any readmissions by hospitals are not considered on a performance basis. Readmission rates are low across the five regional pairs and incidence of readmission does not change markedly due to the change in transfer financing.

7.2 DISCUSSION

The results in this section clearly demonstrate that health outcomes vary at a regional level. Not only does this imply that a national change in transfer prices can have differing local effects, but also that the initial change from a single-purchaser contracted system to a decentralised local approach is in the best interests of the population. Given the variation in the outcomes studied as well as the characteristics of each region, it is necessary they should be able to modify the allocation of funds and provision of health services to suit the healthcare needs of those in their immediate populations. The New Zealand healthcare system under the NZPHDA 2000 is a simple network of purchaser-providers that can adequately cater for their local populations while working closely with a network of purchaser-providers for extended care. Internationally, this is most certainly a case of "easier said than done". The health systems of Canada, Germany and the United Kingdom have been briefly reviewed in Section 3. Their health systems are, in general, larger, fragmented, more complicated and less efficient. It is obvious that the small scale and geographic distribution of the New Zealand population lends itself to the structure described above.

This is reinforced by the substantial variation between the national analysis and the regional analysis. Encouragingly, likelihood of *transfer* increases for CCL3 and CCL4 interaction terms in significant regional results compared to the unusual observation in the national sample. The increased likelihood of *mortality* for transfers in the Northland results is unusual especially after controlling for ethnicity and education. Additional controls for income, incidence of crime and additional social welfare support may help to explain transfer mortality as the Northland and Auckland regions vary in these respects. This data was not available to me at the time of analysis.

I picked the regions based on magnitude of transfer flow in a single direction. Waikato has three feeder regions, Northland has only Auckland as an immediately proximate transfer choice, Wellington may be diluted by transfers to Waikato and Canterbury. There is also limited disruption from transfers that are not executed based on proximity to the higher-level hospital but more specifically to a hospital that has specialised equipment or doctors. This type of transfer may be to a DHB that is in a different location entirely. An example is hyperbaric services. There are two hospitals in New Zealand that offer Hyperbaric services; Christchurch Hospital (Canterbury DHB) and North Shore Hospital (Waitemata DHB). Transfers for

hyperbaric services would therefore not necessarily go to the nearest tertiary hospital and would instead need to be transferred to one of these two locations. These are *mostly* covered under the National Services Programme and are therefore not coded or funded as transfers.

8. Robustness Checks

8.1 Results

This section discusses results from the *Qualification Award Category Code* subsample, the *Major Diagnostic Category 5* subsample and the *Diagnosis Related Grouping 297* subsample. They are compared with the main national analysis in Section 6. There is also a short discussion on *DRGs 274* and *246* with all results included in Appendix 6. This analysis is done at a national level, as the regional subsamples are prohibitively small.

Education Analysis

This subsample has some differences from the main analysis indicating that the education control may not be an efficient control and a more suitable control for individual variation in health would be beneficial. The key finding thus far is a focussing effect where the general likelihood of transfers reduces after the introduction of transfer pricing, but the likelihood of transfer to a tertiary hospital increases. The biggest point of departure is the *30-day mortality* regression where the results vary in both sign and magnitude. The *transfer* and the *length of stay* interaction terms are in line with their national equivalents. There are large differences in the *mortality* and *readmission* results. The *education* subsample is the only robustness check where you observe these differences and the *MDC* and *DRG* subsamples align with the national analysis. The use of an education control is discussed in depth as part of Section 9.

MDC 5 Analysis

Major Diagnostic Category 5 is the study of diseases and disorders of the circulatory system. Analysing a set "umbrella" of diagnoses allows me to narrow the variation in treatment that could be affecting transfer patterns. MDC 5 has the highest volume of transfer cases within the national sample as shown in Table 13. One key reason for this is that diagnoses involving heart attacks (myocardial infarction) are coded within this category.

The results suggest the same transfer "focus" effect that occurs in both the *education* subsample and the national analysis. The pervasiveness of this effect is reassuring and suggests that regardless of the controls in place, the policy has caused a shift from large scale generic transfer of patients toward a more focussed transfer of patients for specialist treatment. Where significant, the results align closely with those of the national sample.

Table 13 Frequency of transfer by MDC during the period of analysis

Major Diagnostic Category	Frequency	Percent
5	27,945	43.5
1	6,618	10.3
8	4,947	7.7
14	4,866	7.57
11	4,107	6.39
4	2,616	4.07
21	2,304	3.59
6	1,674	2.61
3	1,578	2.46
23	1,578	2.46
18	1,005	1.57

Decreases in 30-day mortality are small and consistent suggesting no change around 2003 due to the change in transfer fee. For diseases related to the circulatory system, *30-day readmission* displays markedly different results. Not only are the results more robust here than in the national sample, they are also negative indicating that individuals treated under MDC 5 are less likely to be readmitted in all years. From 2003 to 2007 the coefficient is fairly stable suggesting an approximate 7% decrease in readmission for these years. For those values that are significant, a decrease in *readmission* after the policy change is observed. The 2.4 day decrease in *length of stay* associated with transfer in is more pronounced for MDC 5 compared to the national sample and the effect of *cost weight* on *length of stay* is halved. The year fixed effects and transfer interaction effects are in line with those of the national sample.

DRG ANALYSIS

The DRGs performed very differently. This is by far the most experimental part of my thesis. The results are erratic, and this accurately reflects the nature of transfers on an annual basis. Anecdotal evidence from DHB discussions suggests that IDF flows for individual diagnoses can vary greatly and unpredictably. Physician availability, illness prevalence and treatment options are not consistent over time. Although this can be interpreted as a discouraging statistical conclusion, it represents the true nature of transfers over time. Undoubtedly, and as seen in Sections 6 and 7, there are overall impacts due to the change in IDF funding but at an individual diagnosis level, it would be very difficult to suggest a conscious change in behaviour on the part of the physician when making the transfer decision. This highly specific approach could be refined in further research for a multitude of DRGs similar to the study done by Rouse et al. (2010) in order to gain a better understanding of individual diagnosis behaviour and how a single DRG is affected by price.

The point of difference in the study of specific diagnoses is the precision with which changes can be identified. The three DRGs identified have the highest flow of transfers at a national level as shown in Table 14.

Table 14 Three highest transfer DRGs by frequency over the period of analysis

Diagnosis Related Grouping (V3.1)	Frequency	Percent
297	8,514	13.25
246	3,933	6.12
274	2,970	4.62

A major drawback of this analysis is the sample sizes and specifically the small proportion of transfers relative to routine admissions, deaths within 30 days and readmissions within 30 days that hamper the significance of these results. Interestingly, DRGs 274 and 246 are classed as low or no complication diagnoses. The data is limited to CLL 0-2 with no highly complex cases. This suggests that all transfers in these DRGs are done based on the procedure or treatment type and not the complexity of the case. Not surprisingly, the results suggest decreases in the likelihood of *transfer* for these DRGs after the change in funding flows. This is consistent with the hypothesis that necessary transfers are more likely at higher levels of complexity.

Compared with the national sample, *DRG 297* (*trans-vascular percutaneous cardiac intervention*) is the only subsample to produce an increase in transfers after the policy change. This is coupled with the increase in transfers to tertiary facilities as observed in all other samples. DRG 297 is the insertion of a stent or catheter to reopen blood vessels previously blocked by plaque build-up (Grech, 2003). The factors that commonly contribute to heart conditions such as angina are becoming more common. These include mental stress, consumption of alcohol or large meals, and factors that may increase coronary tone such as drugs and hormonal change. These are also factors that are commonly associated with the population groups in New Zealand that are at higher risk of adverse health effects such as Maori and Pacific ethnicities, lower socioeconomic groups, older males and rural communities.

8.2 Discussion

Across all the empirical analysis conducted, the key finding of a focus effect is present. This occurs were the overall likelihood of transfer decreases but the likelihood of transfer to a tertiary facility increases. In the regional subsample this is reflected as an increase in likelihood of transfer. This holds for groups of diagnoses such as MDC 5 and individual diagnoses such as DRGs 297, 274 and 246. One limitation regarding the latter individual diagnoses is sample size. There is a clear trade-off between regional specificity and diagnosis specificity. The sample size for a single diagnosis at regional level is too small to gain highly significant results over such a small time period but the variation in treatment and case severity increases as geographical scope increases to national size. Additionally, as discussed in Section 3.5, DRG coarseness is an issue that can potentially confound the accuracy of factors such as *cost weight*, severity and probability of transfer due to the granularity of DRGs. An extension of this study could consider the impacts of policy changes, such as this one, on specific DRGs adding a control for coarseness.

An additional aspect I would have liked to investigate is a model that allows me to keep the outliers of *length of stay* (>90) and *age at admissi*on (<18). The use of outliers biases the overall results and violates the assumptions under OLS and Logit analysis. However, these outlying patient groups are most likely to be transferred and receive specialist care, so I would expect much stronger effects or no effect at all. Children and length of stay outliers tend to have

higher CCLs and more complex cases that necessitate transfer. Even with a cost mechanism in place it is likely that these groups of patients would still require transfer.

