Independent Hospital Pricing Authority
Fundamental Review of the National Efficient Price

Final recommendations report

26 August 2019

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Executive Summary

Background and Scope

The National Efficient Price (NEP) is a foundational element of Australia's Activity Based Funding (ABF) model and plays an important role in supporting the principles of our health system, including determining the amount of Commonwealth Government Funding provided for public hospital services and providing a price signal to the system

PricewaterhouseCoopers Australia (PwC) has been engaged by the Independent Hospital Pricing Authority (IHPA) to undertake a Fundamental Review of the NEP.

In Stage 1 of this Fundamental Review, we undertook a literature review of pricing models operating in other jurisdictions, territories and industries that had similarities or differences that were informative to the Fundamental Review objectives.

From this literature review, we identified a number of alternative modelling approaches to explore in Stage 2 of the Fundamental Review, covering each of the six components of the NEP:

1. Data preparation
2. Base model
3. Adjustments
4. Stabilisation
5. Calculation of the NEP/Indexation
6. Back-casting

The analysis and interim findings were presented to IHPA and the Fundamental Review Working Group in a series of meetings and findings papers. This report documents our final findings and recommendations relating to all six components.

Evaluation of alternative approaches

To aid the consistency and transparency of our work and recommendations, we established some metrics for evaluating the impact of the various alternative modelling approaches versus the existing approach. These evaluation metrics include the impact on goodness of fit, stability, and hospital cost ratios, and additionally consider how the alternative approaches align with the underlying pricing philosophy.

Recommendations

After reviewing the components of the NEP and testing possible alternative approaches outlined in this report against the evaluation metrics we have made the following recommendations.

No.	Component	Recommendations
1	Data preparation	**We recommend** that the matching of pharmaceutical benefits to activity data be enhanced by applying an additional business rule relating to the activity date. This would improve the number of unique matches in the data, and it can be implemented with a low amount of effort
2	Data preparation	**We recommend** that Work-In-Progress episodes where the admission date is within one year of the current financial year be included in the model. This makes better use of the available data and reduces potential biases (such as variations due to seasonal illness) while still excluding genuine outliers.

No.	Component	Recommendations
3	Base Model	**We recommend** that the approach to setting inlier bounds be based on percentiles of the Length of Stay distribution. This aligns more closely with the pricing philosophy as it is better able to define inliers that consistently captures both the majority of the episodes and cost for each DRG as well as the "peak" of the Length of Stay distribution. The choice of bounds will need to be set to achieve the right balance of risk sharing implicit between inliers and outliers.
4	Adjustments	**We recommend** that additional age adjustments are added into the NEP models across all the streams. • Acute: adjustment for patients aged 65 years and over • Emergency Department: extended to include an additional adjustment for patients aged 40 to 65 years • Non-admitted: a specialist paediatric adjustment for patients aged 18 years and under in specialist paediatric hospitals This would improve the ability of the NEP to allow for legitimate and unavoidable differences in cost due to a patient's age.
5	Adjustments	**We recommend** further consultation and investigation regarding the following variables, to determine whether they should also be incorporated as additional adjustments • Acute: mode of admission – investigate the underlying drivers for the cost differences and assess the extent to which these are unavoidable • Acute: mental health legal status - further consultation required to determine whether an adjustment is appropriate given the transition to a new classification system • Emergency Department: mode of transport – investigate the underlying drivers for the cost differences and assess the extent to which these are unavoidable
6	Stabilisation	**We recommend** that the Acute same day price weights and specialist paediatric adjustments are stabilised such that changes do not exceed +/- 20% from year to year. This improves the consistency of stabilisation across the various model components without adversely affecting the model fit.
7	Calculation of the NEP/Indexation	**We recommend no change to the current determination of the Reference Cost**. The current approach is in line with the objective of deriving an average price and also maintains comparability of NWAU over time, which is an intentional choice.
8	Calculation of the NEP/Indexation	**We recommend** that IHPA consider 'resetting' the Reference Cost in the future if it diverges too far from the average cost of a typical separation. This would require significant adjustments to historical NWAU calculations to maintain comparability and there would need to be a strong appetite for change.

No.	Component	Recommendations
9	Calculation of the NEP/Indexation	**We recommend no change to the existing approach for deriving the indexation rate.** The current approach meets its objectives of capturing public hospital cost growth (including changes in efficiency and length of stay) and is suitable for converting the cost weight model into a pricing model for a future projected period.
10	Calculation of the NEP/Indexation	**We recommend** monitoring the quality of cost data collection and considering an approach that projects indexation at a more granular cost bucket level if the data quality continues to improve over the next few years.
11	Back-casting	**We recommend no change to the existing approach for back-casting.** The current approach is reasonable and meets its objectives of removing the impact of significant changes to the ABF classification or methodologies.

Abbreviations

ABF	Activity Based Funding
AECC	Australian Emergency Care Classification
AMHCC	Australian Mental Health Care Classification
AR-DRG	Australian Refined – Diagnosis Related Group
CALD	Culturally and Linguistically Diverse
CPI	Consumer Price Index
DRG	Diagnosis Related Group
ICU	Intensive Care Unit
IHPA	Independent Hospital Pricing Authority
LHN	Local Hospital Network
LPI	Labour Price Index
LOS	Length of Stay
MDC	Major Diagnostic Category
NEP	National Efficient Price
NHCDC	National Hospital Cost Data Collection
NHRA	National Health Reform Agreement
NWAU	National Weighted Activity Unit
PBS	Pharmaceutical Benefits Schedule
PPI	Producer Price Index
PwC	PricewaterhouseCoopers Australia Pty Ltd
SMAPE	Symmetric Mean Absolute Percent Error
WIP	Work-in-progress

Contents

1 Introduction

1.1 Background and scope

The National Efficient Price (NEP) is a foundational element of Australia's Activity Based Funding (ABF) model and plays an important role in supporting the principles of our health system, including determining the amount of Commonwealth Government Funding provided for public hospital services and providing a price signal to the system. PricewaterhouseCoopers Australia (PwC) has been engaged by the Independent Hospital Pricing Authority (IHPA) to undertake a Fundamental Review of the NEP.

In Stage 1 of this Fundamental Review, we undertook a literature review of pricing models operating in other jurisdictions, territories and industries that had similarities or differences that were informative to the Fundamental Review objectives. This was documented in our Literature Review findings paper dated December 2018. A summary of findings from this report can be found in Appendix A.

From this literature review, we identified a number of alternative modelling approaches to explore in Stage 2 of the Fundamental Review. Broadly speaking, there are six components of the NEP:

1. Data preparation
2. Base model
3. Adjustments
4. Stabilisation
5. Calculation of the NEP/Indexation
6. Back-casting

The opportunities identified in the literature review were discussed and agreed with IHPA and a number of these were prioritised and investigated during Stage 2. The analysis and interim findings were presented to IHPA and the Fundamental Review Working Group in a series of meetings and findings papers.

This report documents our final findings and recommendations relating to all six components.

1.2 Evaluation of alternative approaches

To aid the consistency and transparency of our work and recommendations, we established some metrics for evaluating the impact of the various alternative modelling approaches versus the existing approach. These evaluation metrics include the impact on goodness of fit, stability, and hospital cost ratios, and additionally consider how the alternative approaches align with the underlying pricing philosophy. The evaluation metrics are summarised in the table below:

Metric	Measurement	Preferred outcome (all else being equal)
Goodness of Fit	R^2 and SMAPE	Closer alignment between actual and modelled episodic costs, as indicated by a higher R^2 or lower SMAPE
Stability	Spread of year on year movements	Lower expected movements from year to year
Hospital Cost Ratios	Spread of Hospital Cost Ratios	Closer alignment between actual and modelled hospital costs (cost ratio = 1), that is, lower spread in cost ratios
Pricing Philosophy	N/A	Closer alignment to underlying pricing philosophy

For some components, additional evaluation metrics were considered and these are described in the relevant sections of this report.

2 *Data Preparation*

2.1 Background and Purpose

The broad objectives of the data preparation stage are to:

- Remove out of scope hospital costs (that is, cost not included in accordance with Section 13(f) of the National Health Reform Act 2011 and Clauses A9-A17 of the National Health Reform Agreement). Examples include costs related to blood products and pharmaceutical costs funded under other Commonwealth arrangements
- Remove outliers so that they do not unduly influence the stability of the model
- Remove records for which there are concerns around data quality, for example, extremely low cost episodes
- Make other necessary adjustments to the data, for example to allow for the National Hospital Cost Data Collection (NHCDC) being only a sample of the total activity during the year.

We have focused our analysis on two key aspects of the data preparation process that were identified as opportunities for further investigation and improvement from Stage 1 of our Fundamental Review:

- The method used to **match pharmaceutical benefit schedule (PBS) data to activity data** – this is important for correctly removing pharmaceutical costs (which are substantial and are out of scope), and is also complex as there is no unique and common identifier available across the two datasets.
- The **removal of episodes that span multiple financial years** (also known as work-in-progress episodes, or WIP), which are currently excluded as the costing for these records is believed to be less reliable.

Our findings and recommendations relating to these are discussed below.

2.2 Matching of Pharmaceutical Benefits

2.2.1 Current approach

Broadly speaking, the current approach for matching pharmaceutical benefit data to activity data involves a three-stage process:

- Data is matched at a **patient-level** where possible using combinations of patient characteristic variables that are common across both datasets to identify likely matches. There are two types of matches that result from this (see Appendix B for further detail):
- **Unique matches**, where only one activity record was matched to a pharmaceutical record – these matches are considered to be more reliable; or
  - **Non-unique matches**, where multiple activity records were matched to a pharmaceutical record. In this case, the pharmaceutical benefit is allocated evenly to all matched records after applying a set of business rules.
- Next, pharmaceutical benefits for unmatched activity records or poor quality matches (e.g. where matched pharmaceutical benefits are greater than in-scope cost) are **imputed by product type** (for example, Diagnosis Related Group), based on the amounts that were successfully matched at a patient-level.
- Finally, the pharmaceutical benefit amounts are scaled so they sum up to the total pharmaceutical benefits in the year.

The pharmaceutical matching process is applied consistently across all jurisdictions, with the exception of NSW and Victoria. This is because:

- NSW submits cost data exclusive of pharmaceutical benefits. Therefore, NSW cost data is not adjusted to remove pharmaceutical benefits.
- Victoria historically did not submit unit level outpatient data, meaning patient-level matching would disproportionately assign pharmaceutical benefits to admitted patient episodes.

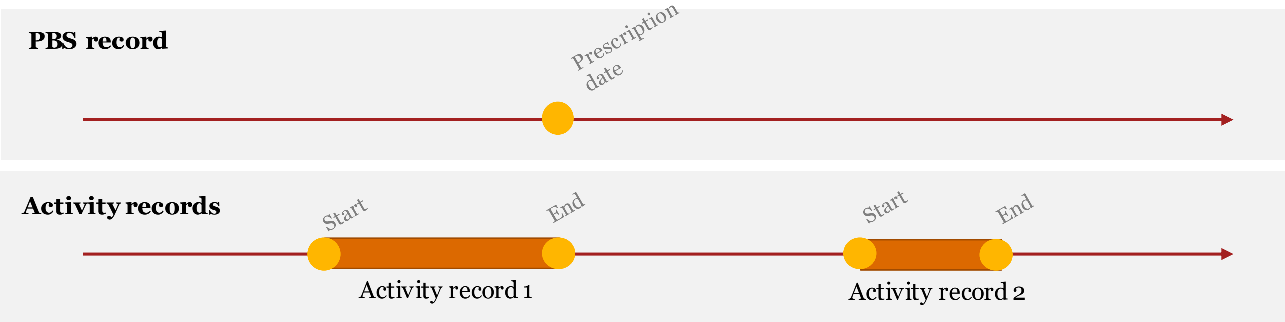
2.2.2 Alternative approach

During our review, we considered two potential enhancements to the matching process which are described below.

Enhancement 1: Business rule refinement relating to activity date

In the situation where multiple activity records are matched to a pharmaceutical record, we considered applying an additional business rule to check whether the pharmaceutical transaction date is closer to a single related activity end date and therefore would be more likely to be associated to that record. For example, Figure 1 illustrates an individual who receives two episodes of care in the same hospital, but the pharmaceutical record is more likely to be associated with the first episode.

Figure 1: Example of date rule



The effect of this business rule is twofold – firstly the use of the prescription and activity dates provide a greater degree of confidence that the records are related and secondly a greater proportion of records are matched in the unique matching step.

Enhancement 2: Developing predictive models for allocation

In the situation where the pharmaceutical benefit amount is allocated evenly across a number of non-unique matches, we tested the use of predictive modelling to better inform which activity records are more likely to be a true match based on the other characteristics of the records. An activity record with more probable characteristics would be allocated a higher amount of the pharmaceutical benefit, and vice versa.

Both of these enhancements aim to improve the *accuracy* of the matching process and assignment of pharmaceutical benefits to the true episodes of care. They do not however alter the total amount of benefits matched in this process as the final stage in the PBS matching process is to scale the matched dataset up to the total report pharmaceutical costs.

Starting with the results from the original NEP19 calculations (using the current matching methodology), the analysis was carried out in three stages:

1. Adding Victorian pharmaceutical data[1] but keeping the same current approach; this forms a 'new baseline' to compare against.
2. Incorporating the date filter enhancement (Enhancement 1)
3. Applying the predictive model to the allocation process for risk allocation (Enhancement 2)

The changes made to the data pharmaceutical matching process were flowed through to the remainder of the data preparation and pricing model process, allowing us to assess the impact on the final model goodness of fit metrics and impact on hospitals.

2.2.3 Comparison against evaluation metrics

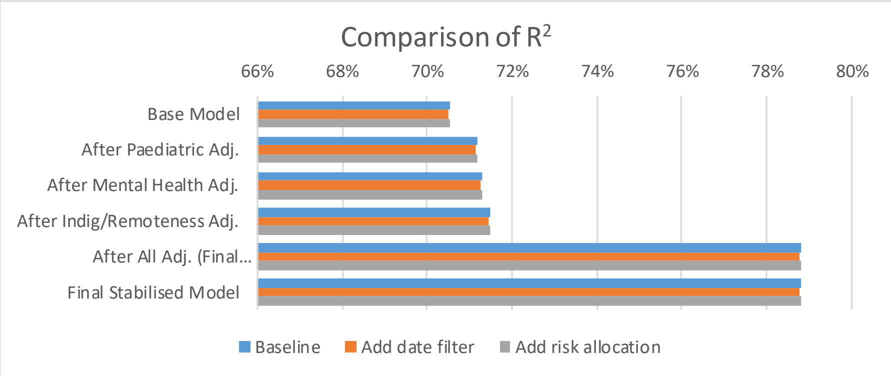
We have examined how the current approach and alternative approaches perform against the evaluation metrics. In addition to the commentary on the 'standard' evaluation metrics, we have also considered other indicators for assessing whether these alternative approaches should be considered for the pharmaceutical matching process.

Goodness of fit (R^2 and SMAPE)

R^2 and SMAPE are two measures that are currently used to assess goodness of fit of the existing NEP pricing models. The preferred outcome we are aiming to achieve is closer alignment between actual and modelled episodic costs, as indicated by a higher R^2 or lower SMAPE.

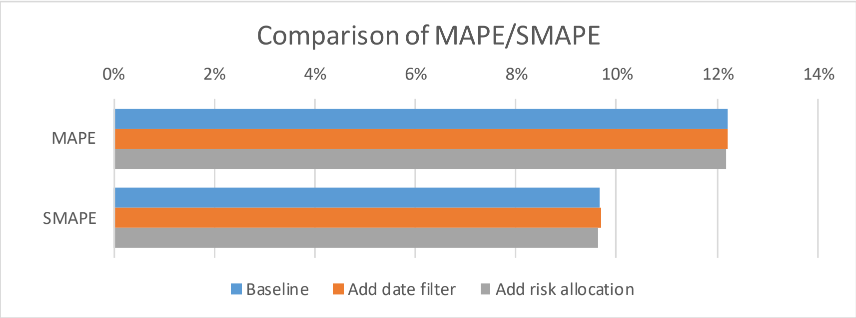
Figure 2 and Figure 3 show the R^2 at various stages of the model (for example, base model, after each set of adjustments, final model) and the SMAPE of the final model.

Figure 2: Comparison of R^2



[1] Prior to 2016/17, Victoria did not submit outpatient data which meant that including Victoria pharmaceutical benefit data in the matching process would cause results to be biased. Further detail on the inclusion/exclusion of Victoria data is provided in 18Appendix B

Figure 3: Comparison of SMAPE



The goodness of fit is similar between the three approaches. There is no material change in the R^2 (0.79 after rounding for all approaches), and SMAPE (from 9.7% for the first two approaches, and 9.6% after risk allocation).