The use of *education* as a socioeconomic control variable has its limitations. As discussed in Section 6.2, the use of any number of social controls fails to perfectly account for exogenous variation in patient outcomes. As such, prior to using MoE data, I tested the use of an occupation variable held within the MoH NMDS and tried to retrieve individual income data form the IR database. Similar to the education data, occupation is available for approximately half of the total sample but is not as reflective of the link between education and health. Occupation is not solely determined by qualification and groupings used in the Australia and New Zealand Standard Classification of Occupation (ANZSCO) framework rely on hierarchy of sector and management levels. At higher levels, this does not distinguish between, for example, an agricultural farmer and a crop farmer, for whom both education and income may vary. The income data stored with the IDI is comprehensive, but is out of the scope of this research. The merging of IR data required matching to a central spine and additional modification before it could be merged with the existing MoH data sample. This was far more complex than the merging of the education and mortality data. Further study in this area would benefit from including a more robust socioeconomic measure or harnessing the completeness of the IR income data available.

9. CONCLUSION

The introduction of Inter-District Flow funding of transfers in 2003 decreased the overall probability of transfer while increasing the probability of transfer to tertiary providers. This result indicates a clear focus of the transfer mechanism to only those facilities where redistribution of funds is the most necessary to sustain specialist services. It also suggests that hospitals with specialist services, after the policy change, are utilising their services for both their own populations and those of other districts.

One implication of this is the concentration effect I observe in the health outcomes analysed. In several of the national, regional and subsample tests, health outcomes worsened after the introduction of the transfer fees. This implies that prior to 2003, patients with less severe diagnoses were being sent alongside patients with more severe diagnoses, diluting the average severity of transfer patient health outcomes. Combined with this focus of transfers to tertiary providers, this suggests that the poorer health outcomes observed are a positive signal that only the most severe patients are being transferred. This is reinforced by post-policy reductions in transfer of DRG 274 and 246, both of which are low severity diagnoses, and stronger transfer effects for *CCL3* and *CCL4* interaction terms. It suggests that the policy change has the intended effect of reducing less severe or less necessary transfers.

The findings of this research suggest an improvement in the overall efficiency of transfer procedure in the New Zealand public health system. This regional analysis is a novel addition to Shin (2013) and it reflects the need for a decentralised system in which districts are able to cater for the needs of the local population. Further, New Zealand is small and simple enough that these decentralised units can be monitored by an overarching central government agency. There are significant variation between the results of the DHB pairs suggesting that local agreements, degree of cooperation and local health needs have a greater effect on the transfer decision than the cost of transfer. The transfer mechanism illustrates that a decentralised system can still function efficiently when centralised services are included for specialised treatment, so long as payment is aligned with service provision.

From the perspective of cost, it is clear that the introduction of a monetary incentive changed provider behaviour. Prior to the policy change, transfers were more common and not necessarily sent to tertiary providers. After the implementation of the policy, results show that the transfer decision concentrates on higher severity cases and tertiary providers. This achieves a redistribution of funds from secondary DHBs with high per capita funding to tertiary DHBs where per capita funding is lower. It also reduces the overall costs within the healthcare system as unnecessary transfers are retained at the secondary DHBs and do not receive arguably more expensive specialist services.

The New Zealand healthcare system is complicated, with 20 separate units throughout the country all individually purchasing and providing healthcare for its constituents. Thus, there are five mechanisms that I suggest could explain the findings outlined in this research. (1) High transfer prices; a recent study argues that transfer prices are set too high thus reducing the transfer of patients on a cost basis (Van Kesteren et al., 2017). (2) MoH guidelines; support a "keep it local" approach, encouraging healthcare providers to retain patients to keep them near support networks, their workplace and community. This would also motivate a decrease in IDFs. (3) Retention of high funding; the allocation of funds to each DHB includes adjusters that target high-cost portions of the population. These areas are seldom areas in which tertiary DHBs are located, thus allocating high levels of funding to secondary DHBs with the purpose of redistribution, through transfer, to the tertiary DHBs. However, Ashton et al. (2008) suggest that budget deficits held by the DHBs from 2000 onwards encouraged secondary DHBs to reduce IDFs and retain this higher level of funding. (4) DHB politics; as transfers often reduce the performance measures and increase the costs of tertiary hospitals in comparison with lower-level hospitals, they are often targeted by health boards as a source of inefficiency (Gordon & Rosenthal, 1996). This negative purview of transfer by the DHBs has the capacity to reduce IDFs. (5) Low transfer prices; an alternate study suggests that transfer prices are set too low and are not reimbursing tertiary hospitals adequately for their services (Shin et al. 2017). Low prices imply a potential underestimation of a price effect on IDFs. Given repricing to accurate cost, the reduction in transfers may be even greater. It is unclear what combination of these five mechanisms have influenced the results of this study and further analysis of these mechanisms is an interesting opportunity for further research.

10. Limitations, Policy Implications and Further Research

The main limitation of this research is the timing of the policy changes analysed. The 1997 quasi-market approach was closely followed by the 2000 NZPHDA and the PBFF was then introduced in 2003 followed by further additions to the new NZPHDA in 2008. The effects of the transfer policy change are encased in this tumultuous ten-year period making it very difficult to separate out effects of transfer payment with those of the other changes around this time. The only way to separate out these effects was to limit the time period analysed to the nearest change on either side which impacts the sample size and strength of effects observed. This reinforces the need for consistent health policy that builds on previous policy rather than reversing it. Not only is this beneficial for data continuity and policy analysis but also for the effectiveness of system implementation. It is clear that the longer adjustment periods amplify policy effectiveness.

As Penno et al. (2012) point out, there is a significant amount of opacity surrounding the PBFF and the process of IDF fund allocation. From a research perspective, this hinders my ability to reproduce similar data and understand the incentives of healthcare providers with respect to funding decisions. From a provider perspective, uncertainty surrounding payment for services can restrict the efficiency of the system and cause reluctance to accept transfers if payment processes are not well defined. This is further emphasised in the transfer pricing paper by Van Kesteren et al. (2017).

Anecdotal evidence from DHB discussions suggest that the settlement of IDF funding flows can take up to 2 years and these lags can affect the accuracy of forecasting future funding flows. It may in turn increase the magnitude of wash-up payments between DHBs. Within the limited scope of my study I did not observe any lags in the year fixed effects, however this would be an avenue for further research. It would be useful to explore the current IDF transfer system and analyse the timing of payment flows and any possible impact this might have on provider funding and patient health outcomes. It also highlights the importance of speaking with individuals involved in the healthcare system. This study relies heavily on quantitative data to form conclusions regarding the change in IDF policy. Useful additional data would include surveys or interviews with key DHB staff regarding the transfer process and how the

practicalities of the system work on a daily basis. This would enable me to assess whether the patterns I observe in the data are consistent with what they observe in their everyday transactions.

DHB funding covers four main areas: Personal Health Other, Personal Health Primary, Health of Older People and Mental Health. A schematic of the division of funding and what is included under each area is given in Appendix 7. This research focusses specifically on the Inpatient Services subsection of Personal Health Other but there are twelve other subsections in total each of which are covered under the same PBFF formula and would incur the same funding changes analysed here. An avenue of further research would be to replicate this study for services such as Mental Health, Pharmaceutical or Aged Residential Care for which there are additional factors at play. Mental Health among Maori and Pacific ethnicities is a particular issue especially in rural regions. Pharmaceutical services are interesting from an economic point of view due to the informational asymmetries and externality problems. Finally, Aged Residential Care in New Zealand and countries around the world is experiencing drastic increases in demand as the baby-boomer generation enters retirement. How the funding system will cope with this surge in demand is an important point of investigation.

Given the decentralised structure of the healthcare system, a concern raised by this study is a potential underutilisation or discouragement of the transfer mechanism. New Zealand is too small geographically and demographically to provide specialist services within each DHB. The concern is that the IDF payment methodology is slow and hampered by varying levels of patient data infrastructure across DHBs. A more streamlined approach to commonly-transferred diagnoses is called for. This study suggests change in policy that reallocates funding more fairly to tertiary DHBs, where advanced treatment is provided, improves transfer rates to these providers. Thus, there may be scope for further transfer increases to these specialist facilities given further improvements in the transfer process. One example of this is the National Services Framework (NSF) which uses Top Slice funding to allocate funds directly to specialist providers who are then obligated to take on cases from all DHBs for services such as organ transplants and severe burns. Further research into the uses and expansion of NSF services would shed light on the necessity of patient transfer as well as the cost efficiencies that could yet be achieved.