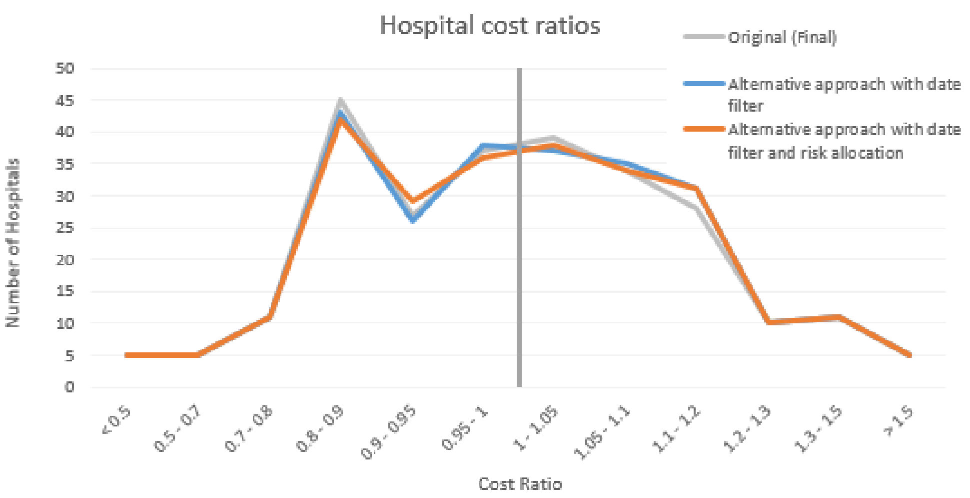
Stability

Although stability is considered a 'standard' evaluation metric, we consider it to be of less importance in the case of evaluating the pharmaceutical matching process. This is because we are looking to improve the overall match quality to accurately remove out of scope costs over time rather than focusing on stability. Our analysis on match quality is considered further in this section.

Hospital cost ratios

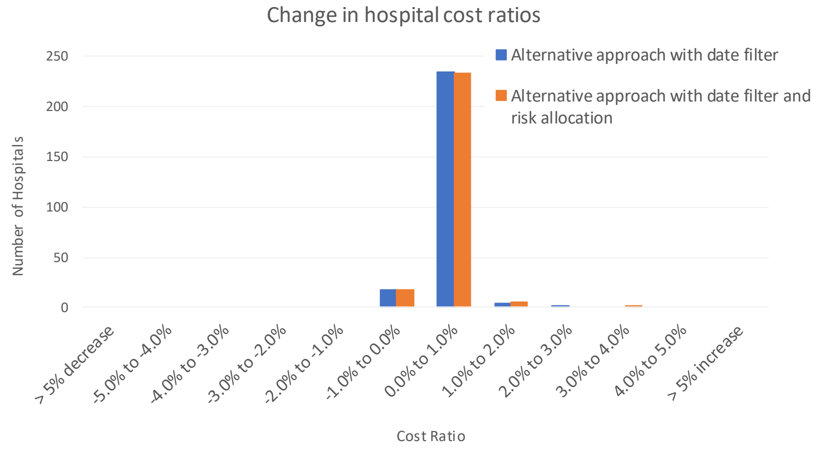
Figure 4 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

Figure 4: Distribution of hospital cost ratios



	Preferred outcome	Current Approach	Enhancement 1: Alternative approach with date filter	Enhancement 2: Alternative approach with date filter and risk allocation
Standard Deviation	Lower is more stable	0.26	0.23	0.23
% between 0.9 and 1.1	Higher is more stable	56.3%	56.6%	57.0%
5th Percentile	Closer to 1 is more stable	0.70	0.72	0.72
95th Percentile		1.46	1.35	1.35

Figure 5: Change in hospital cost ratios



The spread of hospital cost ratios is similar between the baseline approach and the alternative approach, with only minor changes in the distribution and summary statistics.

Furthermore, the majority of hospitals have less than a 1% change in the cost ratio.

Additional evaluation metrics – match quality and reasonableness checks

The pricing model seeks to accurately identify and exclude pharmaceutical benefits as they are out of scope. As such, in addition to considering the evaluation metrics above, we have also considered additional measures to assess the *match quality*. We have done this by considering:

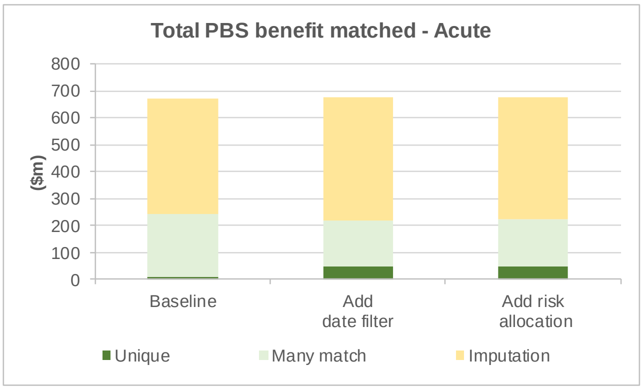
- The proportion of records matched at each stage
- A comparison of the pharmaceutical benefits amounts matched compared to each records' reported in-scope cost

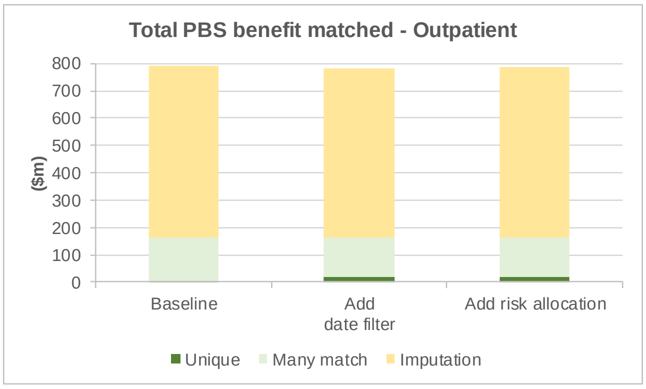
After applying the enhancements described above, **there has been an improvement in the match quality with the addition of the date filter**. A greater amount of pharmaceutical benefits could be uniquely matched to activity records. Our new baseline including Victoria data matched $16m across Acute and Outpatient records. This increased to $68m with the inclusion of the date enhancement.

Total PBS amount matched

Match level	Acute			Outpatient		
	Baseline	Add date filter	Add risk allocation	Baseline	Add date filter	Add risk allocation
Unique match 1 (with Medicare PIN, with date filter)	8,952,516	40,023,397	40,243,661	6,196,429	12,783,689	12,838,337
Unique match 2 (with Medicare PIN, without date filter)	-	5,481,163	5,453,622	-	673,706	676,936
Unique match 3 (without Medicare PIN, with date filter)	586,774	2,125,930	2,153,706	386,786	6,014,772	6,038,969
Unique match 4 (without Medicare PIN, without date filter)	-	705,254	704,647	-	229,536	232,887
Many match 1 (with Medicare PIN)	216,146,932	154,617,481	163,472,378	110,856,463	101,103,374	95,390,705
Many match 2 (without Medicare PIN)	15,713,659	13,796,539	9,543,653	47,288,786	44,199,088	45,855,837
Imputation	428,045,314	461,357,753	452,955,449	626,464,194	617,526,170	625,077,067
Total	**669,445,196**	**678,107,518**	**674,527,116**	**791,192,657**	**782,530,336**	**786,110,738**

Figure 6: Change in PBS benefits matched

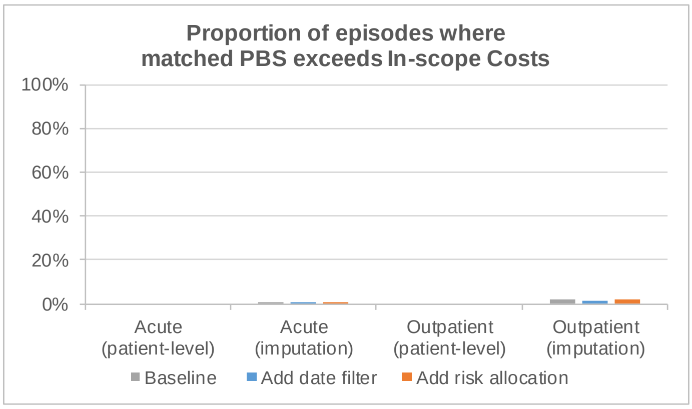




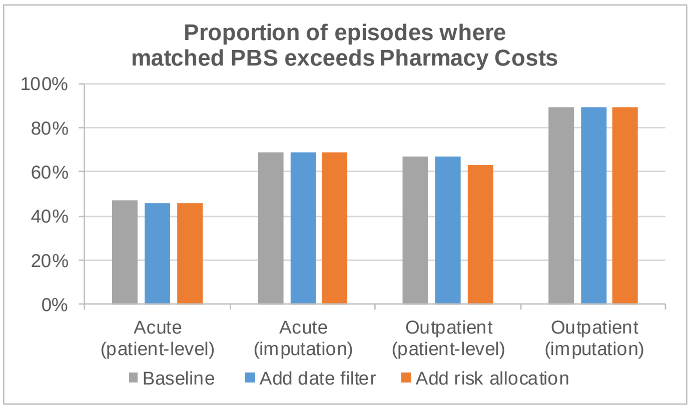
We have also considered the extent to which the various approaches do not violate the following reasonableness checks.

1. **The matched pharmaceutical benefit should not exceed the total in-scope cost of an episode.**

   Under the current approach, only a small proportion of records violate this reasonableness check. The two enhancements also result in a similarly small proportion of records where the pharmaceutical benefit exceeds the total in-scope cost.



2. **The pharmaceutical benefit should not exceed the reported pharmacy cost of an episode.** The current approach results in a significant proportion of records where the matched pharmaceutical benefit exceeds the reported pharmacy cost. There is a small improvement after incorporating the enhancements.



The inclusion of the date rule significantly increases the proportion of records and pharmaceutical benefit amount matched on a unique matching basis. This also results in a relatively small improvement when comparing the matched pharmaceutical benefits against the records' in-scope and direct pharmacy costs.

Pricing philosophy

Pharmaceutical benefit matching is a specific part of the NEP with a well-defined purpose (to remove out of scope costs). The alternatives that we have tested seek to enhance an approach which is consistent with IHPA's pricing philosophy and as such we do not consider this a relevant evaluation metric for assessing this component of the NEP.

2.2.4 Summary and Recommendations

We recommend that the date filter enhancement (Enhancement 1) be incorporated into the existing matching process. The underlying rationale used to differentiate between multiple activity records is sound and improves the number of unique matches identified, and it can be implemented with a low amount of effort.

Given the trade-off between the additional complexity and the small improvements, **we would not recommend adopting the predictive models (Enhancement 2) at this stage.** The results of this investigation have shown that, with the current limitations in the pharmaceutical data (in particular, there are only a limited number of additional variables available on the dataset), there is limited potential for more advanced analytical techniques to obtain improvements in the matching.

We understand that IHPA has limited control over the richness and quality of pharmaceutical data. However, if there are improvements to this data in the future, then it would be worthwhile for IHPA to reconsider methods to improve the matching of pharmaceutical benefits, for example by:

a) Incorporating any additional variables into the existing matching methodology
b) Refitting the suite of predictive models above using additional predictors from the pharmaceutical dataset
c) Relaxing existing matching rules
d) Building additional risk models.

2.3 Work-in-Progress (WIP)

2.3.1 Current approach

The current methodology excludes all WIP records, but applies a weighting to scale up to the total activity level after the trimming of WIP records is carried out. This process is applied at a Diagnosis Related Group (DRG) level and implicitly assumes that WIP records have similar characteristics as the in-scope records. This may not necessarily be true as each financial year begins and ends during the winter period and therefore the WIP records may be affected by seasonal illness.

WIP separations account for a very small proportion of total separations – approximately 0.6% in the 2016/17 year. Examining the proportion of WIP records at a jurisdiction level, there is not significant variation, although there is some variation by hospital.

Table 1: WIP proportion by jurisdiction

	WIP	Non-WIP	% WIP
National	**35,523**	**5,859,597**	**0.6%**
New South Wales	12,866	1,653,862	0.8%
Victoria	8,672	1,666,035	0.5%
Queensland	6,577	1,272,994	0.5%
South Australia	2,814	389,061	0.7%
Western Australia	2,664	505,153	0.5%
Tasmania	700	107,447	0.6%
Northern Territory	550	154,938	0.4%
Australian Capital Territory	680	110,107	0.6%

There is, however, significant variation of up to 30% by DRG (see Appendix C for details).

In addition, we have analysed the distribution of admission dates for WIP records. Almost all the records were admitted in the 2015/16 year (prior year), with 92% of these records being admitted in the June 2016 month. The remaining small number of records are spread across earlier financial years. As such, it is likely that the costed information would be reliable and that including these records in the National Cost models would make greater use of the available data.

2.3.2 Alternative approaches

Based on the findings of the exploratory analysis, two alternative approaches to WIP records were tested to understand the impact of including WIP records into the National Pricing models. Using the Draft NEP19 results as a base, we tested:

1. Including all WIP records

2. Including only WIP records where the admission date was in the prior year (that is, on or after 1 July 2015) – this is henceforth referred to as the "restricted WIP approach".

Eligible WIP records were included at the beginning of the modelling, flowing through into normal trimming, parameter calculation and calibration.

Analysis of the alternative approaches

We can make the following observations about the alternative approach when compared with the current approach:

1. For the model using restricted WIP records (1 July 2015 and later), the majority of the approximately 35,500 records remain untrimmed and would therefore be used in the model. The results are very similar

for the model where all WIP records are included as only a small number of WIP records with cost data actually have an admission date prior to 1 July 2015.

2. Approximately 91% of DRGs and 97% of inlier separations would have a change of less than 1% in the inlier parameter. However, a number of DRGs would have significant changes in the inlier parameter (see Appendix C for further details).

2.3.3 Comparison against evaluation metrics

We have examined the current approach and alternative approaches against the evaluation metrics.

Goodness of fit (R^2 and SMAPE)

Figure 7 to Figure 10 show the R^2 at various stages of the model (for example, base model, after each set of adjustments, final model) and the SMAPE for the models calculated using all WIP and restricted WIP approaches.

Figure 7: Comparison of R^2 – all WIP method

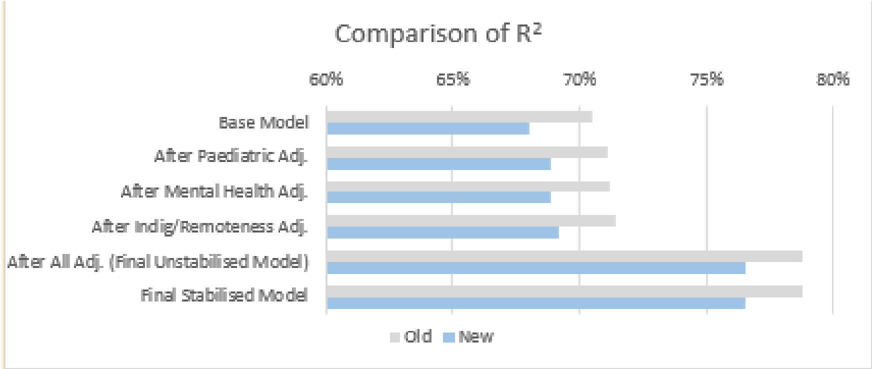


Figure 8: Comparison of SMAPE – all WIP method

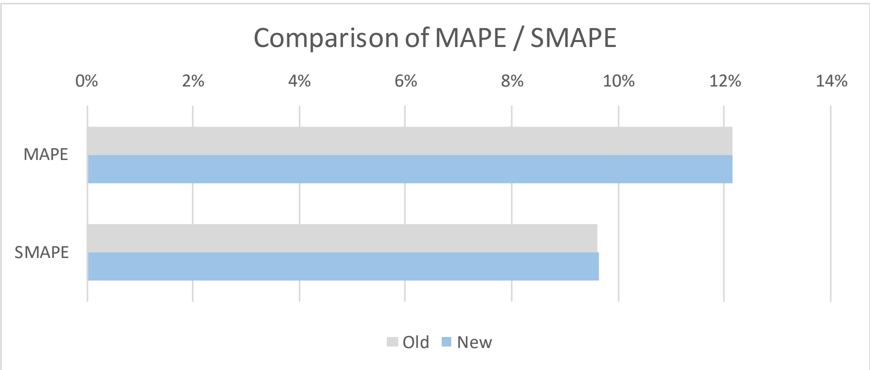


Figure 9: Comparison of R^2 - restricted WIP

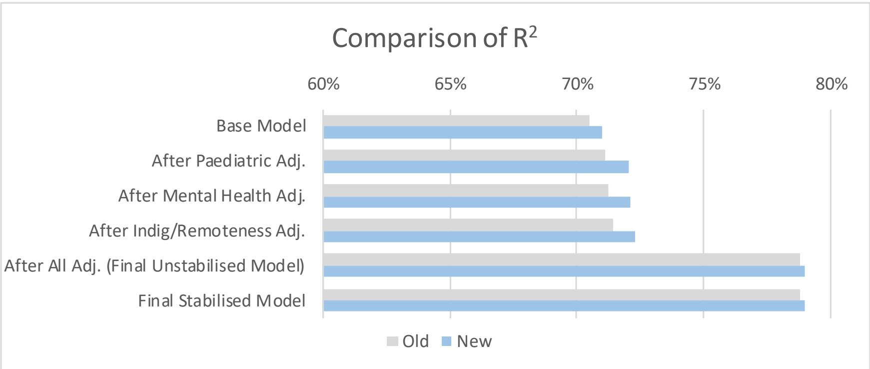
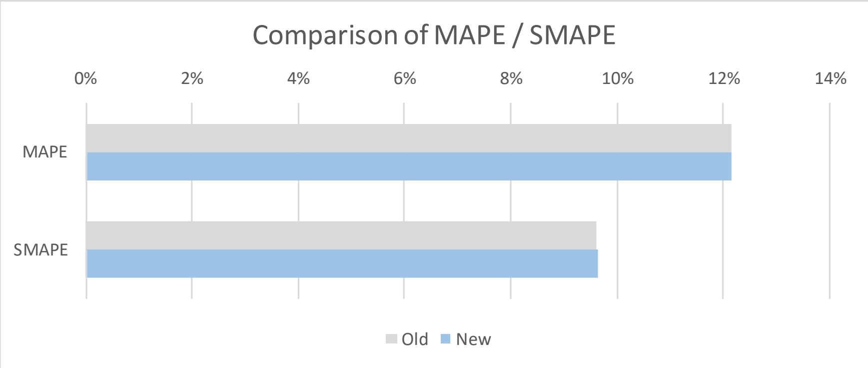


Figure 10: Comparison of SMAPE - restricted WIP



For the approach using all WIP records versus the current approach, there was a very small reduction in R^2 (from 0.79 to 0.77) and increase in SMAPE (from 9.6% to 9.7%).