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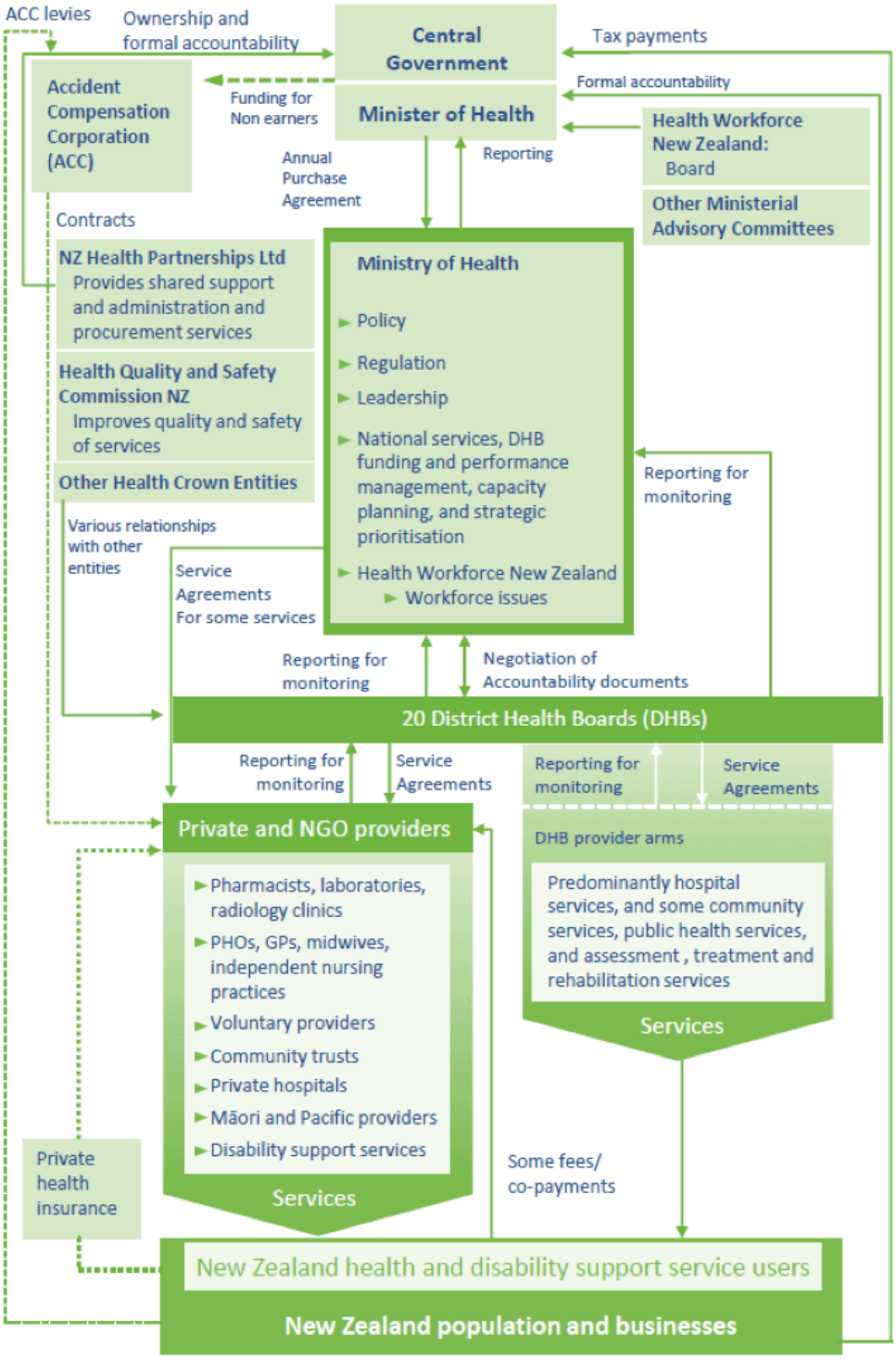
APPENDIX 1: STRUCTURE OF THE NEW ZEALAND HEALTH SYSTEM 2003



Source: Ministry of Health (2017c).

APPENDIX 2: PRIORITISED ETHNICITY

Groupings as per Prioritised Ethnicity priority levels

PBFF Category	Priority Order	Level 1	Level 2
Māori	1	Māori	Māori
Pacific	2	Pacific Island	Tokelau Fijian Nuiean Tongan Cook Island Māori Samoan Other Pacific Island Pacific Island Not Further Defined
Other	3	Asian	South East Asian Indian Chinese Other Asian Asian Not Further Defined
	3	Other ethnic groups	Latin American/Hispanic African Middle Eastern Other
	3	European	Other European European Not Further Defined New Zealand European

Source: Penno et al. (2012, p. 41)

Groupings as per the dummy variables used in empirical analysis		
Grouping	Code	Ethnicity
NZ European	11	NZ European
Maori	21	Maori
Pacific	30	Pacific not further defined
	31	Samoan
	32	Cook Island Maori
	33	Tongan
	34	Niuean
	35	Tokelauan
	36	Fijian
	37	Other Pacific Island
Asian	40	Asian not further defined
	41	South East Asian
	42	Chinese
	43	Indian
	44	Other Asian
Other	51	Middle Eastern
	52	Latin American/Hispanic
	53	African
	54	Other (retired 01/07/2009)
	61	Other ethnicity
	94	Don’t know
	95	Refused to answer
	97	Response unidentifiable
	99	Not stated

APPENDIX 3: REGIONAL SUMMARY STATISTICS

Variable	Mean	Standard Deviation	Minimum	Maximum
Northland-Auckland				
I. Full Northland-Auckland Dataset 30/06/2000-01/07/2008 N=193,110				
Length of Stay	2.690353	4.465362	0	90
30-day Mortality	0.0216561	0.1455582	0	1
30-Day Readmission	0.1434882	0.3505709	0	1
45-Day Readmission	0.1727824	0.37806	0	1
60-Day Readmission	0.1953757	0.3964907	0	1
Transfer	0.0209259	0.1431367	0	1
Post	0.6972037	0.459469	0	1
Tertiary	0.0622443	0.2415994	0	1
CCL0	0.2186215	0.4133123	0	1
CCL1	0.4998084	0.5000013	0	1
CCL2	0.1973642	0.3980105	0	1
CCL3	0.0684377	0.2524961	0	1
CCL4	0.0157682	0.1245779	0	1
Gender (female)	0.5645176	0.4958213	0	1
NZ European	0.5543421	0.4970395	0	1
Maori	0.3337942	0.4715684	0	1
Pacific	0.0076537	0.08715	0	1
Asian	0.0053079	0.0726616	0	1
Other	0.0989022	0.2985314	0	1
Age at Admission	53.75922	20.52134	18	S
Cost Weight	0.9855372	1.450006	S	S
Post Graduate	0.0105484	0.1021625	0	1
Under Graduate	0.0610119	0.2393527	0	1
High School	0.2355756	0.4243591	0	1
Vocation	0.0011807	0.0343407	0	1
No Education	0.6916835	0.4617992	0	1
II. Pre-Policy Change 30/06/2000-01/07/2003 N=58,473				
Length of Stay	2.667419	4.399956	0	86
30-day Mortality	0.0245754	0.1548286	0	1
30-Day Readmission	0.1482052	0.3553063	0	1
45-Day Readmission	0.1800318	0.3842172	0	1
60-Day Readmission	0.2042994	0.4031922	0	1
Transfer	0.0123305	0.1103569	0	1
Post	0	0	0	0
Tertiary	0.0349392	0.1836274	0	1
CCL0	0.2472594	0.4314225	0	1
CCL1	0.480615	0.4996284	0	1
CCL2	0.1961589	0.3970936	0	1
CCL3	0.0619602	0.2410853	0	1
CCL4	0.0140065	0.1175182	0	1
Gender (female)	0.530125	0.4990959	0	1

NZ European	0.5622253	0.4961171	0	1
Maori	0.3149317	0.4644926	0	1
Pacific	0.005866	0.0763652	0	1
Asian	0.0039847	0.0629995	0	1
Other	0.1129923	0.3165861	0	1
Age at Admission	55.17524	20.11785	18	S
Cost Weight	0.9421285	1.290597	S	S
Post Graduate	0.0096968	0.0979945	0	1
Under Graduate	0.0486891	0.2152192	0	1
High School	0.1947737	0.3960297	0	1
Vocation	0.0014537	0.0380995	0	1
No Education	0.7453868	0.4356473	0	1
III. Post-Policy Change 01/07/2003-01/07/2008 N=134,535				
Length of Stay	2.700378	4.494245	0	90
30-day Mortality	0.0203816	0.1413024	0	1
30-Day Readmission	0.1414151	0.3484505	0	1
45-Day Readmission	0.1696238	0.3753034	0	1
60-Day Readmission	0.1914846	0.393471	0	1
Transfer	0.0246631	0.1550968	0	1
Post	1	0	1	1
Tertiary	0.0741231	0.2619721	0	1
CCL0	0.2062096	0.4045843	0	1
CCL1	0.5081356	0.4999357	0	1
CCL2	0.1978622	0.3983892	0	1
CCL3	0.0712613	0.2572618	0	1
CCL4	0.0165313	0.1275072	0	1
Gender (female)	0.5794563	0.4936482	0	1
NZ European	0.5509578	0.4973984	0	1
Maori	0.3419458	0.4743633	0	1
Pacific	0.0084292	0.091423	0	1
Asian	0.005887	0.0765011	0	1
Other	0.0927802	0.2901253	0	1
Age at Admission	53.14495	20.66544	18	S
Cost Weight	1.004425	1.514018	S	S
Post Graduate	0.0109267	0.1039585	0	1
Under Graduate	0.0663034	0.2488127	0	1
High School	0.2532984	0.434902	0	1
Vocation	0.0010629	0.0325855	0	1
No Education	0.6684085	0.4707868	0	1
Taranaki-Waikato				
I. Full Taranaki-Waikato Dataset 30/06/2000-01/07/2008 N=110,745				
Length of Stay	3.138931	4.628963	0	90
30-day Mortality	0.0290033	0.1678165	0	1
30-Day Readmission	0.1465877	0.353696	0	1
45-Day Readmission	0.1816589	0.3855649	0	1
60-Day Readmission	0.2080978	0.405949	0	1

Transfer	0.0040453	0.0634741	0	1
Post	0.6284651	0.4832172	0	1
Tertiary	0.0332382	0.1792588	0	1
CCL0	0.2147075	0.4106211	0	1
CCL1	0.492379	0.4999442	0	1
CCL2	0.1971538	0.3978513	0	1
CCL3	0.0779802	0.2681417	0	1
CCL4	0.0177794	0.1321494	0	1
Gender (female)	0.5801203	0.4935412	0	1
NZ European	0.7309068	0.4434905	0	1
Maori	0.1345782	0.3412741	0	1
Pacific	0.0043072	0.0654877	0	1
Asian	0.0068264	0.0823401	0	1
Other	0.1233814	0.328876	0	1
Age at Admission	56.72656	21.31914	18	S
Cost Weight	1.056061	1.336275	S	S
Post Graduate	0.0102216	0.1005843	0	1
Under Graduate	0.0543406	0.2266895	0	1
High School	0.1571163	0.363912	0	1
Vocation	0.000605	0.0245892	0	1
No Education	0.7777166	0.4157825	0	1
II. Pre-Policy Change 30/06/2000-01/07/2003 N=41,148				
Length of Stay	2.922374	4.326604	0	80
30-day Mortality	0.0298449	0.1701615	0	1
30-Day Readmission	0.1599913	0.3666024	0	1
45-Day Readmission	0.1967627	0.3975563	0	1
60-Day Readmission	0.2257814	0.4181009	0	1
Transfer	0.0036699	0.0604688	0	1
Post	0	0	0	0
Tertiary	0.0340009	0.1812336	0	1
CCL0	0.2592962	0.4382537	0	1
CCL1	0.4603607	0.4984323	0	1
CCL2	0.1954747	0.3965705	0	1
CCL3	0.0684392	0.2525012	0	1
CCL4	0.0164293	0.1271211	0	1
Gender (female)	0.5350945	0.4987729	0	1
NZ European	0.7371555	0.440184	0	1
Maori	0.1159773	0.3202015	0	1
Pacific	0.0035969	0.0598673	0	1
Asian	0.0046177	0.0677974	0	1
Other	0.1386526	0.3455878	0	1
Age at Admission	59.01913	20.27304	18	S
Cost Weight	1.003067	1.243117	S	S
Post Graduate	0.0082876	0.0906591	0	1
Under Graduate	0.0412677	0.1989111	0	1
High School	0.1211053	0.3262536	0	1

Vocation	0.0003889	0.0197159	0	1
No Education	0.8289506	0.3765567	0	1
III. Post-Policy Change 01/07/2003-01/07/2008 N=69,546				
Length of Stay	3.267621	4.795436	0	90
30-day Mortality	0.0284991	0.1663951	0	1
30-Day Readmission	0.1386564	0.3455901	0	1
45-Day Readmission	0.172749	0.3780328	0	1
60-Day Readmission	0.1976534	0.3982321	0	1
Transfer	0.0042706	0.0652103	0	1
Post	1	0	1	1
Tertiary	0.0327841	0.1780722	0	1
CCL0	0.1883502	0.3909943	0	1
CCL1	0.5113594	0.4998745	0	1
CCL2	0.1980991	0.3985701	0	1
CCL3	0.0835993	0.276788	0	1
CCL4	0.018592	0.13508	0	1
Gender (female)	0.6067495	0.4884752	0	1
NZ European	0.7272021	0.445401	0	1
Maori	0.1455727	0.3526799	0	1
Pacific	0.0047307	0.0686176	0	1
Asian	0.0081385	0.0898464	0	1
Other	0.114356	0.3182454	0	1
Age at Admission	55.37001	21.80285	18	S
Cost Weight	1.087526	1.387778	S	S
Post Graduate	0.0113594	0.1059741	0	1
Under Graduate	0.0620596	0.2412656	0	1
High School	0.178443	0.382888	0	1
Vocation	0.0007333	0.0270703	0	1
No Education	0.7474046	0.4345039	0	1
Lakes-Waikato				
I. Full Lakes-Waikato Dataset 30/06/2000-01/07/2008 N=126,690				
Length of Stay	2.962136	4.907128	0	89
30-day Mortality	0.0208621	0.1429232	0	1
30-Day Readmission	0.1354893	0.3422468	0	1
45-Day Readmission	0.1628002	0.3691848	0	1
60-Day Readmission	0.183986	0.3874743	0	1
Transfer	0.0120768	0.1092294	0	1
Post	0.6991452	0.4586315	0	1
Tertiary	0.1034896	0.3045985	0	1
CCL0	0.241118	0.4277634	0	1
CCL1	0.5213476	0.499546	0	1
CCL2	0.1700305	0.3756611	0	1
CCL3	0.0557902	0.229517	0	1
CCL4	0.0117137	0.1075946	0	1
Gender (female)	0.6070061	0.4884174	0	1
NZ European	0.4859538	0.4998046	0	1

Maori	0.3822037	0.4859279	0	1
Pacific	0.018652	0.1352931	0	1
Asian	0.0139475	0.1172737	0	1
Other	0.099243	0.2989892	0	1
Age at Admission	50.35974	20.7437	18	S
Cost Weight	0.9217542	1.304513	S	S
Post Graduate	0.0138844	0.1170116	0	1
Under Graduate	0.087332	0.282322	0	1
High School	0.2628326	0.440174	0	1
Vocation	0.0014445	0.037979	0	1
No Education	0.6345065	0.4815702	0	1
II. Pre-Policy Change 30/06/2000-01/07/2003 N=38,115				
Length of Stay	3.212384	5.283588	0	86
30-day Mortality	0.0235603	0.1516766	0	1
30-Day Readmission	0.1369277	0.3437755	0	1
45-Day Readmission	0.1656303	0.3717533	0	1
60-Day Readmission	0.1884822	0.3911019	0	1
Transfer	0.0111242	0.1048846	0	1
Post	0	0	0	0
Tertiary	0.1177227	0.3222837	0	1
CCL0	0.2356028	0.4243805	0	1
CCL1	0.496445	0.4999939	0	1
CCL2	0.1900826	0.3923713	0	1
CCL3	0.0642792	0.2452528	0	1
CCL4	0.0135904	0.1157847	0	1
Gender (female)	0.5564738	0.496807	0	1
NZ European	0.5130264	0.4998368	0	1
Maori	0.3550046	0.478521	0	1
Pacific	0.0218549	0.1462116	0	1
Asian	0.0098911	0.0989623	0	1
Other	0.100223	0.3003011	0	1
Age at Admission	51.94653	20.54579	18	S
Cost Weight	0.9718046	1.421572	S	S
Post Graduate	0.0121999	0.1097789	0	1
Under Graduate	0.0693165	0.253995	0	1
High School	0.2266562	0.4186738	0	1
Vocation	0.0018103	0.0425098	0	1
No Education	0.6900171	0.4624923	0	1
III. Post-Policy Change 01/07/2003-01/07/2008 N=88,533				
Length of Stay	2.854719	4.732629	0	89
30-day Mortality	0.0196991	0.1389649	0	1
30-Day Readmission	0.1348778	0.3415949	0	1
45-Day Readmission	0.1615687	0.3680568	0	1
60-Day Readmission	0.1820359	0.3858763	0	1
Transfer	0.0124814	0.1110212	0	1
Post	1	0	1	1

Tertiary	0.0973546	0.2964417	0	1
CCL0	0.2435052	0.4291998	0	1
CCL1	0.5320449	0.4989749	0	1
CCL2	0.1614219	0.3679217	0	1
CCL3	0.0521393	0.2223092	0	1
CCL4	0.0108887	0.1037799	0	1
Gender (female)	0.6287444	0.4831434	0	1
NZ European	0.4742692	0.4993403	0	1
Maori	0.3939028	0.4886165	0	1
Pacific	0.0172819	0.1303204	0	1
Asian	0.0157005	0.1243149	0	1
Other	0.0988456	0.2984563	0	1
Age at Admission	49.67779	20.79186	18	S
Cost Weight	0.9003013	1.250381	S	S
Post Graduate	0.0146049	0.1199656	0	1
Under Graduate	0.0951294	0.2933953	0	1
High School	0.278453	0.4482401	0	1
Vocation	0.0012877	0.0358612	0	1
No Education	0.610525	0.487634	0	1