There was also no material change in the goodness of fit (R^2 and SMAPE) between the restricted WIP approach and the current approach.

Stability

We have measured the stability of the proposed WIP approaches by assessing the changes in inlier parameters with and without WIP records. The results are shown below for the restricted WIP approach. The majority of DRGs (approximately 91% of DRGs and 97% of inlier separations) had a change of less than 1% in the inlier parameter.

Note that a transition to using WIP records will likely result in a one-off shift in the parameters in some DRGs, as shown in the table below. Subsequent to this, there should be minimal impact on the stability of parameters from year to year as WIP records only represent a small proportion of the total separations and will be consistently included in each year. We note that treatment of year on year movements can continue to be subject to IHPA's stabilisation policy.

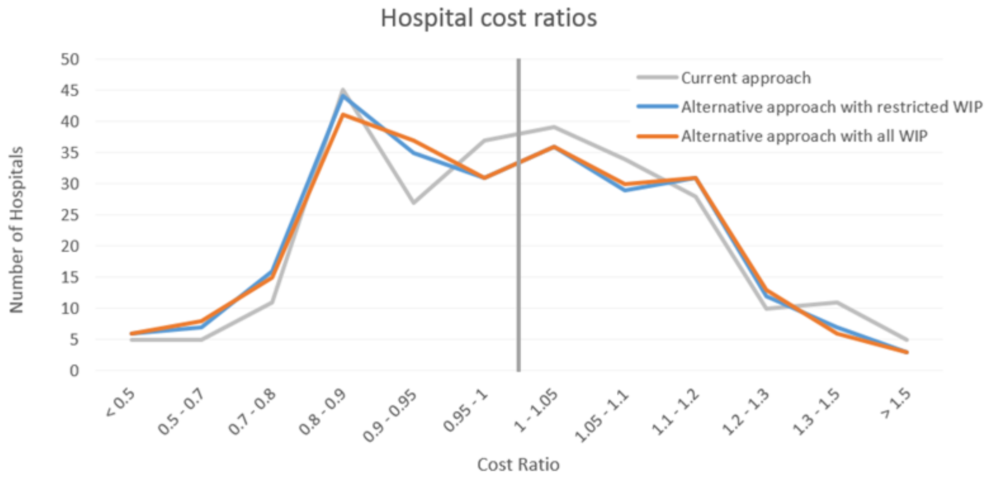
% change in inlier parameter	Number of DRGs	Number of inlier seps	% of DRGs	% of inlier seps
-10.00% to -5.01%	2	446	0.3%	0.0%
-5.00% to -4.01%	0	0	0.0%	0.0%
-4.00% to -3.01%	0	0	0.0%	0.0%
-3.00% to -2.01%	8	23,228	1.0%	0.4%
-2.00% to -1.01%	27	62,065	3.4%	1.2%
-1.00% to -0.51%	102	335,636	12.8%	6.5%
-0.50% to -0.01%	500	4,424,880	62.7%	85.4%
0.01% to 0.50%	99	279,659	12.4%	5.4%
0.51% to 1.00%	26	26,191	3.3%	0.5%
1.01% to 2.00%	22	25,678	2.8%	0.5%
2.01% to 3.00%	6	2,047	0.8%	0.0%
3.01% to 4.00%	1	29	0.1%	0.0%
4.01% to 10.00%	2	2,246	0.3%	0.0%
10.01% to 15.00%	3	285	0.4%	0.0%
Total	798	5,182,390	100.0%	100.0%

The inclusion of WIP records will likely result in a one-off shift in the parameters. Subsequent to this, there should be minimal impact on the stability from year to year.

Hospital cost ratios

Figure 11 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

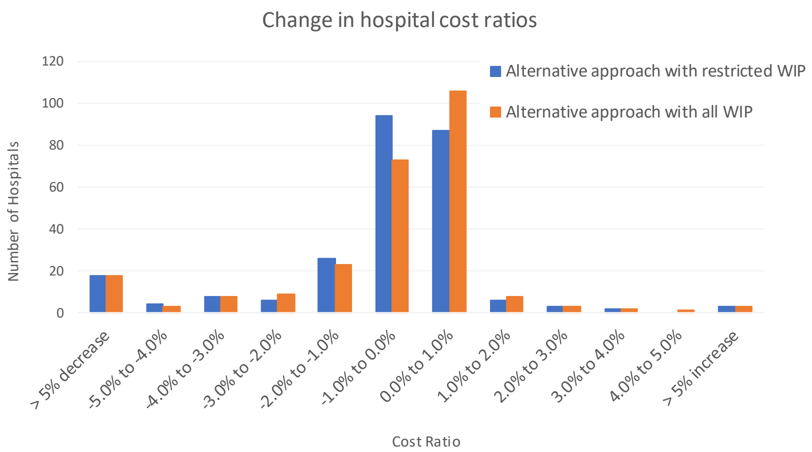
Figure 11: Distribution of hospital cost ratios



	Preferred outcome	Current Approach	Alternative Approach (restricted WIP)	Alternative Approach (all WIP)
Standard Deviation	Lower is more stable	0.26	0.23	0.23
% between 0.9 and 1.1	Higher is more stable	56.3%	54.8%	55.91%
5th Percentile	Closer to 1 is more stable	0.70	0.69	0.68
95th Percentile		1.46	1.27	1.27

Overall, the spread of hospital cost ratios is similar between the current approach and the tested alternatives. However, there were some large changes for some individual hospitals.

Figure 12: Change in hospital cost ratios



For the restricted WIP option:

- 21 hospitals had a change in cost ratio greater than 5%, with 18 of these hospitals having a reduction in the cost ratio.
- All but four of these were small hospitals with fewer than 1,000 separations and are therefore more likely to have greater volatility in the predicted costs.

- More than half of these hospitals were classified as subacute and non-acute hospitals or un-peered hospitals.

The results are similar for the all WIP option, with a number of hospitals overlapping with those identified in the restricted WIP approach:

- 20 hospitals had a change in cost ratio greater than 5%, with 18 of these hospitals having a reduction in the cost ratio.

- However, the all WIP approach results in the cost ratio for a large children's hospital and large principal referral hospital decreasing by more than 5%

The spread of hospital cost ratios is similar between the current approach, the all WIP approach and restricted WIP approach, with only minor changes in the distribution and summary statistics.

Although the majority of hospitals have a less than 1% change in cost ratio, some hospitals (typically smaller hospitals) had larger movements, reducing the cost ratio.

Pricing philosophy

The current pricing philosophy aims to utilise as much of the available data as possible to develop the NEP. This involves considering the full mix of episodes across the population and year. Our analysis of WIP records indicates that the majority of the WIP records are actually admitted in June of the prior year and this limits the uncertainty about their data quality.

However, we are aware that there may be differences in between jurisdictions for how WIP records are handled on their costing systems and whether costs are correctly allocated between financial years. This will need to be taken into account prior to implementation.

Including WIP records with an admission date in the prior year better aligns with the pricing philosophy while balancing the risk of including unreliable cost data from those records.

2.3.4 Summary and Recommendation

On balance, **we recommend that WIP episodes where the admission date is in the most recent year are included:**

- This makes better use of the available data and reduces potential biases (such as seasonal illness). Although historically WIP records were excluded due to concerns about the quality of costed data, it is likely that the costed information would be reliable for these more recent WIP episodes occurring within the last financial year.

- Our analysis confirms that the restricted WIP approach is still able to exclude genuine outliers for which there may still be concerns around the quality of their costing.

- There were no material differences in the goodness of fit of the Acute cost model and the distribution of hospital cost ratios of the restricted WIP approach.

Additional considerations for transitioning to the restricted WIP approach include:

- We are aware that there may be differences in between jurisdictions for how WIP records are handled on their costing systems and whether costs are correctly allocated between financial years. This will need to be taken into account prior to implementation

- Many of the DRGs with a high proportion of WIP records have a low volume of activity. Clinical advice may need to be sought as to whether it would be acceptable to include WIP records for these low volume and higher cost DRGs.

- Adopting the alternative approach could lead to a large one-off change in the price parameters. Although the majority of parameters change only by a small amount, some of these DRGs represent a significant proportion of the total in-scope cost (“high volume” DRGs). It would be appropriate to assess these changes in conjunction with IHPA’s stabilisation policy.

3 Base Model

3.1 Background and purpose

The base model forms the core of the NEP pricing models, being the key mechanism to develop the Acute admitted price weights, but also the Reference Cost underpinning the NEP. It plays an important role in delivering on the current pricing philosophy: to balance supporting a hospital's ability to bundle services under a range of delivery models with a mechanism for fair risk sharing between the Commonwealth and the jurisdictions.

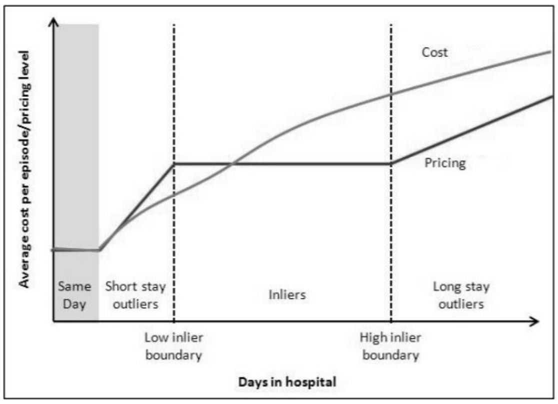
A key component of the base model is the determination of "inlier bounds", which divide the separations within each Diagnosis Related Group (DRG) into "inliers" and "outliers" based on their lengths of stay (LOS):

- Inliers represent the majority of separations which have typical lengths of stay for that DRG. The current pricing philosophy aims to price these episodes at the average cost so that they are neither under- nor over-priced.

- Outliers represent separations which have unusually low or high lengths of stay. The current pricing philosophy aims to over-price short-stay outliers and under-price long-stay outliers (relative to their likely actual cost) to incentivise efficiency.

Same-day episodes are priced separately and this results in four separation categories for each DRG: same-day, short-stay outliers, inlier and long-stay outliers.

Once the inlier bounds have been set, the base model firstly calculates a base price for inlier separations broadly in line with the average cost. Short-stay outliers and long-stay outliers are then priced to incentivise efficiency (that is, over-pricing and under-pricing them respectively relative to their likely actual cost), with the overall model scaled such that modelled costs are equal to actual in-scope hospital costs. This is illustrated in the diagram below.



In our review, we have focused our analysis on the **selection of inlier bounds**, noting that the choice of the lower and upper inlier bounds determines which separations fall into which category and therefore the level of over- and under-pricing in those categories.

Unless otherwise stated, the analysis in this section was carried out using hospital cost and activity data from the 2016/17 activity year which formed the basis for developing the NEP19 Draft Determination models at the time of the analysis.

3.2 Inlier Bounds

3.2.1 Current approach

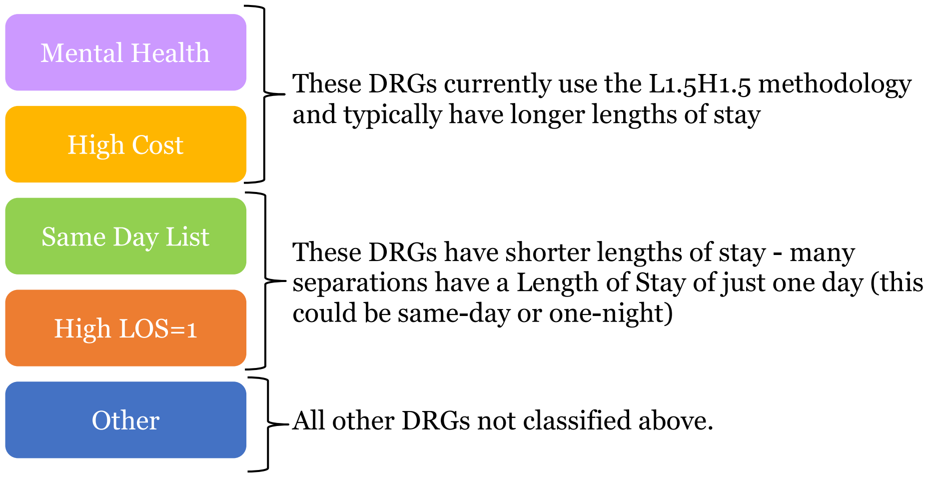
The current approach to setting inlier bounds uses the 'L3H3' methodology, or in the case of mental health and a select group of high-cost DRGs, 'L1.5H1.5'. This methodology involves:

- Setting the inlier lower bound to the average Length of Stay divided by 3 (or by 1.5 in the case of 'L1.5H1.5')
- Setting the inlier upper bound to the average Length of Stay multiplied by 3 (or by 1.5 in the case of 'L1.5H1.5')

Some further stabilisation considerations and rounding are made to ensure the bounds are consistent, reasonable, and stable from year to year.

Analysis of the current approach

To examine how well the current pricing model is working with regard to the inlier bounds methodology we categorised the DRGs into five groups:



Separately, we also identified a group of 31 "high volume" DRGs that are either within the top 20 DRGs overall by in-scope cost, or within the top 5 of any of the above five categories by in-scope cost. These 31 DRGs account for approximately 36% of total separations and 23% of the total in-scope costs across all DRGs in 2016-17.

Table 2: Number of separations and in-scope cost for "high volume" DRGs – 2016/17

DRG	Description	Category	Separations Count	Separations % of All DRGs	Inscope Cost $	Inscope Cost % of All DRGs
L61Z	Haemodialysis	High LOS=1	1,122,268	19.6%	586.5m	2.3%
O60B	Vaginal Delivery, Intermediate Complexity	Other	66,162	1.2%	386.7m	1.5%
O01B	Caesarean Delivery, Intermediate Complexity	Other	31,596	0.6%	365.8m	1.4%
E62A	Respiratory Infections and Inflammations, Major Complexity	Other	41,757	0.7%	337.4m	1.3%
U61A	Schizophrenia Disorders, Major Complexity	Mental Health	7,475	0.1%	262.1m	1.0%
U61B	Schizophrenia Disorders, Minor Complexity	Mental Health	16,362	0.3%	292.2m	1.2%
I04B	Knee Replacement, Minor Complexity	Other	13,857	0.2%	263.1m	1.0%
R63Z	Chemotherapy	High LOS=1	213,373	3.7%	250.2m	1.0%
O01C	Caesarean Delivery, Minor Complexity	Other	26,019	0.5%	247.0m	1.0%
O60C	Vaginal Delivery, Minor Complexity	High LOS=1	55,511	1.0%	238.4m	0.9%
O60A	Vaginal Delivery, Major Complexity	Other	23,844	0.4%	206.1m	0.8%
U63B	Major Affective Disorders, Minor Complexity	Mental Health	13,140	0.2%	189.5m	0.8%
C16Z	Lens Procedures	High LOS=1	69,492	1.2%	187.7m	0.7%
F62A	Heart Failure and Shock, Major Complexity	Other	17,146	0.3%	180.0m	0.7%
U63A	Major Affective Disorders, Major Complexity	Mental Health	5,352	0.1%	163.9m	0.6%
H08B	Laparoscopic Cholecystectomy, Minor Complexity	High LOS=1	23,263	0.4%	180.1m	0.7%
I33B	Hip Replacement for Non-Trauma, Minor Complexity	Other	8,687	0.2%	171.4m	0.7%
E65A	Chronic Obstructive Airways Disease, Major Complexity	Other	21,855	0.4%	162.9m	0.6%
G48B	Colonoscopy, Minor Complexity	High LOS=1	80,803	1.4%	156.0m	0.6%
O01A	Caesarean Delivery, Major Complexity	Other	9,024	0.2%	149.7m	0.6%
J64B	Cellulitis, Minor Complexity	On SD List	46,396	0.8%	135.5m	0.5%
E62B	Respiratory Infections and Inflammations, Minor Complexity	On SD List	36,892	0.6%	118.0m	0.5%
U67B	Personality Disorders and Acute Reactions, Minor Complexity	Mental Health	15,276	0.3%	96.7m	0.4%
R60A	Acute Leukaemia, Major Complexity	High Cost	2,595	0.0%	88.4m	0.4%
F42B	Circulatory Dsrds, Not Adm for AMI W Invasive Cardiac Inves Proc, Minor (	On SD List	24,540	0.4%	95.0m	0.4%
G70B	Other Digestive System Disorders, Intermediate Complexity	On SD List	31,533	0.5%	89.3m	0.4%
Q60A	Reticuloendothelial and Immunity Disorders, Major Complexity	On SD List	10,625	0.2%	85.3m	0.3%
P03A	Neonate, AdmWt 1000-1499g W Significant GI/Vent>=96hrs, Major Compl	High Cost	423	0.0%	56.9m	0.2%
I12A	Misc Musculoskeletal Procs for Infect/Inflam of Bone/Joint, Major Complex	High Cost	1,914	0.0%	64.7m	0.3%
P66A	Neonate, AdmWt 2000-2499g W/O Significant GI/Vent>=96hrs, Extreme C	High Cost	1,330	0.0%	36.2m	0.1%
P02Z	Cardiothoracic and Vascular Procedures for Neonates	High Cost	220	0.0%	28.0m	0.1%
Total High Volume DRGs			2,038,730	35.5%	5,870.5m	23.3%

We then analysed the proportion of separations that were classified as inliers and the cost ratios for each DRG and separation category. A summary of the outcomes is presented below, and further detailed analysis can be found in Appendix D.