Taiarawhiti-Waikato

I. Full Taiarawhiti-Waikato Dataset 30/06/2000-01/07/2008 N=60,825

Length of Stay	3.088682	5.200265	0	87
30-day Mortality	0.0228199	0.1493304	0	1
30-Day Readmission	0.1435289	0.3506143	0	1
45-Day Readmission	0.1716428	0.3770728	0	1
60-Day Readmission	0.1938708	0.3953321	0	1
Transfer	0.0091905	0.0954261	0	1
Post	0.6623866	0.4728999	0	1
Tertiary	0.0577075	0.2331914	0	1
CCL0	0.2046561	0.4034534	0	1
CCL1	0.5491253	0.4975849	0	1
CCL2	0.1724813	0.3778013	0	1
CCL3	0.0598284	0.2371705	0	1
CCL4	0.013909	0.1171143	0	1
Gender (female)	0.5967381	0.4905565	0	1
NZ European	0.4649974	0.4987774	0	1
Maori	0.4667565	0.4988977	0	1
Pacific	0.0105386	0.1021162	0	1
Asian	0.004439	0.0664786	0	1
Other	0.0532684	0.2245701	0	1
Age at Admission	51.93163	20.3098	18	S
Cost Weight	0.9674113	1.29463	S	S
Post Graduate	0.0135637	0.1156718	0	1
Under Graduate	0.0780284	0.2682185	0	1
High School	0.2767164	0.4473787	0	1
Vocation	0.0012495	0.0353266	0	1

No Education	0.6304419	0.4826891	0	1
II. Pre-Policy Change 30/06/2000-01/07/2003 N=20,535				
Length of Stay	3.246652	5.391526	0	87
30-day Mortality	0.0252252	0.1568123	0	1
30-Day Readmission	0.1436085	0.3507008	0	1
45-Day Readmission	0.1757	0.380574	0	1
60-Day Readmission	0.1990748	0.3993141	0	1
Transfer	0.0070124	0.0834481	0	1
Post	0	0	0	0
Tertiary	0.0523009	0.2226387	0	1
CCL0	0.2025323	0.4018965	0	1
CCL1	0.5420989	0.4982367	0	1
CCL2	0.1841247	0.3875953	0	1
CCL3	0.0580959	0.2339305	0	1
CCL4	0.0131483	0.1139124	0	1
Gender (female)	0.5931337	0.4912615	0	1
NZ European	0.4730947	0.4992877	0	1
Maori	0.4451911	0.496999	0	1
Pacific	0.0083272	0.0908752	0	1
Asian	0.0029705	0.054423	0	1
Other	0.0704164	0.2558536	0	1
Age at Admission	52.06798	20.34455	18	S
Cost Weight	0.9636678	1.234402	S	S
Post Graduate	0.0143657	0.1189959	0	1
Under Graduate	0.0668128	0.2497035	0	1
High School	0.2494765	0.4327206	0	1
Vocation	0.0013148	0.0362376	0	1
No Education	0.6680302	0.4709317	0	1
III. Post-Policy Change 01/07/2003-01/07/2008 N=40,263				
Length of Stay	3.008668	5.099326	0	87
30-day Mortality	0.0215831	0.1453196	0	1
30-Day Readmission	0.1435064	0.3505929	0	1
45-Day Readmission	0.169585	0.3752724	0	1
60-Day Readmission	0.1911929	0.3932455	0	1
Transfer	0.0103072	0.1010012	0	1
Post	1	0	1	1
Tertiary	0.0604525	0.2383263	0	1
CCL0	0.205772	0.4042697	0	1
CCL1	0.5526414	0.4972273	0	1
CCL2	0.1665301	0.3725604	0	1
CCL3	0.0607506	0.2388752	0	1
CCL4	0.0143059	0.1187503	0	1
Gender (female)	0.5985893	0.4901899	0	1
NZ European	0.4609691	0.4984805	0	1
Maori	0.4776842	0.499508	0	1
Pacific	0.0116732	0.1074117	0	1

Asian	0.005166	0.0716901	0	1
Other	0.0445074	0.206222	0	1
Age at Admission	51.86301	20.29378	18	S
Cost Weight	0.9692233	1.32389	S	S
Post Graduate	0.0131635	0.1139759	0	1
Under Graduate	0.083799	0.2770896	0	1
High School	0.2905645	0.4540285	0	1
Vocation	0.001217	0.0348647	0	1
No Education	0.611256	0.487471	0	1
		Midcentral-Capital&Coast		
		I. Full Midcentral-Capital&Coast Dataset 30/06/2000-01/07/2008 N=155,943		
Length of Stay	3.171674	5.344503	0	90
30-day Mortality	0.0210721	0.1436251	0	1
30-Day Readmission	0.1344868	0.3411756	0	1
45-Day Readmission	0.1620549	0.3685023	0	1
60-Day Readmission	0.1838452	0.3873591	0	1
Transfer	0.0094331	0.0966651	0	1
Post	0.726621	0.4456952	0	1
Tertiary	0.0491853	0.2162554	0	1
CCL0	0.237545	0.4255802	0	1
CCL1	0.5051718	0.4999749	0	1
CCL2	0.1709813	0.3764939	0	1
CCL3	0.0710782	0.2569562	0	1
CCL4	0.0152237	0.122442	0	1
Gender (female)	0.5979505	0.4903134	0	1
NZ European	0.7260118	0.4460044	0	1
Maori	0.1391424	0.3460961	0	1
Pacific	0.0156149	0.1239805	0	1
Asian	0.0165768	0.1276797	0	1
Other	0.1026542	0.3035077	0	1
Age at Admission	52.89822	21.61427	18	S
Cost Weight	1.051814	1.549566	S	S
Post Graduate	0.0222328	0.1474402	0	1
Under Graduate	0.0862506	0.2807346	0	1
High School	0.1750854	0.3800414	0	1
Vocation	0.0008401	0.0289717	0	1
No Education	0.7155912	0.4511339	0	1
		II. Pre-Policy Change 30/06/2000-01/07/2003 N=42,633		
Length of Stay	3.726232	5.399099	0	88
30-day Mortality	0.027093	0.1623562	0	1
30-Day Readmission	0.1374352	0.3443102	0	1
45-Day Readmission	0.1656306	0.3717531	0	1
60-Day Readmission	0.1877742	0.3905363	0	1
Transfer	0.0068495	0.0824786	0	1
Post	0	0	0	0
Tertiary	0.0577749	0.23332	0	1

CCL0	0.2179165	0.4128352	0	1
CCL1	0.4918721	0.4999398	0	1
CCL2	0.1869062	0.3898408	0	1
CCL3	0.0842814	0.2778126	0	1
CCL4	0.0190237	0.1366099	0	1
Gender (female)	0.5637916	0.4959198	0	1
NZ European	0.7335272	0.4421195	0	1
Maori	0.1164176	0.3207288	0	1
Pacific	0.0130422	0.1134564	0	1
Asian	0.0123619	0.110496	0	1
Other	0.1246511	0.3303267	0	1
Age at Admission	55.15053	20.95537	18	S
Cost Weight	1.177849	1.607162	S	S
Post Graduate	0.0198213	0.1393873	0	1
Under Graduate	0.068659	0.2528763	0	1
High School	0.138655	0.3455902	0	1
Vocation	0.0007037	0.0265186	0	1
No Education	0.7721611	0.419443	0	1
III. Post-Policy Change 01/07/2003-01/07/2008 N=113,247				
Length of Stay	2.963046	5.307906	0	90
30-day Mortality	0.0187818	0.1357542	0	1
30-Day Readmission	0.1333887	0.3399958	0	1
45-Day Readmission	0.1607357	0.3672886	0	1
60-Day Readmission	0.1823785	0.3861579	0	1
Transfer	0.0104108	0.1015012	0	1
Post	1	0	1	1
Tertiary	0.0459699	0.2094208	0	1
CCL0	0.2449403	0.4300537	0	1
CCL1	0.510137	0.4998994	0	1
CCL2	0.1650184	0.3711988	0	1
CCL3	0.0661204	0.2484935	0	1
CCL4	0.0137839	0.1165934	0	1
Gender (female)	0.6107304	0.4875868	0	1
NZ European	0.7231916	0.4474229	0	1
Maori	0.1476494	0.3547537	0	1
Pacific	0.0165919	0.1277371	0	1
Asian	0.0181725	0.1335755	0	1
Other	0.0943946	0.2923782	0	1
Age at Admission	52.05475	21.79723	18	S
Cost Weight	1.004467	1.52484	S	S
Post Graduate	0.0231527	0.1503891	0	1
Under Graduate	0.0927699	0.2901109	0	1
High School	0.1887892	0.3913428	0	1
Vocation	0.0008918	0.0298506	0	1
No Education	0.6943964	0.4606647	0	1

APPENDIX 4: NATIONAL AND SUBSAMPLE READMISSION

	Readmission 30	Readmission 45	Readmission 60
National	N=4,431,129	N=4,431,129	N=4,431,129
2001	0.006	0.0046	0.0036
2002	0.0098	0.0042	0.0025
2003	-0.0027	-0.0079	-0.0049
2004	-0.0008	-0.0084	-0.0102*
2005	0.0079	-0.0024	-0.0014
2006	0.0345***	0.0275***	0.0254***
2007	0.0389***	0.0363***	0.0409***
Transfer	-0.5854***	-0.714***	-0.78***
Cost weight	0.038***	0.0396***	0.0399***
2001xTransfer	0.0237	-0.0032	-0.0333
2002xTransfer	-0.0155	-0.035	-0.0725
2003xTransfer	-0.0169	-0.0509	-0.085
2004xTransfer	0.0005	-0.0165	-0.0564
2005xTransfer	0.0547	0.021	-0.0205
2006xTransfer	-0.1253*	-0.1599**	-0.1822***
2007xTransfer	-0.2954***	-0.3086***	-0.3333***
Education	N=1,234,539	N=1,234,539	N=1,234,539
2001	0.0226	0.0157	0.0183
2002	0.0655***	0.0557***	0.0561***
2003	0.0086	0.0046	0.012
2004	-0.0149	-0.0143	-0.0031
2005	0.0138	0.0092	0.0192
2006	0.0367*	0.0366**	0.0459***
2007	0.0314*	0.0325*	0.0459***
Transfer	-0.2154	-0.2809*	-0.3265**
Cost weight	0.0604***	0.0616***	0.0623***
2001xTransfer	0.1518	0.0671	0.0596
2002xTransfer	-0.36*	-0.409*	-0.386*
2003xTransfer	-0.3167*	-0.289	-0.2913
2004xTransfer	-0.1821	-0.1623	-0.1713
2005xTransfer	-0.0672	-0.09	-0.1084
2006xTransfer	-0.1314	-0.1978	-0.2341
2007xTransfer	-0.2916	-0.3141*	-0.3137*
MDC 5	N=662,886	N=662,886	N=662,886
2001	-0.0101	-0.0128	-0.0153
2002	-0.0348*	-0.0539***	-0.0562***
2003	-0.0731***	-0.0836***	-0.0881***
2004	-0.0719***	-0.0885***	-0.0981***
2005	-0.0739***	-0.0873***	-0.0941***
2006	-0.0537***	-0.0652***	-0.0717***

2007	-0.0756***	-0.0864***	-0.0913***
Transfer	-0.8327***	-0.98***	-1.0781***
Cost weight	0.0293***	0.0289***	0.0289***
2001xTransfer	0.1724	0.135	0.1033
2002xTransfer	0.268**	0.2282**	0.1715*
2003xTransfer	**	0.2118*	0.1516
2004xTransfer	0.1258	0.0513	-0.0133
2005xTransfer	0.0531	-0.0044	-0.0434
2006xTransfer	-0.2902**	-0.3589***	-0.418***
2007xTransfer	-0.5945***	-0.6404***	-0.6623***
DRG 297	N=35,985	N=35,985	N=35,985
2001	-0.3136***	-0.3713***	-0.4326***
2002	-0.4368***	-0.5256***	-0.5686***
2003	-0.5518***	-0.5828***	-0.5792***
2004	-0.5102***	-0.6187***	-0.6454***
2005	-0.4159***	-0.5322***	-0.6434***
2006	-0.4868***	-0.4834***	-0.5945***
2007	-0.4456***	-0.5364***	-0.5882***
Transfer	-1.0251***	-1.3479***	-1.5366***
Cost weight	-0.1039**	-0.1739***	-0.2564***
2001xTransfer	0.436	0.453	0.4399
2002xTransfer	0.3602	0.3959	0.3575
2003xTransfer	0.4106	0.4097	0.3439
2004xTransfer	0.3652	0.4207	0.3461
2005xTransfer	0.4314	0.4919*	0.554**
2006xTransfer	0.2064	0.1284	0.1521
2007xTransfer	-0.3433	-0.2358	-0.1793
DRG 246	N=12,438	N=12,441	N=12,441
2001	-0.2757	-0.2507	-0.1723
2002	-0.4251**	-0.3357*	-0.2796*
2003	-0.5696***	-0.5156***	-0.4643***
2004	-0.8928***	-0.7899***	-0.73***
2005	-0.8049***	-0.7175***	-0.6685***
2006	-0.6795***	-0.5952***	-0.5695***
2007	-0.8956***	-0.8001***	-0.7325***
Transfer	-2.1962***	-2.2416***	-2.2881***
Cost weight	-0.7718***	-0.7208***	-0.6956***
2001xTransfer	-1.2918	-1.3102	-1.3911
2002xTransfer	-0.4946	-0.5759	-0.6345
2003xTransfer	-0.4747	-0.5157	-0.5648
2004xTransfer	-0.1091	-0.2026	-0.2645
2005xTransfer	0.1667	0.1313	0.1286
2006xTransfer	-0.6448	-0.6436	-0.6827
2007xTransfer	0.1592	0.0435	-0.0434
DRG 274	N=33,075	N=33,075	N=33,075
2001	0.0985	0.0789	0.0266

2002	-0.0477	-0.111	-0.1163
2003	-0.0388	-0.1006	-0.1423*
2004	-0.0471	-0.1472*	-0.1924**
2005	-0.1986*	-0.2344**	-0.31***
2006	-0.0823	-0.1652*	-0.2166***
2007	-0.1375	-0.2372***	-0.3065***
Transfer	-1.3307***	-1.6231***	-1.75***
Cost weight	0.3312***	0.3167***	0.2913***
2001xTransfer	0.1982	0.1917	0.2607
2002xTransfer	0.1591	0.2959	0.2748
2003xTransfer	0.7625	0.8111*	0.6766
2004xTransfer	-0.0613	0.1036	-0.0205
2005xTransfer	-0.6039	-0.6616	-0.3385
2006xTransfer	0.52	0.5099	0.3981
2007xTransfer	0.3666	0.374	0.5128

APPENDIX 5: REGIONAL READMISSION RESULTS

	Readmission 30	Readmission 45	Readmission 60
Northland	N=193,110	N=193,110	N=193,110
2001	-0.0085	-0.0118	-0.0064
2002	0.0178	-0.0103	-0.0108
2003	0.0067	-0.0161	-0.0012
2004	0.0064	-0.0083	-0.0193
2005	-0.01	-0.0333	-0.0326
2006	0.0103	-0.0074	-0.014
2007	0.0604*	0.036	0.0285
Transfer	-1.2532***	-1.3624***	-1.4903***
Cost weight	0.0555***	0.0615***	0.0634***
2001xTransfer	0.2175	0.1577	0.2087
2002xTransfer	0.1222	0.0278	-0.0234
2003xTransfer	0.349	0.3237	0.3943
2004xTransfer	0.5086	0.4294	0.4266
2005xTransfer	0.5204	0.4071	0.4396
2006xTransfer	0.3467	0.2307	0.2607
2007xTransfer	0.3062	0.1793	0.2418
Taiarawhiti	N=60,825	N=60,825	N=60,825
2001	-0.0414	-0.0151	-0.0181
2002	0.0378	0.027	0.0003
2003	0.108*	0.0779	0.058
2004	0.0179	-0.0212	-0.0496
2005	0.0147	-0.024	-0.022
2006	0.09	0.0299	0.0118
2007	-0.0681	-0.0792	-0.0846*
Transfer	-0.7968	-0.7897	-0.7423
Cost weight	0.0416***	0.042***	0.0401***
2001xTransfer	-0.4246	-0.4717	-0.4766
2002xTransfer	0.3387	0.0842	0.1593
2003xTransfer	-0.1663	-0.1376	-0.3261
2004xTransfer	0.3919	0.3415	0.1579
2005xTransfer	0.65	0.5908	0.5169
2006xTransfer	0.6897	0.6068	0.414
2007xTransfer	-0.7641	-1.003	-1.0555
Lakes	N=126,690	N=126,690	N=126,690
2001	0.0509	0.0507	0.021
2002	0.1027**	0.0901**	0.075*
2003	0.0398	0.0252	0.0135
2004	0.1308***	0.1217***	0.0975**
2005	0.1354***	0.1243***	**
2006	0.1453***	0.1438***	0.121***