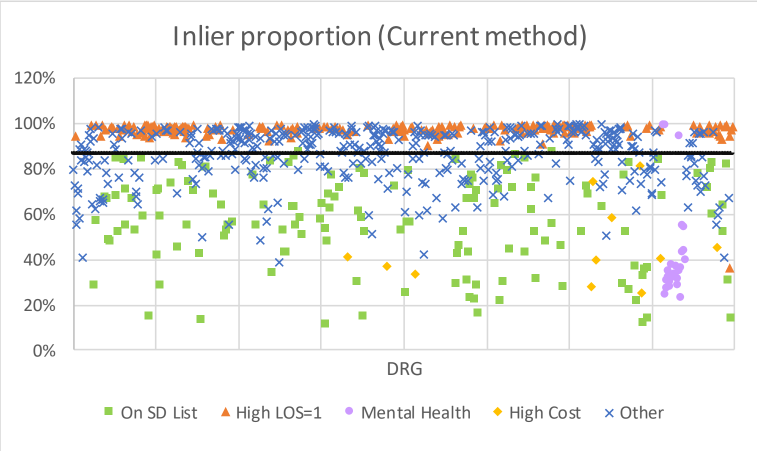
1. Inlier proportions

To test the underlying principle that the *inlier category represents a typical separation and contains the majority of separations and associated in-scope costs* we calculated the proportion of separations that were classified as inliers.

The analysis (see Figure 13 below) showed that under the current approach, the inlier bounds generally capture the majority of the separations. Approximately 90% of DRGs (which account for 97% of total separations) have an inlier proportion greater than 50%, and more than half of the DRGs (which account for 81% of total separations) have an inlier proportion of over 90%. The average proportion of separations within the inlier bounds is 88% across all DRGs. There are however, a number of DRGs with lower inlier proportions. This includes (but is not limited to):

- DRGs in the mental health and high cost category generally had a high proportion of short-stay outlier separations, which is a result of using the L1.5H1.5 methodology
- For those DRGs on the Same Day List a high proportion of separations were in the same-day category, which was as expected

Figure 13: Inlier proportions by DRG



2. Cost ratios by separation category

To test the underlying principle that the *inlier category should be broadly priced in line with average cost (or a cost ratio close to 1.0)* we analysed the cost ratios for each DRG and separation category, where the cost ratio is defined as:

$$\text{Cost ratio} = \frac{\text{Actual in-scope cost}}{\text{Model predicted cost}}$$

A cost ratio greater than 1.0 indicates that the actual costs are greater than the model predicted costs and therefore the DRG or separation is under-priced relative to the average cost. Conversely, a cost ratio of less than 1.0 indicates that the DRG or separation category is over-priced relative to the average cost.

Figure 14 shows the cost ratio for inliers for each of the 798 DRGs and Figure 15 shows the inlier cost ratio for each of the 31 high volume DRGs.

Figure 14: Inlier cost ratio by DRG (sorted alphabetically)

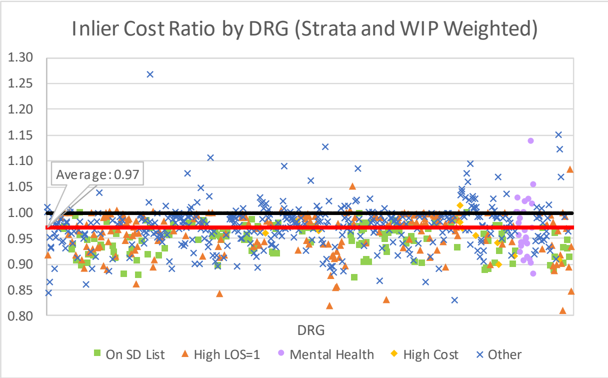
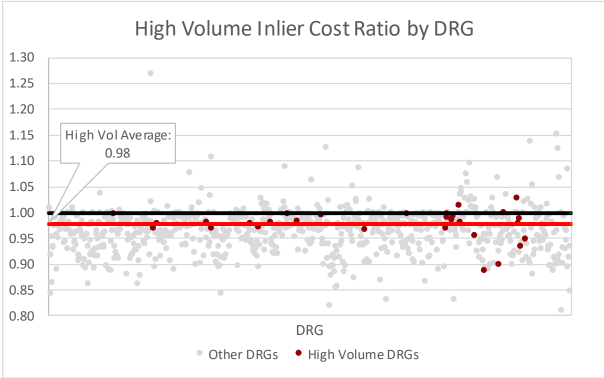


Figure 15: Inlier cost ratios for high volume DRGs



The results show that there is considerable variation in inlier cost ratios by DRG. The cost ratio of most DRGs varies between 0.90 and 1.00 and this is broadly consistent across the various separation categories which have been defined. However, for the 31 high volume DRGs, the cost ratios are generally more consistent.

We also analysed the cost ratios for short-stay and long-stay outliers and found that, as expected, the cost ratios for short-stay outliers are generally significantly lower than 1.0, while those for long-stay outliers are generally significantly higher than 1.0. There is more variation across DRGs for outlier episodes compared to the inlier cost ratios, which is to be expected, given the (generally) much small number of separations in these categories.

These findings are in line with the principles of the pricing methodology and indicate that, in general, the inlier category is broadly priced in line with average cost.

3.2.2 Alternative approach – percentile based inlier bounds

An alternative approach to setting the inlier bounds would be to choose certain percentiles of the LOS distribution as the bounds. This approach to setting the inlier bounds may result in more consistency in the proportion of episodes identified in each category (inlier, short-stay outlier, and long-stay outlier) across the DRGs.

Figure 16 shows the average LOS expressed as a percentile of the LOS distribution for each DRG. The results show that the average LOS is generally higher than the median (50^{th} percentile). Excluding DRGs with a high proportion of same-day or one-night separations, the average LOS generally lies between the 60^{th} and 75^{th} percentiles.

Figure 16: Average Length of Stay as a percentile of the LOS distribution for each DRG

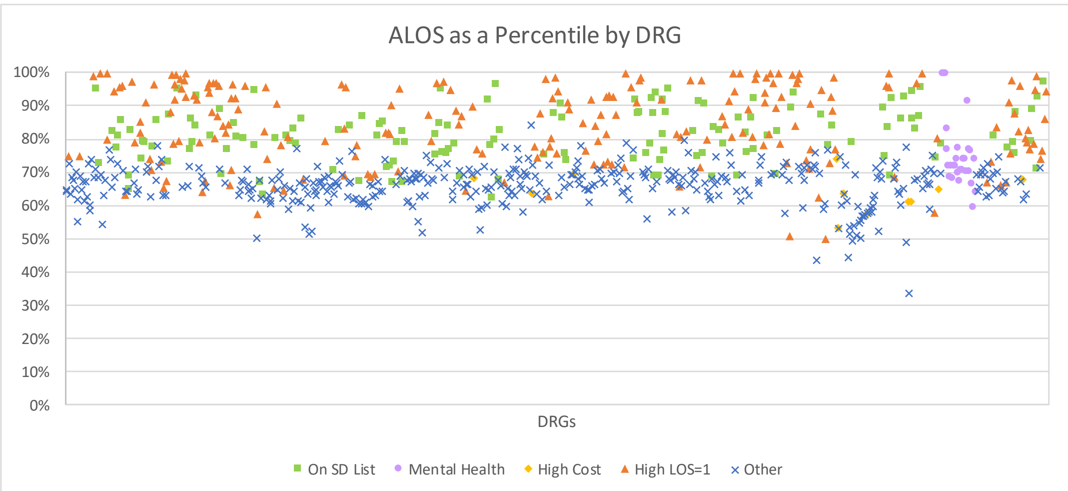


Figure 17 and Figure 18 show the current inlier bounds expressed as percentiles of the LOS distribution for each DRG, that is, they show what percentiles are implicitly being chosen by the current methodology.

Figure 17: Current inlier lower bound as a percentile by DRG

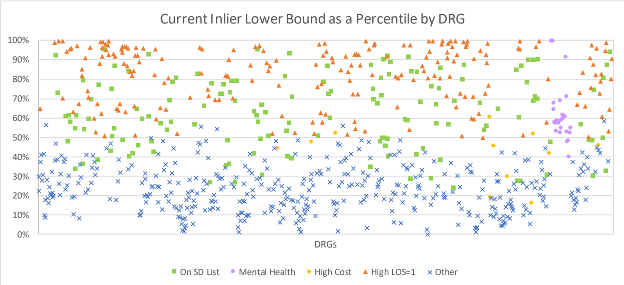
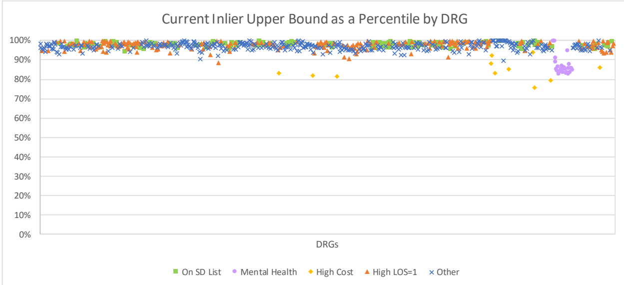


Figure 18: Current inlier upper bound as a percentile by DRG



The results show that there is significant variation in the percentile that corresponds to the current inlier lower bound:

- The percentile is very high for DRGs with a high proportion of same-day or one-night separations, which is to be expected
- The percentile corresponding to the inlier lower bound is high for mental health DRGs, approximately the 63rd percentile
- The lower bound is at approximately the 25th percentile for other DRGs with a significant variation between the 10th and 40th percentiles.

The inlier upper bound is at a very high percentile (approximately 97.5th percentile for most DRGs) although mental health and high cost DRGs have an upper bound closer to the 85th percentile, due to the use of L1.5H1.5.

Analysis of the alternative approach

The alternative percentile based approach has a lower bound set at the 25th percentile and an upper bound set at the 95th percentile. Further details about the alternative approach can be found in Appendix D.

We can make the following observations about the alternative approach when compared with the current approach:

1. Change in inlier bounds –the majority of lower bounds do not change, however there are large changes in the upper bounds which is to be expected given these bounds are well into the tail of the LOS distribution. We observe that using the 95th percentile, more DRGs had a decrease in the upper bound compared with the current approach, although mental health and high cost DRGs generally had an increase in their upper bound.

2. Change in inlier proportions – the inlier proportions become more consistent across DRGs; they are generally within a much narrower range of 80% to 90%. This is one advantage of the percentile based method.

3. Change in price weights – while most of the inlier and long-stay outlier per diem price weights do not change significantly, there are significant changes in the short-stay outlier per diem price weights. This means there would be a significant one-off shift in these parameters if there was a change in the adopted approach for setting inliers.

3.2.3 Comparison against evaluation metrics

We have examined how the current approach and alternative approach to setting inlier bounds performs against three evaluation metrics (1) goodness of fit, (2) stability, and (3) hospital cost ratios. Both approaches are also then evaluated against the pricing philosophy described earlier.

Goodness of fit (R^2 and SMAPE)

R^2 and SMAPE are two measures that are currently used to assess goodness of fit of the existing NEP pricing models. The preferred outcome we are aiming to achieve is closer alignment between actual and modelled episodic costs, as indicated by a higher R^2 or lower SMAPE.

Figure 19 and Figure 20 show the R^2 at various stages of the model (e.g. base model, after each set of adjustments, final model) and the SMAPE of the final model.

Figure 19: Comparison of R^2

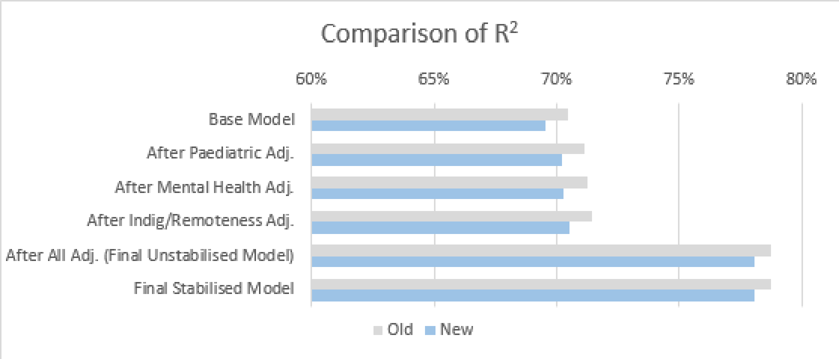
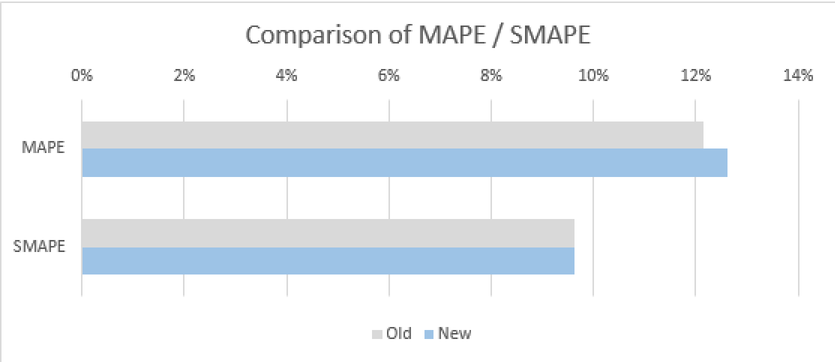


Figure 20: Comparison of SMAPE



The goodness of fit is similar between the two approaches. There is a marginal change in R^2 (from 0.79 to 0.78) and SMAPE (from 9.6% to 9.7%), however these difference are immaterial.

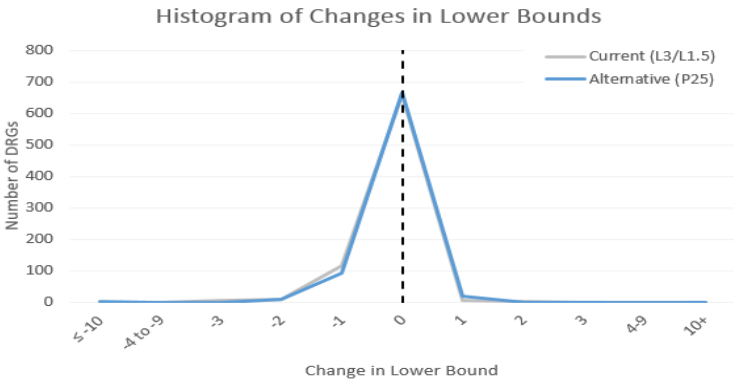
Stability

We have measured the stability of the proposed inlier bounds by assessing the year on year change between NEP18 and NEP19 Draft of the lower and upper bounds. A lower magnitude of change is desirable.