2007	0.1815***	0.1708***	0.1525***
Transfer	-0.1241	-0.3662	-0.4903*
Cost weight	0.0443***	0.0465***	0.0473***
2001xTransfer	-0.2165	-0.1522	-0.177
2002xTransfer	-0.1565	-0.0602	0.1163
2003xTransfer	0.0954	0.2538	0.2366
2004xTransfer	-0.8133	-0.644	-0.5348
2005xTransfer	-0.0236	0.2019	0.2599
2006xTransfer	-0.2232	-0.1203	-0.0948
2007xTransfer	-1.3903***	-1.3769***	-1.292***
Taranaki	N=110,712	N=110,712	N=110,712
2001	0.0527	0.0637*	0.0614*
2002	0.0341	0.0287	0.0343
2003	0.0358	0.0494	0.0457
2004	-0.015	-0.0102	-0.019
2005	-0.0953**	-0.0635*	-0.0646*
2006	-0.0753*	-0.0462	-0.0555
2007	-0.1494***	-0.1355***	-0.1107***
Transfer	-0.3059	-0.5485	-0.3938
Cost weight	0.0252***	0.0222***	0.0243***
2001xTransfer	-0.6574	-0.5131	-0.8528
2002xTransfer	-0.8697	-0.8654	-0.4296
2004xTransfer	-0.5903	-0.5871	-0.9217
2005xTransfer	0.5385	0.5242	0.1933
2006xTransfer	-1.8596	-1.8825	-2.215*
2007xTransfer	-3.0486***	-2.3593**	-2.7305***
Midcentral	N=155,943	N=155,943	N=155,943
2001	-0.0473	-0.0422	-0.0261
2002	-0.0619	-0.0597	-0.0468
2003	-0.1165***	-0.0948**	-0.0874**
2004	-0.107***	-0.0933**	-0.0704*
2005	0.0562	0.0563	0.0778**
2006	0.0777*	0.0894**	0.1018***
2007	0.1122***	0.1205***	0.1378***
Transfer	-3.0802**	-3.3073**	-3.464***
Cost weight	0.0449***	0.0448***	0.0453***
2001xTransfer	0.0378	0.0277	0.7121
2002xTransfer	1.2014	1.19	1.1708
2003xTransfer	1.2682	1.243	1.4208
2004xTransfer	0.9588	1.096	1.0659
2005xTransfer	-0.7666	-0.7737	-0.1061
2006xTransfer	1.076	1.0599	1.0429
2007xTransfer	0.9397	1.0527	1.2438

APPENDIX 6: ROBUSTNESS CHECK RESULTS

Education – National Sample				
	(27)	(28)	(29)	(30)
	Transfer	30-day Mortality	30-day Readmission	Length of Stay
	N=1,234,539	N=1,234,539	N=1,234,539	N=1,234,539
2001		0.3308	0.0226	-0.1253***
2002		0.7309***	0.0655***	-0.0983***
2003		1.0194***	0.0086	0.1488***
2004		1.2876***	-0.0149	0.0848***
2005		1.5096***	0.0138	0.0083
2006		1.6669***	0.0367*	-0.0022
2007		1.7253***	0.0314*	-0.0173
Transfer		0.0972	-0.2154	0.2946*
Cost weight	0.1773***	0.1408***	0.0604***	2.2336***
Post	-2.5048***			
Tertiary	-0.2596***			
CCL1	0.3935***			
CCL2	0.7202***			
CCL3	1.4918***			
CCL4	1.5482***			
Interaction terms (Marginal Effects except for LOS)				
PostxTertiary	0.0173***			
PostxCCL1	-0.0015***			
PostxCCL2	-0.0014***			
PostxCCL3	-0.0124***			
PostxCCL4	-0.0141***			
2001xTransfer		0.0014*	0.0091	-0.2477
2002xTransfer		0.0001*	-0.0193*	-0.6789**
2003xTransfer		0.0007*	-0.0159	-0.0079
2004xTransfer		0.002**	-0.0093	-0.6049**
2005xTransfer		0.0009***	-0.0039	-0.8438***
2006xTransfer		-0.0004**	-0.0077	-0.5552*
2007xTransfer		0.0009**	-0.0154*	-0.336

MDC 5 – National Sample				
	(31)	(32)	(33)	(34)
	Transfer	30-day Mortality	30-day Readmission	Length of Stay
	N=662,886	N=662,886	N=662,886	N=662,886
2001		-0.0670*	-0.0101	-0.1686***
2002		-0.0874**	-0.0348*	-0.2464***
2003		-0.0657*	-0.0731***	-0.2302***
2004		-0.1311***	-0.0719***	-0.2012***
2005		-0.1329***	-0.0739***	-0.2509***
2006		-0.1733***	-0.0537***	-0.3323***
2007		-0.2100***	-0.0756***	-0.3362***
Transfer		-0.0529	-0.8327***	-2.4258***
Cost weight	0.1736***	0.0959***	0.0293***	1.6578***
Post	-2.8059***			
Tertiary	1.5456***			
CCL1	0.4498***			
CCL2	0.0271			
CCL3	0.5343***			
CCL4	1.050***			
Interaction terms (Marginal Effects except for LOS)				
PostxTertiary	0.024***			
PostxCCL1	0.0143***			
PostxCCL2	0.0065*			
PostxCCL3	-0.0002**			
PostxCCL4	-0.0159***			
2001xTransfer		-0.0015*	0.0138	0.1809
2002xTransfer		-0.0039*	0.0231**	-0.1765
2003xTransfer		-0.0038*	0.0258***	-0.3573**
2004xTransfer		-0.0041**	0.0134	-0.4409***
2005xTransfer		-0.0094***	0.0082	-0.8697***
2006xTransfer		-0.0093***	-0.0143***	-0.5396***
2007xTransfer		-0.0048***	-0.0267***	-0.18

DRG 297 – National Sample				
	(35)	(36)	(37)	(38)
	Transfer	30-day Mortality	30-day Readmission	Length of Stay
	N=35,985	N=35,985	N=35,985	N=35,985
2001		0.2676	-0.3136***	1.433***
2002		0.3711	-0.4368***	1.2205***
2003		0.0286	-0.5518***	1.0676***
2004		0.3824	-0.5102***	1.3911***
2005		0.6026	-0.4159***	1.525***
2006		0.4183	-0.4868***	1.4584***
2007		0.3614	-0.4456***	1.6117***
Transfer		0.0511	-1.0251***	-1.2477***
Cost weight	0.1588***	0.2591***	-0.1039**	2.6445***
Post	0.6367***			
Tertiary	5.2130***			
CCL1	1.0992***			
CCL2	0.9720***			
CCL3	0.9373***			
CCL4	1.2065***			
Interaction terms (Marginal Effects except for LOS)				
PostxTertiary	0.0418			
PostxCCL1	-0.0092***			
PostxCCL2	-0.0472			
PostxCCL3	-0.0405			
PostxCCL4	-0.0809			
2001xTransfer		0.0015	0.0418	-0.6414***
2002xTransfer		-0.0024	0.0422	-0.8507***
2003xTransfer		0	0.0488	-0.8255***
2004xTransfer		0.0005	0.0452	-1.0667***
2005xTransfer		-0.0042	0.0452	-1.0194***
2006xTransfer		-0.0031	0.037	-0.8171***
2007xTransfer		-0.0003	0.0161***	-0.3398**

DRG 246 – National Sample				
	Transfer N=12,453	Mortality N=12,012	Readmission N=12,438	Length of Stay N=12,453
2001		-0.208	-0.2757	0.1496
2002		0.2508	-0.4251**	-0.5845***
2003		0.0663	-0.5696***	-0.7987***
2004		-0.0777	-0.8928***	-0.8093***
2005		-0.4413	-0.8049***	0.0609
2006		-0.05	-0.6795***	0.075
2007		-0.4263	-0.8956***	0.258
Transfer		0.0608	-2.1962***	-1.4797***
Cost weight	-2.2632***	0.2725	-0.7718***	3.5594***
Post	-3.2113**			
Tertiary	3.1616***			
CCL1	-0.5259			
CCL2	0.0529			
CCL3				
CCL4				
PostxTertiary	3.7515***			
PostxCCL1	0.2065			
PostxCCL2	0.0354			
PostxCCL3				
PostxCCL4				
2001xTransfer		0.2661	-1.2918	0.2502
2002xTransfer		-0.4236	-0.4946	1.0734***
2003xTransfer		0.4925	-0.4747	1.3153***
2004xTransfer		-0.846	-0.1091	1.2785***
2005xTransfer		0.1239	0.1667	-0.7185**
2006xTransfer		-0.7646	-0.6448	-0.7328**
2007xTransfer		0.611	0.1592	-0.7951**

DRG 274 – National Sample				
	Transfer N=32,445	Mortality N=32,445	Readmission N=33,075	Length of Stay N=33,075
2001		0.4606	0.0985	-0.2689***
2002		0.6751	-0.0477	-0.3073***
2003		0.2413	-0.0388	-0.3057***
2004		0.381	-0.0471	-0.2086***
2005		-0.9306	-0.1986*	-1.1353***
2006		-0.068	-0.0823	-1.1371***
2007		0.3717	-0.1375	-1.1127***
Transfer		2.0731***	-1.3307***	0.0182
Cost weight	-0.144	0.2916***	0.3312***	5.5656***
Post	-0.2716**			
Tertiary	2.9466***			
CCL1	-1.0718***			
CCL2	-1.2634***			
CCL3				
CCL4				
PostxTertiary				
PostxCCL1	0.3627***			
PostxCCL2	0.3729**			
PostxCCL3				
PostxCCL4				
2001xTransfer		-1.3399	0.1982	-0.3828***
2002xTransfer		-1.1559	0.1591	-0.3012***
2003xTransfer		-0.8496	0.7625	-0.3237***
2004xTransfer		-1.1484	-0.0613	-0.4133***
2005xTransfer			-0.6039	-0.549***
2006xTransfer		-1.6206	0.52	-0.4029***
2007xTransfer		-1.8213	0.3666	-0.2359*

APPENDIX 7: PBFF FUNDING ALLOCATIONS

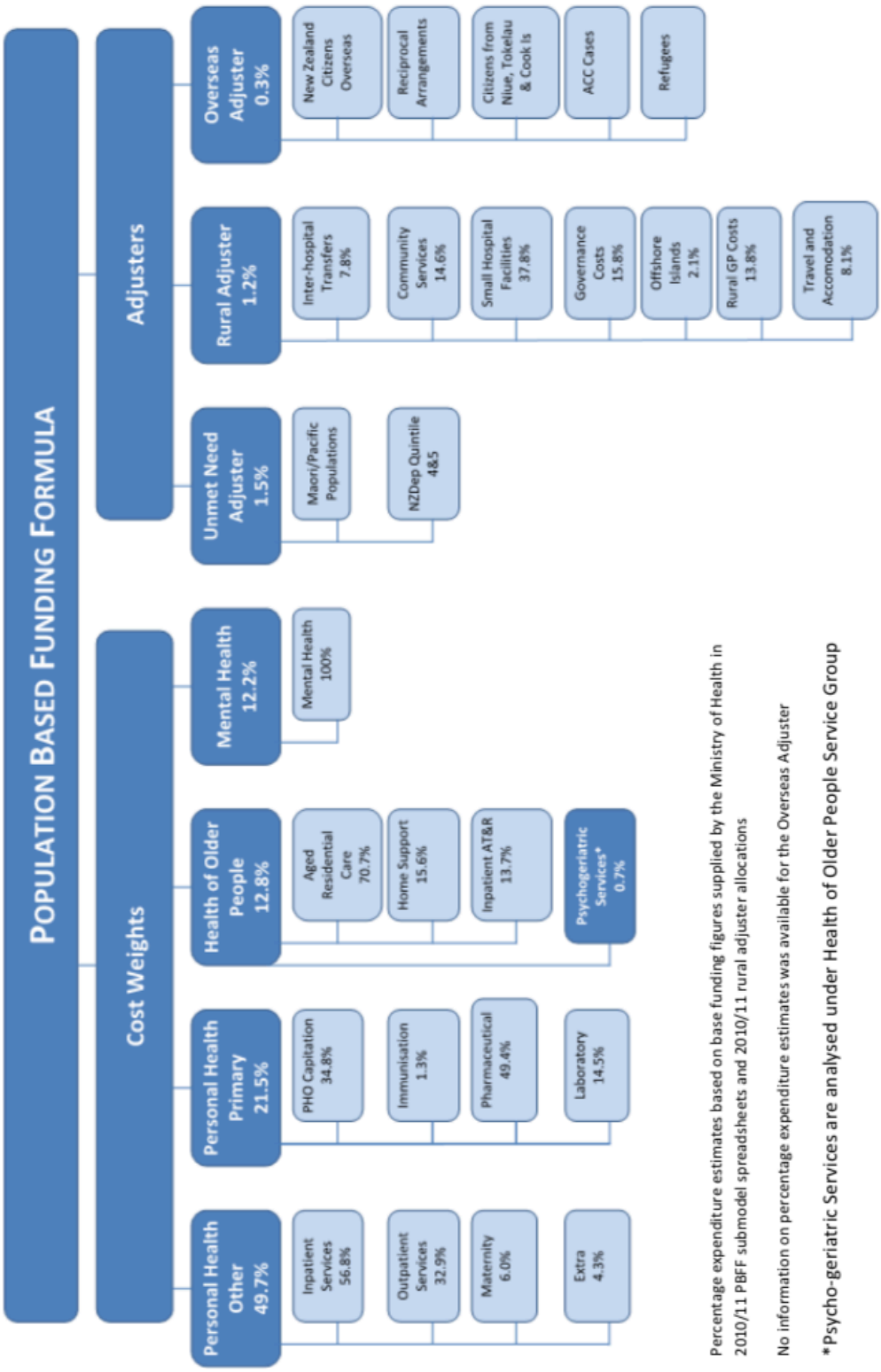


Figure 1: Schematic Diagram of the Population-Based Funding Formula with percentage expenditure estimates

Source: Penno et al. (2012, p.19)

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Accident Compensation Corporation (ACC) – no fault insurance coverage run by the government through levies established in 1974.

Area Health Boards (AHB) – the first attempt at a DHB-type structure. Fourteen regional units established in 1983 to cater for local populations

Casemix – is the mix of patients treated in a specific hospital or DHB and describes the healthcare events and other characteristics of services and patients admitted. Not only is it used to inform funding decisions but also for future planning and comparative ranking with other DHBs. New Zealand uses the ICD-10 coding system in conjunction with DRG,s MDCs, WIES and CCLs as tools for clinical coding.

Complexity Comorbidity Levels (CCL) – describe the likelihood of other diagnoses or illnesses affecting the current course of treatment. They are strongly positively correlated with cost weight.

Concentration effect – prior to the policy change, a mix of patients of differing severity levels are transferred to a different DoS. After the policy change, there is a reduction in low severity transfers, increasing the relative concentration of high severity patients. This is one mechanism for worsening health outcomes in the years after 2003 for transfers.

Crown Health Enterprises (CHE) – 23 competitive units established across New Zealand in 1993 that vied for contracts awarded by RHAs to provide healthcare services.

Diagnosis Related Grouping (DRG) – narrower coding within an MDC that groups together individual health events under a common code with similar characteristics and input costs.

District Health Board (DHB) – the 20 local boards that govern the provision of healthcare to their respective local populations throughout New Zealand.

District of Domicile (DoD) – the district in which a patient lives as recorded on the latest census.

District of Service (DoS) – the district in which a patient receives treatment.

Focus effect – a decrease in overall probability of transfer combined with an increase in probability of transfer to a tertiary DHB.

Health Funding Authority (HFA) – the consolidation of the four RHAs into a single funding authority in 1997.

Hospital Health Services (HHS) – in a move away from a competitive system HHSs replaced CHEs in the provision of healthcare services across New Zealand on a cooperative, not-for-profit basis.

Integrated Data Infrastructure (IDI) – an expansive, multi-disciplinary network of databases managed by Statistics New Zealand.

Inter-District Flow (IDF) – the number of patients transferred between two DHBs.

Major Diagnostic Category (MDC) – 23 large categories that group together diagnoses, usually by a functional system such as the circulatory system or the skeletal system.

Ministry of Health (MoH) – the government portfolio responsible for overseeing the overall health system including, but not limited to, public health, hospital services, primary care, disability services, mental health services and geriatric care.

National Prices – are healthcare event prices calculated based on the historical accounting information provided on a mandatory basis by each DHB to the MoH. It can be argued that the way in which national prices are calculated is biased toward those DHBs with more sophisticated accounting software. The costs of these DHBs are more detailed and often higher than average due to the correlation between high level accounting software and more advanced healthcare providers.

National Services Framework (NSF) – an initiative formally established in 2010 which provides a select range of services nationally from a single or small number of providers. These services are selected based on the need for specialised skill, equipment or services.

Population Based Funding Formula (PBFF) – is a form of capitation funding, with each resident allocated funding based on age, gender, ethnicity and a measure of socioeconomic depravation and additional adjusters for rurality, overseas individuals and tertiary provision.

Regional Health Authority (RHA) – four funding units that controlled the funding and purchasing of healthcare services across New Zealand from 1993 to 1997.

Secondary Provider – providers are ranked into five categories by resource and service capability. A secondary provider is in the middle with health centres and sub-acute units below and lower-level tertiary and tertiary providers above.

Tertiary Provider – providers are ranked into five categories by resource and service capability. A tertiary provider is at the top with health centres, sub-acute units, secondaries and lower-level tertiary providers below.

VoteHealth Funding – the portion of general tax revenue that is allocated to healthcare.

Wash-up Payments – net adjustments in the flow of transfer funds made at the end of each year (year end June) due to incorrect forecasting of IDFs throughout the period.

Weighted Inlier Equivalent Separations (WIES) – separation is the Australian term for "discharge". This term describes the weighting assigned to each DRG based on an average treatment time. It is a guide to the portion of funding that should be allocated based on the diagnosis. It provides an incentive to complete treatment at or below the average treatment time. Any efficiencies are compensated because the average funding is paid regardless of how long it took to treat the patient. There are allowances for complications or extended cases so that moral hazard issues do not arise.