The magnitude of lower bound changes is shown in the histogram below, and is also summarised by the following statistics:

- Standard deviation of changes in the bound (lower is more stable)
- Proportion of DRGs with changes in the bound within +/- 1 (higher is more stable)
- 5th and 95th Percentiles of changes in the bound (closer to zero is more stable)

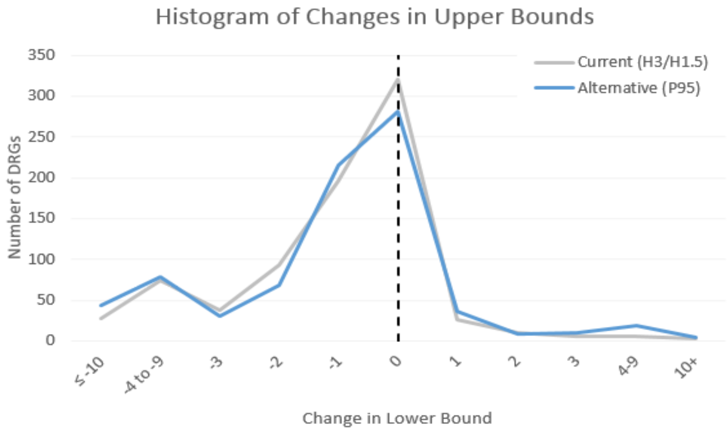
Figure 21: Distribution of changes in inlier lower bounds



	Preferred outcome	Current Approach	Alternative Approach
Standard Deviation	Lower is more stable	0.50	0.98
% within +/- 1	Higher is more stable	82.5%	83.6%
5th Percentile	Closer to zero is more stable	-1	-1
95th Percentile		0	0

Similarly, the spread of changes in the upper bound is shown in Figure 22 below.

Figure 22: Distribution of changes in inlier upper bounds



	Preferred outcome	Current Approach	Alternative Approach
Standard Deviation	Lower is more stable	3.59	6.10
% within +/- 1	Higher is more stable	67.9%	66.8%
5th Percentile	Closer to zero is more stable	-8	-10
95th Percentile		1	2

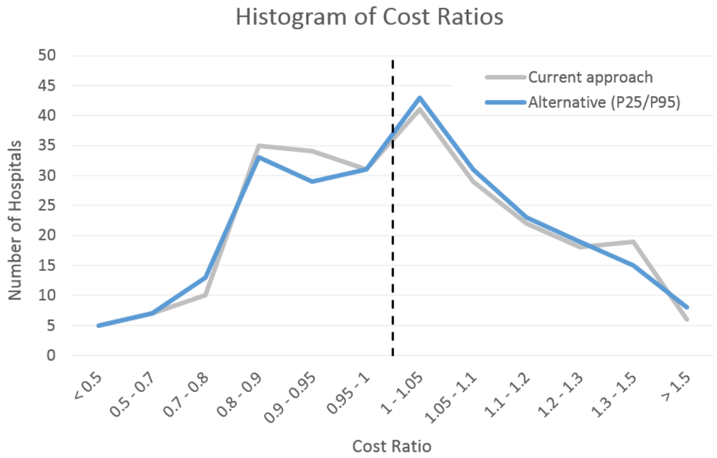
The percentile approach shows a higher standard deviation in the bounds but results in a greater proportion of records captured in the inlier category which is aligned with the intention current pricing philosophy.

The stability of the inlier lower bounds is similar under both approaches. However, the inlier upper bounds defined using the alternative approach are slightly less stable than the current approach (as indicated by a higher standard deviation and a 5th percentile that is further away from zero).

Hospital cost ratios

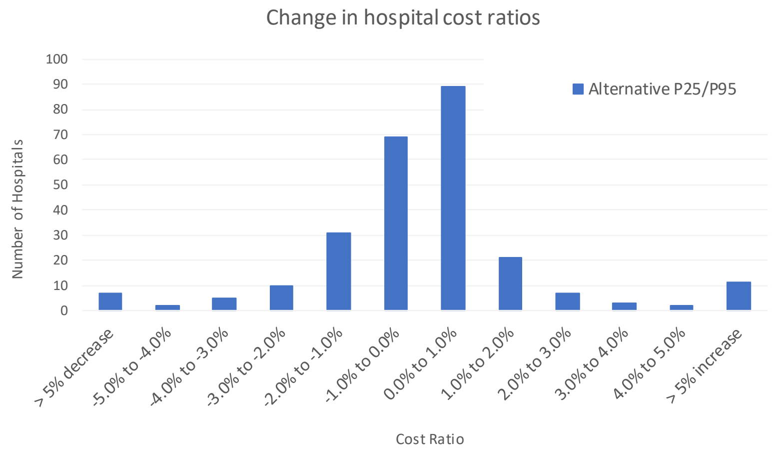
Figure 23 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

Figure 23: Distribution of hospital cost ratios



	Preferred outcome	Current Approach	Alternative Approach
Standard Deviation	Lower is more stable	0.26	0.26
% between 0.9 and 1.1	Higher is more stable	56.3%	55.9%
5th Percentile	Closer to 1 is more stable	0.70	0.70
95th Percentile		1.46	1.46

Figure 24: Change in hospital cost ratios



Overall, the spread of hospital cost ratios is similar between the current approach and the percentile approach. However, there were some large changes for some individual hospitals.

- 18 hospitals had a change in cost ratio greater than 5%. Of these, all except two hospitals had fewer than 500 separations in 2016/17 and thus are more likely to experience volatility in the cost ratio due to the lower volume of episodes.

- All of these hospitals were subacute and non-acute, psychiatric or un-peered hospitals.

The spread of hospital cost ratios is similar between the current approach and the alternative approach, with only minor changes in the distribution and summary statistics.

Some hospitals experienced large changes in the cost ratio, although these were predominately small subacute and non-acute hospitals.

Pricing philosophy

Under the current pricing philosophy the inlier separations are intended to be representative of a 'typical' separation and in doing so, capture a large proportion of the cost in the DRG, whereas the outliers represent separations that usually have shorter or longer lengths of stay.

The choice of inlier bounds acts as a mechanism for risk sharing. The NEP pricing model aims to price inliers broadly in line with their average cost, whilst short-stay outliers are over-priced and long-stay outliers are under-priced to incentivise efficiency.

The alternative methodology is more aligned to the pricing philosophy as the inlier bounds are better able to capture the majority of the episodes for each DRG as well as the "peak" of the Length of Stay distribution, resulting in an inlier price more representative of a true "average" separation.

3.2.4 Summary and Recommendation

On balance, **we recommend that the alternative percentile-based approach is adopted to set the inlier bounds**. This is because:

- The alternative approach aligns closer with the model philosophy:
  - The majority of episodes as well as inscope cost for each DRG are captured as 'inliers' more consistently;
  - The most likely lengths of stays (i.e. the "peak" of the LOS distribution) will be captured as 'inliers' more consistently;

  - Therefore, the inlier price weight is more representative of a true "average" separation.
- There are relatively minor differences in the models against other evaluation metrics, for example the variability of cost ratios (across DRGs, separation categories and hospitals) and the overall goodness of fit.

If a shift to the alternative methodology is made, however, there would be some one-off large changes in bounds and price weights, in particular in relation to short-stay outliers. The stability of the inlier bounds from year to year is also expected to reduce slightly.

If inlier bounds are to be chosen using a percentile, then a decision must also be made as to which specific percentiles are selected, as well as whether the percentile approach should be applied for both lower and upper bounds. The following recommendations are made with regard to this:

- It is important to select percentiles that are sufficiently far apart so that there is a large proportion of separations that will be categorised in the inlier category.
- When a distribution is symmetric, it is common to select percentiles that are also symmetric (e.g. 10^{th} and 90^{th} percentiles). However, due to the skewness of the Length of Stay distribution, selecting non-symmetric percentiles (such as 25^{th} and 95^{th}) would be reasonable.
- The analysis shows that the proportion of records and costs captured in the inlier bound is more consistent across DRGs. Ultimately, the choice of bound should be made with regard to the desired balance between proportions of inlier and outlier separations and implicitly the impact this has on the level of risk sharing that is in place through the current funding arrangements given long stay outliers are under-priced.
- We also recommend that the choice of percentile be made with clinical input, for example, testing whether the resulting inlier bounds for "high volume" DRGs represent reasonable lengths of stay of typical episodes of care. The percentile approach tested in this analysis resulted in more consistency in the proportion of costs captured in the inlier bound, but exceptions may be needed for particular DRGs informed by clinical input.
- Percentile points that are too extreme will be less stable from year to year. The current approach to setting inlier bounds includes criteria for stabilisation. The slightly reduced stability in the inlier bounds (and therefore the inlier price weight) means that these rules should also be reviewed for appropriateness if a percentile approach is adopted, especially for changes in the lower bound. This would also need to be considered if there are changes to the classification system.

4 Adjustments

4.1 Background and purpose

The purpose of adjustments is to allow for legitimate and unavoidable variations in the costs of delivering health care services. This ensures that hospitals who service a larger proportion of patients with these legitimate and unavoidable costs are not unfairly penalised.

There are a large number of adjustments that already exist in the NEP, including adjustments for Indigenous patients, patient residential and treatment remoteness, and age among other factors. These adjustments, including both their existence and quantum, may differ across the various service streams.

Our analysis focussed on identifying and testing whether there were any additional adjustments that are warranted over and above the existing adjustments. We only performed this analysis for the Acute, Emergency Department and Non-Admitted streams, noting that adjustments for Subacute are generally aligned with those for Acute.

4.2 Approach

The overall approach was to investigate whether there were any variables available in the activity data which could help to explain the variation that is currently unexplained by the cost models, using the cost ratio as a key measure of this unexplained variation. Our analysis considered as many variables as possible, using machine learning and other analyses to assess whether adjustments were warranted. This quantitative analysis was then supplemented by a qualitative consideration of whether these variables represent legitimate and unavoidable variations or not.

The following is a summary of the key stages of our work:

1. Develop an initial extensive list of variables for consideration
2. Remove variables with poor quality data (e.g. missing or biased towards certain jurisdictions)
3. For the Acute stream (where there are a large number of candidate variables), use machine learning techniques[2] to provide an indication of which variables are more important in explaining the variation in cost ratios:

$$\text{Cost ratio} = \frac{\text{Actual in-scope cost}}{\text{Model predicted cost}}$$

4. Analyse how the cost ratios differ by each of the variables and whether any cohorts are over- or under-priced
5. Consider the reasonableness of these variations in cost ratio, along with whether the data captured by the variables represent legitimate and unavoidable variations
6. Conclude which variables, if any, are worth further consideration and test the impact of including them as an adjustment in the cost models.

[2] A regression tree was fit to the cost ratios, with pruning based on cost-complexity. Variable importance was measured based on the total reduction in mean-squared error achieved by including the variable.

Our analysis considered the cost models developed from NEP17, NEP18 and NEP19. Detailed commentary for Acute Admitted, Emergency Department and Non-admitted are presented in the following sections.

4.3 Acute Model Adjustments

The adjustments currently applied to the Acute model are documented in the National Efficient Price Determination 2019-20[3] and include:

Adjustment	Value
Paediatric adjustment	Varies by DRG
Specialist psychiatric age adjustment	For patients aged ≤ 17 years and in MDC 19 or 20 • In Specialised Children's Hospital – 16% • Otherwise – 49% For patients aged ≤ 17 years and not in MDC 19 or 20 • In Specialised Children's Hospital – 72% • Otherwise – 89% For patients aged > 17 years and not in MDC 19 or 20 – 32%
Patient residential remoteness adjustment	Outer Regional Area – 8% Remote Area – 27% Very Remote Area – 29%
Indigenous adjustment	4%
Radiotherapy Adjustment	36%
Dialysis adjustment	27%
Patient treatment remoteness adjustment	Remote Area – 8% Very Remote Area – 10%
Intensive Care Unit (ICU) adjustment	0.432 NWAU(19) per hour spent in specified ICU
Private Patient Service Adjustment	Varies by DRG
Private Patient Accommodation Adjustment	Varies by jurisdiction

The Acute model also applies a Hospital Acquired Complications (HAC) adjustment to reduce the funding of an episode where a HAC is present. A review of HACs is out of scope for this review.

[3] National Efficient Price Determination 2019-20, March 2019, Independent Hospital Pricing Authority

4.3.1 Analysis of potential adjustments

Table 3 below summarises the variables for consideration after removing variables that were not appropriate for developing adjustments.

Table 3: Summary of Acute admitted variables for consideration

Variable	Data quality		Variable Importance		Cost Ratio		Other comments	Potential for new adjustment
Marital status	×	Incomplete						No
Type of usual accommodation	×	Incomplete						No
Type of accommodation prior to admission	×	Incomplete						No
Previous specialised treatment	×	Incomplete						No
Source of Referral to Public Psych	×	Incomplete						No
Number of leave periods	×	Biased data						No
Urgency of Admission	✓	Ok	✓	High	×	Differences occur in "missing" categories		No
Sex	✓	Ok	×	Low	×	No material differences		No
Total psychiatric care days	✓	Ok	×	Low	✓	Some evidence of differences at number of psycdays	This will be correlated with LOS	No
Admission weight	✓	Ok	✓	Medium	×	No clear trend	Correlated to DRG structure for neonates	No
Duration of continuous ventilatory support	✓	Ok	×	Low	×	Main differences occur in "missing" category	Correlated to DRG structure and hmv > 0 already have cost ratio < 1	No
Country of birth	✓	Ok	✓	Medium	×	No clear trend/reason for observed differences		No
Mode of separation	✓	Ok	✓	High	✓	Some evidence, but maybe correlated with admission mode	Not necessarily unavoidable cost difference.	No
Hospital in home days	✓	Ok	×	Low	✓	Some evidence	Not necessarily unavoidable cost difference, and correlated with LOS.	No
Mental health legal status	✓	Ok	✓	Medium	✓	Some evidence	Expect some correlation with mental health DRGs. Furthermore, AMHCC flagged for use soon	Maybe
Mode of admission	✓	Ok	✓	Medium	✓	Some evidence		Maybe
Years of age	✓	Ok	✓	High	✓	Some evidence		Yes

We observed the following:

- Some variables had a high proportion of missing values (or in the case of the number of leave periods, missing values heavily biased towards certain jurisdictions). These were removed and the remainder used in the variable importance analysis and cost ratio analysis.

- The variable importance analysis showed that three variables – urgency of admission, mode of separation and age (in years) – consistently demonstrated a high level of discriminatory power in explaining variations in cost ratio. Further results from the variable importance analysis is provided in Appendix F

- The country of birth variable exhibited some discriminatory power, though the cost ratio analysis did not show any clear trends for the under-priced groups and as such we would not recommend using this to develop an adjustment. This was the only variable available on the activity data to consider culturally and linguistically diverse (CALD) patients and previous costing studies also identified a lack of nationally consistent CALD indicators (and did not recommend any adjustments at the time). We have not considered CALD patients further given the lack of consistent indicators available.

- There appear to be systematic differences in cost ratios for the following variables: mental health legal status, mode of admission, age (in years), as shown in Figure 25 below. In particular:

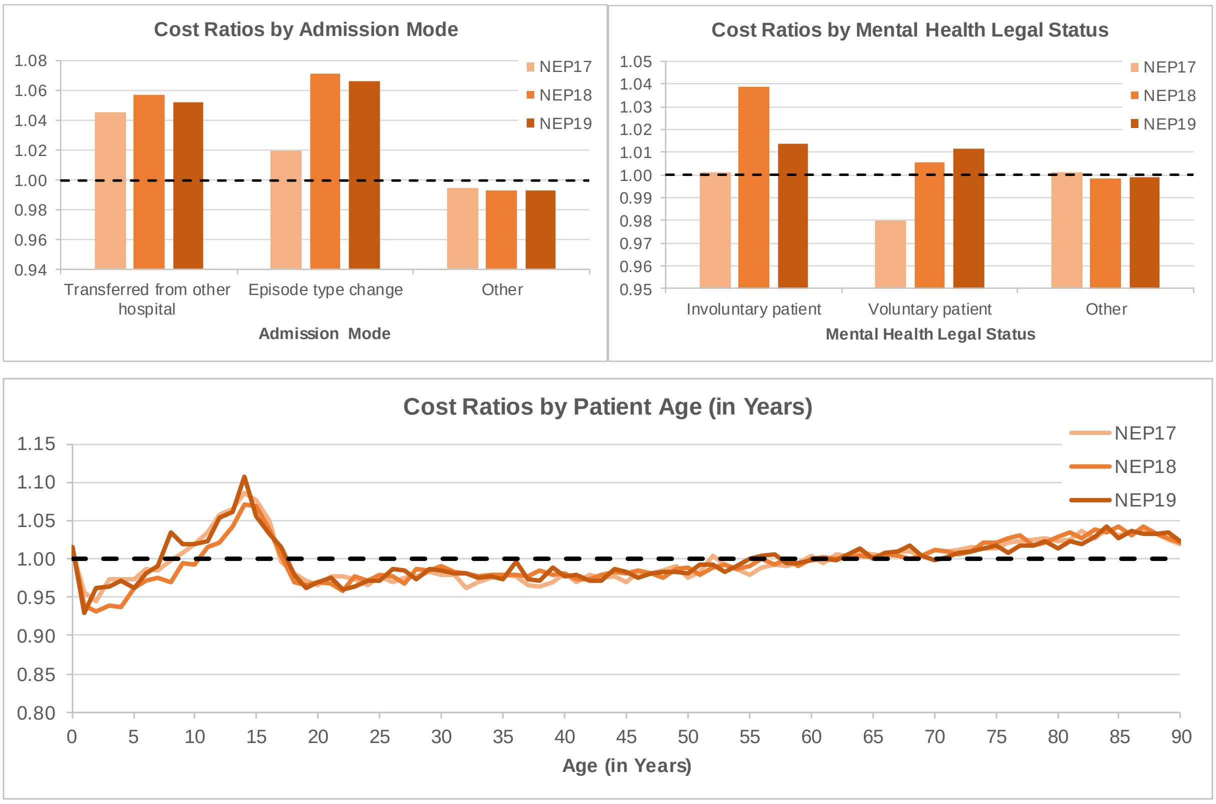
    - Patients who were transferred from another hospital or admitted due to a change in episode type are under-priced (cost ratio greater than 1). This is consistent across the three years.

    - Patients where the mental health legal status was classified as involuntary or voluntary are under-priced in NEP18 and NEP19, although not in NEP17.

    - Younger children (aged 1 to 7 years) tend to be over-priced while older children (aged 8 to 18 years) are under-priced. We note that there is already a paediatric adjustment in the Acute model, although this only applies for specialist paediatric hospitals and does not discriminate between children of different ages.

    - Older people (aged 65 and over) tend to be under-priced – this is offset by an over-pricing of the population aged 19 to 64.

Figure 25: Cost ratios by Acute admitted variables



- There were also systematic differences in cost ratios for Hospital In The Home (HITH) days, psychiatric care days and mode of separation. We note that HITH days or psychiatric care days will be correlated with length of stay for which there is an intentional over- and under-pricing of short and long stay episodes respectively in accordance with the pricing philosophy and design of the base model (Section 3). As such we did not consider these to be legitimate and unavoidable differences.

After taking into account both quantitative and qualitative factors, we consider that there is strong evidence for adding a new adjustment by age.

Although there is also some evidence for considering mode of admission and mental health legal status, however further consultation with jurisdictions may be required before adopting these as adjustments.

- For mode of admission, IHPA and its stakeholders will need to consider whether any changes in incentive for patient transfer may be introduced through this adjustment.
- For the mental health legal status variable (which may be correlated with the existing DRG classification system), IHPA should also consider whether an adjustment should be introduced given the planned transition to the Australian Mental Health Care Classification system (AMHCC) in the near future, which may remove such cost differences.

4.3.2 Proposed new adjustments

Following on from the observations above, we propose to include an **age adjustment of +3% for patients aged 65 years or above**.

The size of this adjustment was selected using the regression approach that is consistent with the approach used to derive other adjustments (e.g. remoteness).

We have not added an age adjustment for the 1-7 years and 8-18 years age groups despite these groups showing cost ratio differentials (see Figure 25) as this would require adding a negative adjustment for the 1-7 years group (which is inconsistent with other adjustments). We note that the NEP model is already rather complex in these age groups due to the existing paediatric adjustment, and adding further complexity would also not have a material impact on funding at a hospital level due to the offsetting nature of these two cost ratio differentials.

4.3.3 Comparison of proposed adjustments against evaluation metrics

We have examined the impact of including the proposed age adjustment in the Acute model against the evaluation metrics.

Goodness of fit (R^2 and SMAPE)

Figure 26 and Figure 27 show the R^2 at various stages of the model (for example, base model, after each set of adjustments, final model) and the SMAPE of the final model.

Figure 26: Comparison of R^2

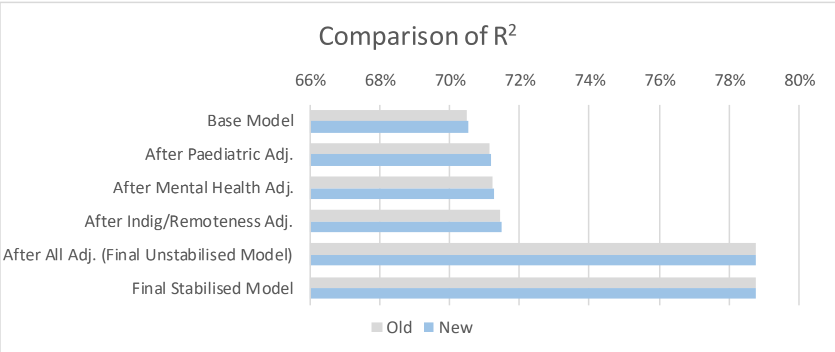
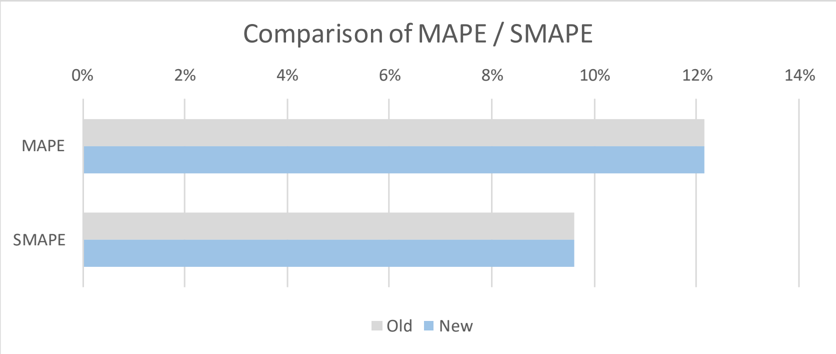


Figure 27: Comparison of SMAPE



The inclusion of the age adjustment does not have a material impact on the overall goodness of fit as measured by the R^2 and SMAPE metrics.

Stability

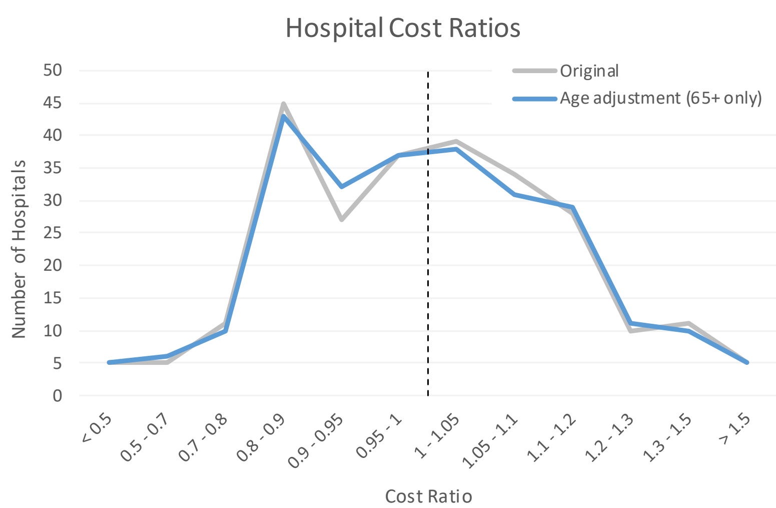
We have measured the stability of the proposed age adjustment by assessing how the cost ratios varied by age across different years of data (and in particular whether this is consistent across the years or not). This was shown earlier in Figure 25.

The relatively higher cost for patients aged 65 years and over is consistent across the latest three years of data. The proposed age adjustment is therefore expected to be relatively stable over time.

Hospital cost ratios

Figure 28 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

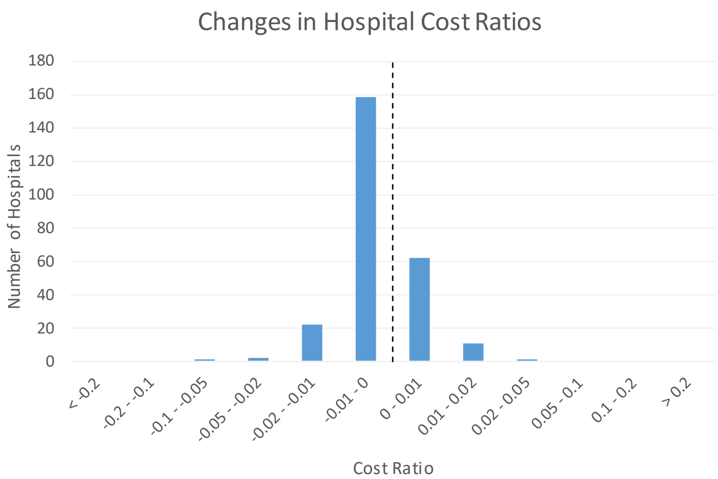
Figure 28: Distribution of hospital cost ratios



	Preferred outcome	Current Approach	Alternative Approach (Age adjustment for 65+)
Standard Deviation	Lower is more stable	0.23	0.23
% between 0.9 and 1.1	Higher is more stable	57.0%	57.3%
5th Percentile	Closer to 1 is more stable	0.71	0.70
95th Percentile		1.35	1.35

Overall, the spread of hospital cost ratios is similar between the current approach and new approach including the age adjustment. Individual hospital cost ratios also did not change significantly, as shown in Figure 29 below.

Figure 29: Change in hospital cost ratios



The spread of hospital cost ratios is similar between the current approach and the alternative approach including the age adjustment, with only minor changes in the distribution and summary statistics. There were only minor changes in individual hospital cost ratios.

Pricing philosophy

The current pricing philosophy aims to include adjustments to allow for legitimate and unavoidable variations in the costs of delivering health care services. This was considered earlier in section 2.3.1, where we observed systemic cost differences by age (which we consider to be legitimate and unavoidable). We also noted some other variables which were inconsistent with this philosophy and have not tested these any further.

We consider that the consistently higher costs of servicing older patients (aged 65 years or above) are legitimate and unavoidable, and therefore the proposed age adjustment is in line with the pricing philosophy.

4.3.4 Summary and Recommendation

We recommend that an adjustment for patients aged 65 years and over to be added to the Acute model:

- The data shows that these older patients are consistently under-priced.
- The age of a person is a legitimate and unavoidable reason for cost variation, in particular when considering the needs of older patients and there is a precedent for adopting an age adjustment in the Emergency Department model.
- There were no material differences in the goodness of fit of the Acute cost model and the distribution of hospital cost ratios as a result of adding this adjustment.

There was also some evidence to suggest that the mode of admission and mental health legal status variables could be investigated further to determine whether an adjustment could be appropriate.

- Although there are consistent differences in cost ratio, it is important to understand the underlying drivers of the cost differentials in mode of admission, to determine whether these are legitimate and unavoidable or not.
- For mental health legal status, this may depend on further consultation and analysing the impact after the introduction of the AMHCC.

4.4 Emergency Department Model Adjustments

The adjustments currently applied to the Emergency Department model are documented in the National Efficient Price Determination 2019-20 and include:

Adjustment	Value
Patient residential remoteness adjustment	Remote Area or Very Remote Area– 24%
Indigenous adjustment	4%
Patient treatment remoteness adjustment	Remote Area or Very Remote Area– 5%
Emergency care age adjustment	Emergency Department Patient who is aged: • 65 to 79 years – 13% • Over 79 years – 20%

4.4.1 Analysis of potential adjustments

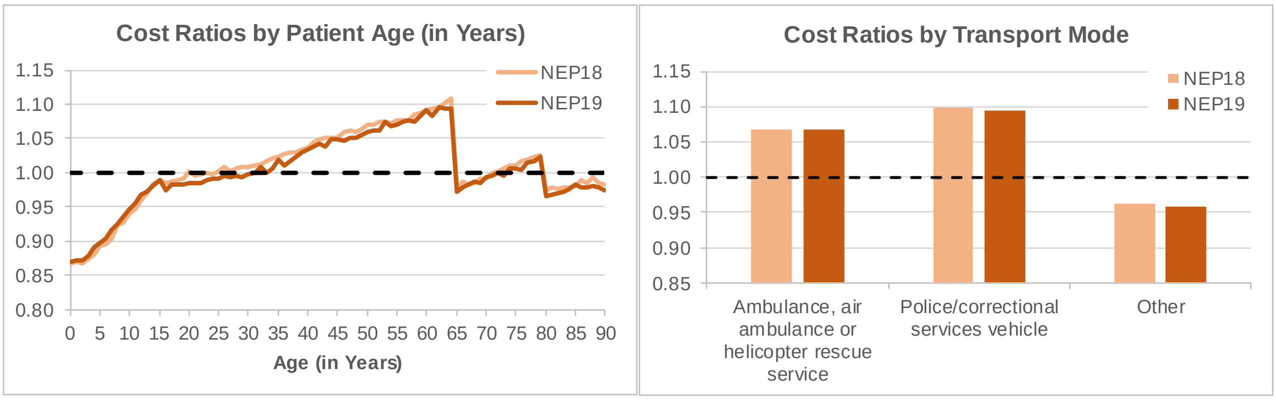
Table 4 below summarises the variables for consideration after removing variables that were not appropriate for developing adjustments. Fewer variables were available for consideration for Emergency Department.

Table 4: Summary of Emergency Department variables for consideration

Variable	Data quality		Cost Ratio		Other comments	Potential for new adjustment
Sex	✓	Ok	×	No material differences		No
Country of birth	✓	Ok	×	No material differences	Appears volatile between years	No
Mode of transport	✓	Ok	✓	Material difference between ambulance/police and other	Further investigations required to understand underlying drivers and costing methodology	Maybe
Years of age	✓	Ok	✓	Material difference between example age groups		Yes

There appear to be systematic differences in cost ratios for mode of transport and age (in years), as shown in Figure 30 below.

Figure 30: Cost ratios by Emergency Department variables



We observed the following:

- Patients aged between 40 to 65 years are currently under-priced (cost ratio greater than 1), while patients aged under 15 years are over-priced. We note that the cost ratios for patients aged 65 years and over are broadly in line with 100% (and seen in the step changes for Figure 30) as the cost differential has already been allowed for through the current age adjustment.

- Patients who arrived in hospital via ambulance (including helicopter) or a police/correctional services vehicle also appear to be under-priced.

We consider that there is strong evidence for extending the existing age adjustments to patients aged between 40 to 65 years. For patients aged under 15 years, while the data suggests an adjustment would be warranted, the adjustment would be negative which is inconsistent with other streams and most other adjustments (which are usually positive).

The mode of transport could also potentially be added as a new adjustment. However, further investigations are required to understand whether there are differences in the scope of ambulance services or the costing methodology which give rise to the differences in cost ratio. Additionally, we understand that the Australian Emergency Care Classification (AECC) is being considered for the near future, which may remove such cost differences and the need for this adjustment.

Following on from the observations above, we propose to include an additional **age adjustment of +10% for patients aged 40 to 65 years**. This quantum was selected using the regression approach currently being used for the existing age adjustment.

This results in a revised age adjustment for Emergency Department

Age group	Adjustment
0 to 39 years	Nil
40 to 64 years	10%
65 to 79 years	13%
Over 79 years	20%

4.4.3 Comparison of proposed adjustments against evaluation metrics

We have examined the impact of including the proposed age adjustment in the Emergency Department model against the evaluation metrics.

Goodness of fit (R^2 and SMAPE)

As with previous analysis, Table 5 compares the R^2 and SMAPE of the current Emergency Department model with the results after adding the new adjustments.

Table 5: Comparison of R^2 and SMAPE

	R^2	MAPE	SMAPE
Original (NEP19 Final)	26.7%	19.5%	14.2%
Add Adjustment for Age 40-65	27.0%	19.6%	14.2%
Difference	0.3%	0.0%	0.0%

Note: Rounded to 1 decimal place

The inclusion of the additional age adjustment does not have a material impact on the overall goodness of fit as measured by the R^2 and SMAPE metrics.

Stability

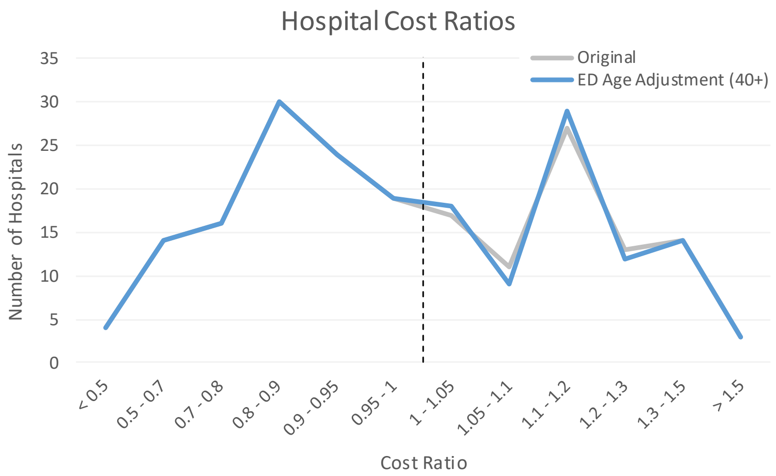
We have measured the stability of the proposed age adjustment by assessing how the cost ratios vary by age across different years of data (and in particular whether this is consistent across the years or not). This was shown earlier in Figure 30.

The relatively higher cost of servicing patients aged 40 to 65 years is consistent across the latest two years of data. The proposed age adjustment is expected to be relatively stable over time.

Hospital cost ratios

Figure 31 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

Figure 31: Distribution of hospital cost ratios

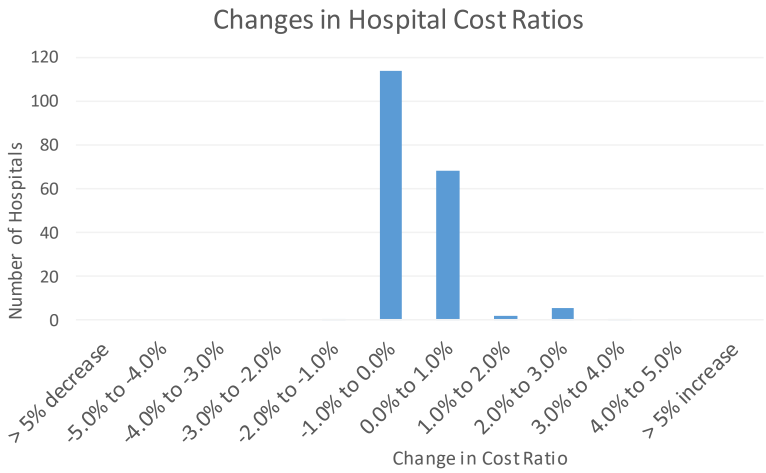


	Preferred outcome	Current Approach	Alternative Approach (age adjustment 40+)
Standard Deviation	Lower is more stable	0.24	0.24
% between 0.9 and 1.1	Higher is more stable	37.0%	36.5%
5th Percentile	Closer to 1 is more stable	0.64	0.64
95th Percentile		1.39	1.38

Overall, the spread of hospital cost ratios is similar between the current approach and new approach including the age adjustment. Individual hospital cost ratios also did not change significantly, as shown in Figure 32 below, with the majority of hospitals have a change of less than 1%.

However, it should be noted that the small number of hospitals with a 2-3% increase in cost ratio were mainly women's and children's hospitals. Applying a negative adjustment for younger age groups (as discussed in previously) is likely to further increase the cost ratio for these hospitals and thus reconfirms our decision to only consider the 40 to 65 years age group.

Figure 32: Change in hospital cost ratios



The spread of hospital cost ratios is similar between the current approach and the alternative approach including the new age adjustment, with only minor changes in the distribution and summary statistics. There were only minor changes in individual hospital cost ratios.

Pricing philosophy

The current pricing philosophy aims to include adjustments to allow for legitimate and unavoidable variations in the costs of delivering health care services. This was considered earlier in section 4.4.1, where we observed systemic cost differences by age (which we consider to be legitimate and unavoidable). Furthermore, this is an extension of an existing adjustment.

We consider that the consistently higher costs of servicing patients aged 40 to 65 years are legitimate and unavoidable, and therefore the proposed age adjustment is in line with the pricing philosophy.

4.4.4 Summary and Recommendation

We recommend that the age adjustment for the Emergency Department to be extended to include an additional adjustment for patients aged 40 to 65 years.

- The data shows that these patients are consistently under-priced.
- The age of a person is a legitimate and unavoidable reason for cost variation.
- There are no material differences in the overall goodness of fit of the Emergency Department cost model and the distribution of hospital cost ratios as a result of adding this adjustment.

We also suggest further investigation into whether there are other drivers of cost differentials due to mode of transport and potentially reconsidering this as an adjustment in the future.

4.5 Non-Admitted Model Adjustments

The adjustments currently applied to the Non-Admitted model are documented in the National Efficient Price Determination 2019-20 and include:

Adjustment	Value
Patient residential remoteness adjustment	Outer Regional Area – 8% Remote Area – 27% Very Remote Area – 29%
Indigenous adjustment	4%
Patient treatment remoteness adjustment	Remote Area – 8% Very Remote Area – 10%
Multidisciplinary Clinic Adjustment	46%

4.5.1 Analysis of potential adjustments

Table 6 below summarises the variables for consideration after removing variables that were not appropriate for developing adjustments.

Table 6: Summary of Non-Admitted variables for consideration

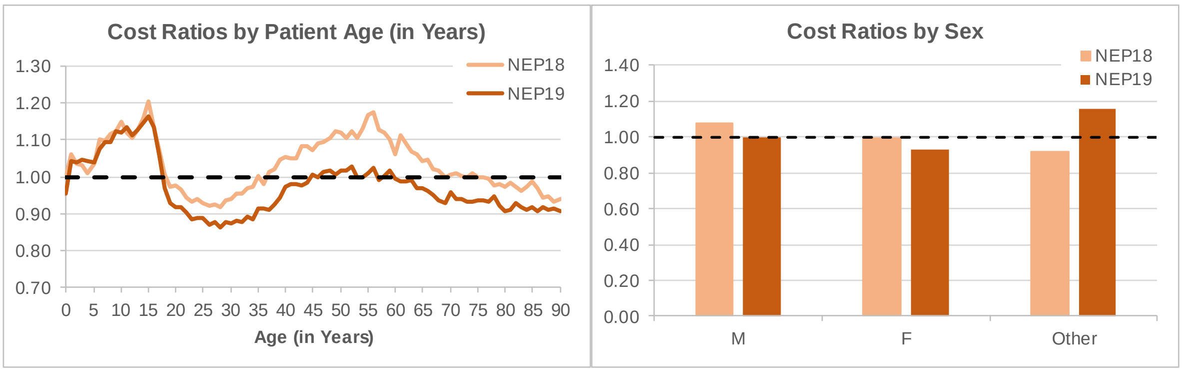
Variable	Data quality		Cost Ratio		Other comments	Potential for new adjustment
Care type	✗	Incomplete			Large proportion in "Missing/Other"	No
Service request source	✗	Biased by state	✗	Differences reflect biases in data collection by state		No
Country of birth	✓	Ok	✗	No material differences		No
Service mode	✓	Ok	✓	Some evidence	Not considered an unavoidable cost difference	No
Service settings	✓	Ok	✓	Some evidence	Need to consider incentives for different models of care	No
Sex	✓	Ok	✓	Some evidence	Cost ratios are not consistent across Tier 2 Clinics	Maybe
Years of age	✓	Ok	✓	Material difference between example age groups	Adjustments recommended for younger age groups	Yes

We observe the following:

- Variables with a high proportion of missing values (or in the case of service request source, missing values heavily biased towards certain jurisdictions) were removed and the remainder used in the cost ratio analyses.

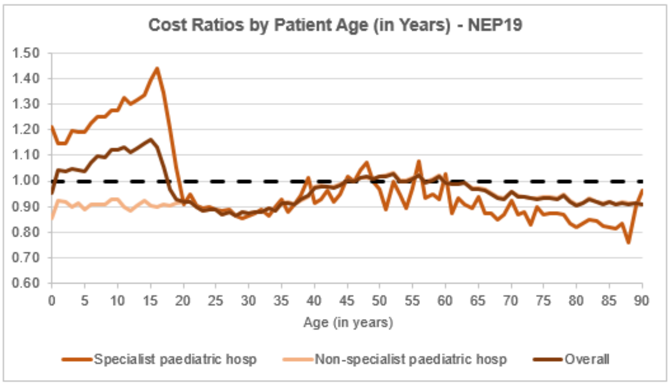
- There are some systematic differences in cost ratios for age (in years) and sex:
  - Patients up to age 18 years are consistently under-priced (cost ratio greater than 1), while there are some differences across other age ranges as well. This can be seen in Figure 33 below.
  - The cost ratios are higher for males than for females, suggesting that males are under-priced across Non-Admitted services overall. However, this cost differential is not consistent across different Tier 2 Clinics. Therefore a broad adjustment for sex would not be equitable across different clinic types and establishments who may specialise in different types of Non-Admitted services.

Figure 33: Cost ratios by Non-Admitted variables



Additionally, was a significant difference between specialist paediatric hospitals and non-specialist paediatric hospitals.

Figure 34: Cost ratios by age – specialist and non-specialist paediatric hospitals



- There were also systematic differences in cost ratios for service settings and service mode. However:
  - The cost ratios relating to different service settings suggested that patients serviced on hospital campus are under-funded. Adding an adjustment would therefore incentivise more services to be provided on hospital campus rather than off campus, which may not be desirable.
  - We did not consider the service mode to be an unavoidable difference.

Based on these observations, we consider that there is a strong case for adding a new adjustment for patients aged up to 18 years in specialist paediatric hospitals.

4.5.2 Proposed new adjustments

Following on from the observations above, we propose to include an **age adjustment of +28% for patients aged up to 18 years in specialist paediatric hospitals – a specialist paediatric adjustment**. This quantum was selected using the regression approach that is consistent with the approach used to derive other adjustments (e.g. remoteness).

4.5.3 Comparison of proposed adjustments against evaluation metrics

We have examined the impact of including the proposed specialist paediatric adjustment in the Non-Admitted model against the evaluation metrics.

Goodness of fit (R^2 and SMAPE)

As with previous analysis, Table 7 compares the R^2 and SMAPE of the current Non-Admitted model with the results after adding the new adjustment.

Table 7: Comparison of R^2 and SMAPE

	R^2	MAPE	SMAPE
Original (NEP19 Final)	2.4%	33.6%	22.3%
Add specialist paediatric adjustment	2.5%	32.3%	21.7%
Difference	0.1%	-1.3%	-0.6%

Note: Rounded to 1 decimal place

The inclusion of the age adjustment improves the overall goodness of fit marginally as measured by the R^2 and SMAPE metrics.

Stability

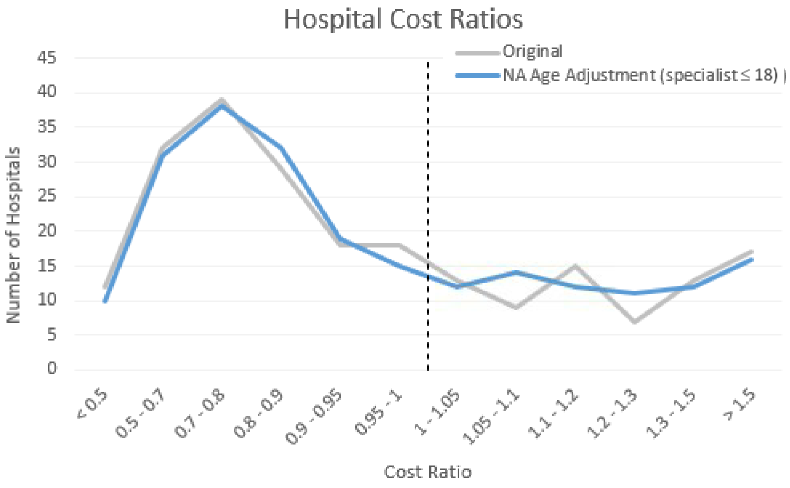
We have measured the stability of the proposed specialist paediatric adjustment by assessing how the cost ratios vary by age across different years of data (and in particular whether this is consistent across the years or not). This was shown earlier in Figure 33.

The relatively higher cost of servicing patients aged 18 years and under is consistent across the latest two years of data. The proposed age adjustment is therefore expected to be relatively stable over time.

Hospital cost ratios

Figure 35 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

Figure 35: Distribution of hospital cost ratios

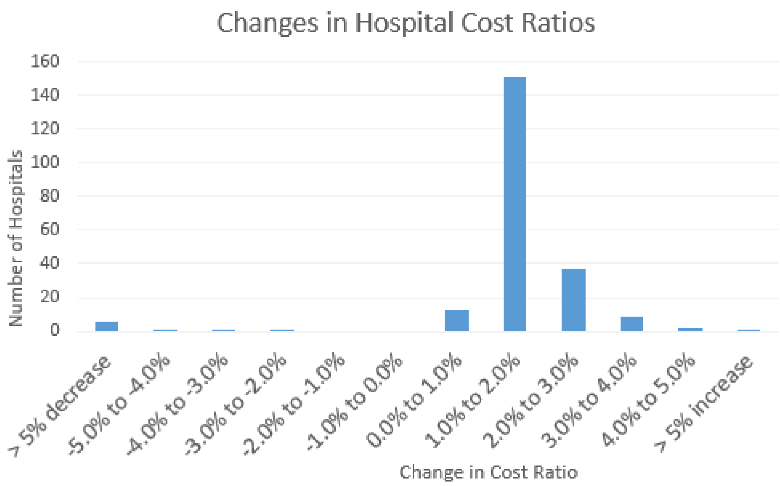


	Preferred outcome	Current Approach	Alternative Approach (specialist paediatric adjustment)
Standard Deviation	Lower is more stable	0.43	0.43
% between 0.9 and 1.1	Higher is more stable	26.1%	27.0%
5th Percentile	Closer to 1 is more stable	0.50	0.51
95th Percentile		1.69	1.72

Overall, the spread of hospital cost ratios is similar under the new approach including the specialist paediatric adjustment.

Figure 36 below shows the distribution of changes in hospital cost ratios after adding the specialist paediatric adjustment.

Figure 36: Change in hospital cost ratios



The vast majority of hospital cost ratios increased between 1% and 2%. There were some larger reductions in cost ratios for children's hospitals which is expected given the age adjustment was focused on younger patients. These reductions are desirable as they bring the cost ratio closer to 100% for these hospitals and therefore reduce the extent to which actual costs exceed modelled costs.

There is a similar level of variation in hospital cost ratios under the alternative approach including the specialist paediatric adjustment. The vast majority of hospital cost ratios did not change significantly, with the main changes being a reduction in the cost ratios for some children's hospitals.

Pricing philosophy

The current pricing philosophy aims to include adjustments to allow for legitimate and unavoidable variations in the costs of delivering health care services. This was considered earlier in section 4.5.1, where we observed systemic cost differences by age (which we consider to be legitimate and unavoidable).

We consider that the consistently higher costs of servicing younger patients (aged 18 years or under) are legitimate and unavoidable, and therefore the proposed age adjustment is in line with the pricing philosophy.

4.5.4 Summary and Recommendation

We recommend that a specialist paediatric adjustment (for patients aged 18 years and under in specialist paediatric hospitals) be added to the Non-Admitted model:

- The data shows that these younger patients are consistently under-priced.
- The age of a person is a legitimate and unavoidable reason for cost variation, in particular when considering the needs of younger patients.
- There are slight improvements across the various evaluation metrics (e.g. goodness of fit, hospital cost ratios) as a result of adding this adjustment.

5 Stabilisation

5.1 Background and purpose

Year-on-year stability in the price weights and adjustments is important to ensure funding stability and predictability for jurisdictions and hospital networks. IHPA has a stabilisation policy[4] which governs the methodology used to stabilise the data so that the impact of statistical noise on the pricing model is minimised while ensuring the model reflects genuine changes in costs in public hospitals.

In particular, the current approach to stabilising price weights and adjustments generally involves:

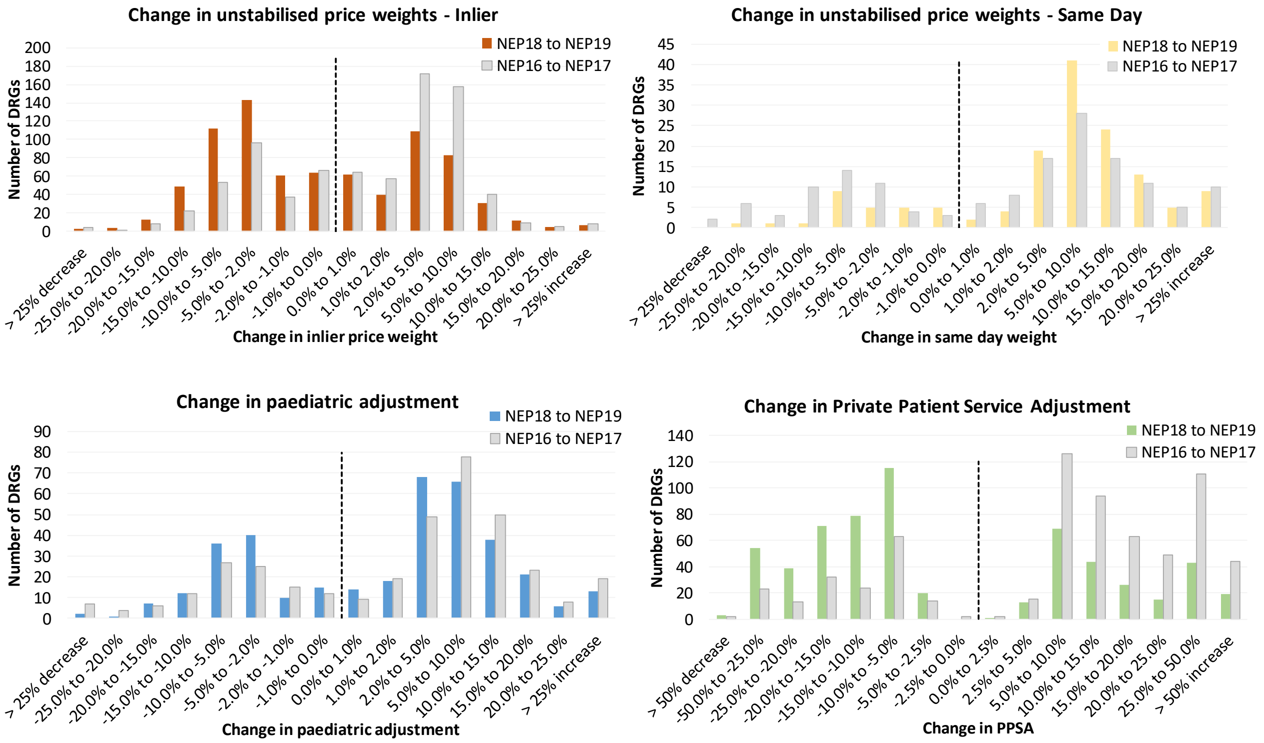
- Limiting year-on-year changes in price weights to +/- 20%
- Adopting a three-year average when determining the quantum of adjustments

We analysed the historical year-on-year variability of unstabilised price weights and adjustments (that is, prior to stabilisation), and assessed the appropriateness of the current stabilisation approach. We have focused on the Acute, Subacute and Emergency Department streams; we have not analysed the Non-Admitted stream as there have been significant changes in the cost models driven by the transition from using costing study data to cost data from the National Hospital Cost Data Collection (NHCDC).

5.2 Historical variability in price weights and adjustments

The following charts show the distribution of year-on-year changes in the key price weights and adjustments in the Acute stream. Note that we have excluded the year of change between NEP17 and NEP18 as these pricing models were based on different versions of the DRG classification system.

Figure 37: Distribution of year on year changes in price weights and adjustments – Acute



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4 National Pricing Model Stability Policy, Version 3.1 May 2018, Independent Hospital Pricing Authority

For Acute, the AR-DRG classification used for pricing changes every two years. As such we only considered pairwise comparisons of NEP changes: NEP16 to NEP17 (DRG v8.0) and NEP18 to NEP19 (DRG v9.0)

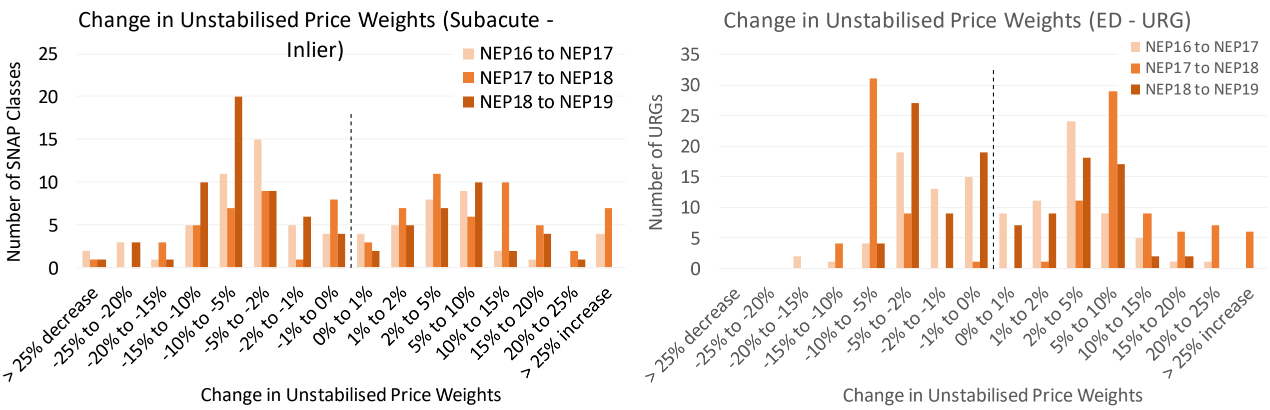
We observe that:

- The majority of the parameters do not change by more than 10% from year to year.
- In general, around 90% to 95% of the year on year changes in parameters do not exceed the current stabilisation thresholds of +/- 20%.
- In the Acute model, only the inlier price weights are explicitly stabilised – the same day, short stay outlier and long stay outlier parameters not subject to the +/-20% cap in movements. The year on year variation for these price weights is slightly higher than that for the inlier parameter, which is to be expected given the lower volume of separations involved. Despite this, the variation in price weights generally still lies between +/- 20%.
- There are several adjustments where little or no stabilisation is applied. These are:
  - The specialist paediatric adjustment, which only applies stabilisation under specific criteria and impact only a small number of eligible hospitals; and
  - The private patient service adjustment, which does not impact the distribution of costs between separations; rather, it exists to exclude privately funded costs when using the NEP to determine public funding.

  There is some variation in these adjustments from year to year, in particular the private patient service adjustment between NEP16 and NEP17.

The following charts show the distribution of year-on-year changes in the key price weights in the Subacute and Emergency Department streams.

Figure 38: Distribution of year on year changes in price weights – Subacute and ED



Similar to the Acute price weights, the majority of Subacute and Emergency Department price weights do not change by more than 10% from year to year, with over 90% of the year on year changes remaining within the current thresholds of +/- 20% despite some larger changes between NEP17 and NEP18.

5.3 Cross-subsidisation as a result of stabilisation

Whenever a price weight or adjustment is stabilised, there is a subsequent recalibration of all the model parameters to ensure that the cost models account for the total in-scope cost across all services in a year in aggregate. Therefore, a consequence of stabilisation is that there will be more cross-subsidisation in the model, as costs originally allocated to one group of episodes are redistributed across all other episodes.

The following charts show the amount and proportion of the modelled in-scope cost that is redistributed across other episodes as the stabilisation thresholds for the inlier parameters are varied. This is a measure of the amount of cross-subsidisation that is introduced into the model due to stabilisation and has been presented for the overall pool

Figure 39: Amount of cost redistributed – Acute (inlier price weight)

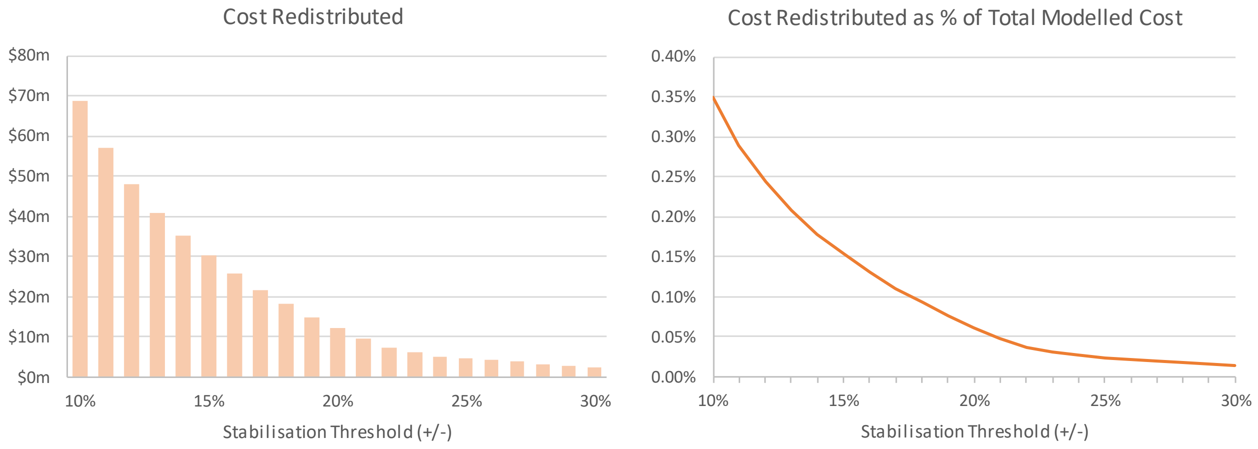


Figure 40: Amount of cost redistributed – Subacute (inlier price weight)

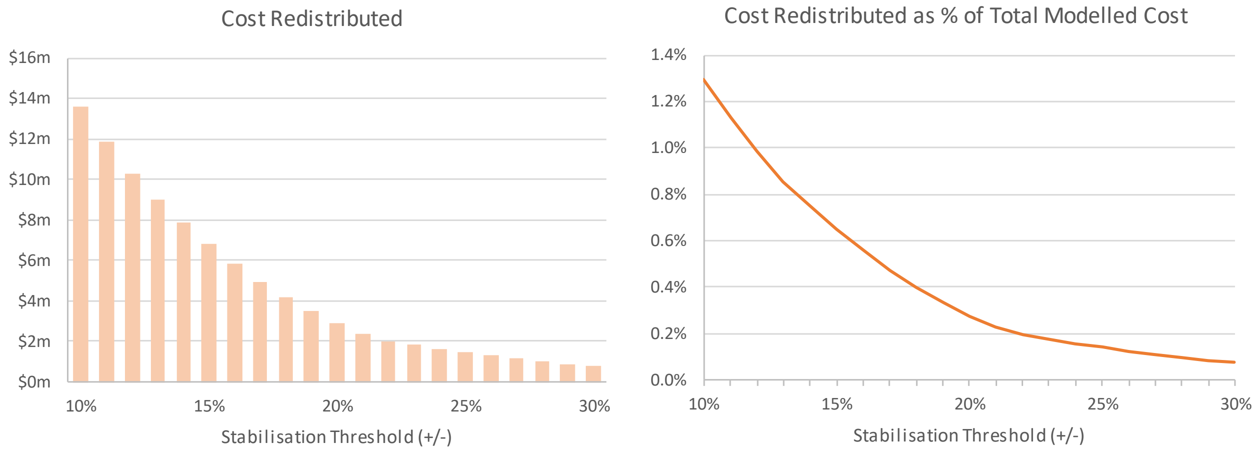
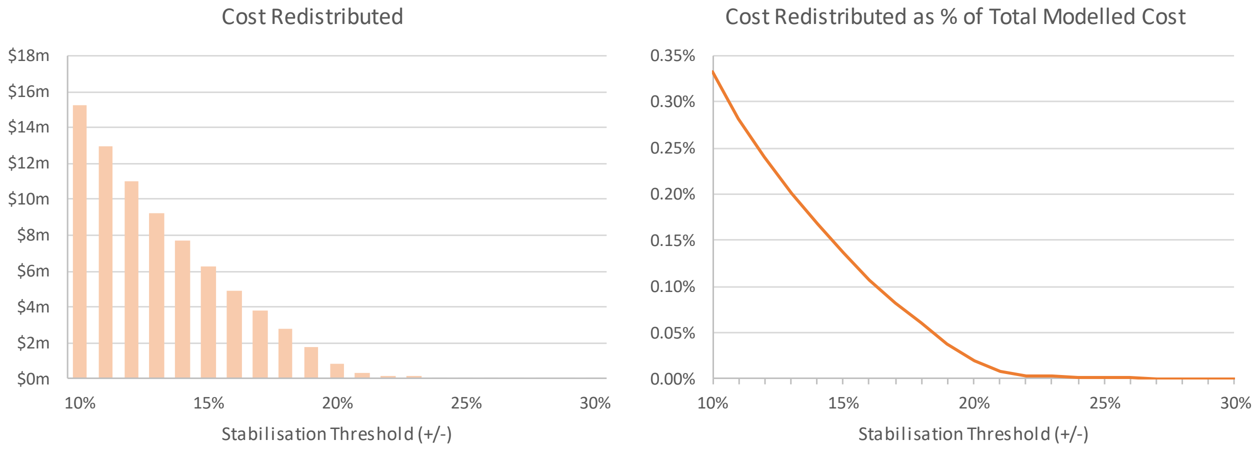


Figure 41: Amount of cost redistributed – Emergency Department (URG price weight)



From the charts above, we observe that the current stabilisation thresholds only result in a small proportion of cost being redistributed to other groups of episodes (0.06% for Acute, 0.3% for Subacute, and 0.02% for Emergency Department).

5.4 Alternative stabilisation approach

The stabilisation approach should strike a balance between reducing year-on-year variability and ensuring an excessive amount of cost is not redistributed to other episodes, as this would undermine the objective of accurately allowing for legitimate differences in activity.

We consider that the current thresholds of +/- 20% for stabilising price weights are broadly appropriate as:

- Only a small number of parameters exceed the thresholds each year
- The amount of cost redistributed is not excessive
- They achieve the objective of limiting changes in parameters to an acceptable level of stability

However, we consider that additional stabilisation could be added for the Acute same day price weight and specialist paediatric adjustment, both of which are currently not stabilised using the +/-20% rule. Stabilising these parameters would increase consistency across the NEP model, given that:

- Both the same day price weight (currently not stabilised) and the inlier price weight (currently stabilised) represent episodic average costs
- The specialist paediatric adjustment is the only adjustment that is currently not stabilised (except for a small number of low volume DRGs), other than the private patient service adjustment which does not impact the distribution of modelled cost between separations.

A threshold of +/- 20% would be appropriate for these parameters, given that:

- Their spread of year on year changes is broadly similar to the spread observed for other price weights which are stabilised to +/- 20%.
- Their derivation is similar to the other price weights currently being stabilised to +/- 20% in that they are selected at a classification level (i.e. by individual DRGs) and therefore also subject to the volatility that arises from using a smaller volume of data.

We have examined the impact of stabilising (to +/- 20%) the same day price weight and specialist paediatric adjustment in the Acute model against the evaluation metrics.

5.5 Comparison against evaluation metrics

Goodness of fit (R^2 and SMAPE)

As with previous analysis, Figure 42 and Figure 43 show the R^2 at various stages of the model (for example, base model, after each set of adjustments, final model) and the SMAPE of the final model.

Figure 42: Comparison of R^2

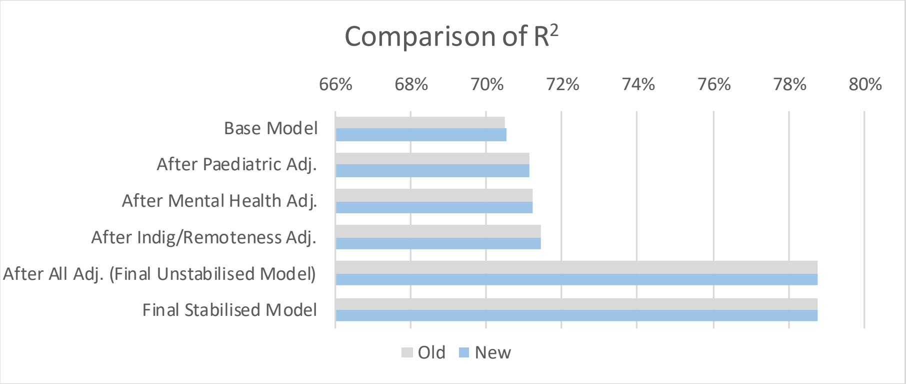
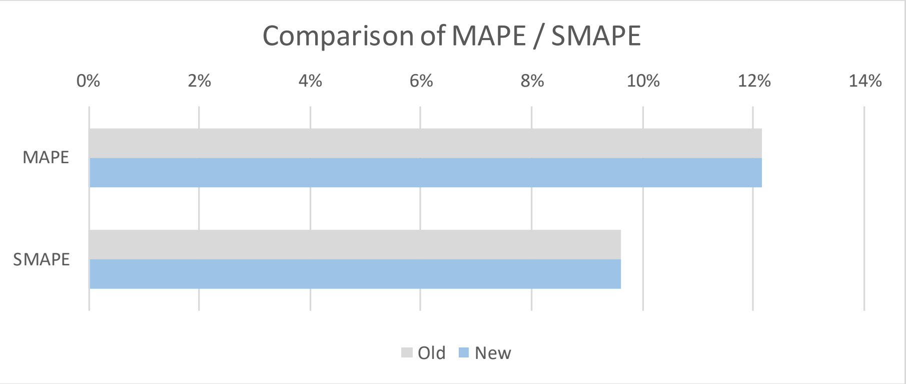


Figure 43: Comparison of SMAPE



Stabilising the same day price weight and specialist paediatric adjustment does not have a material impact on the overall goodness of fit as measured by the R^2 and SMAPE metrics.

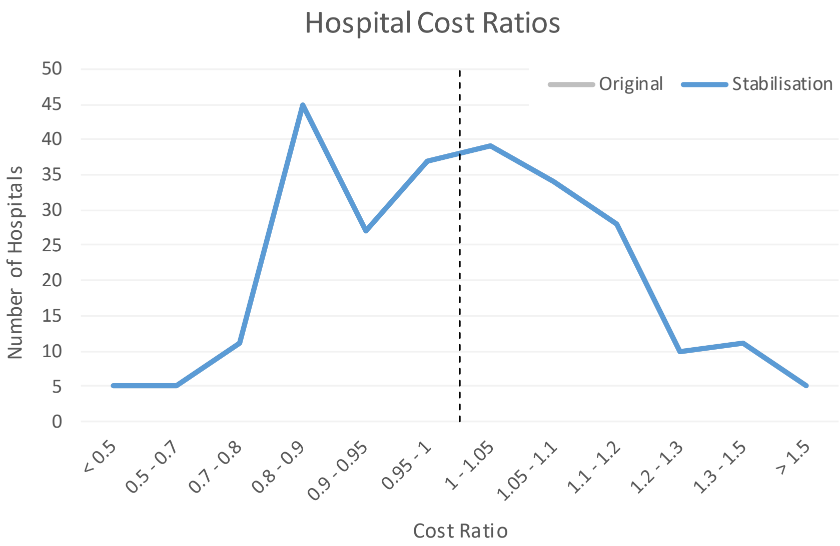
Stability

Adding extra stabilisation for the same day price weight and specialist paediatric adjustment will by definition limit year on year changes and improve the stability of these parameters and adjustments.

Hospital cost ratios

Figure 44 shows the distribution of hospital cost ratios and several measures of the spread of this distribution. Closer alignment between actual and modelled hospital costs (cost ratio = 1) is preferred.

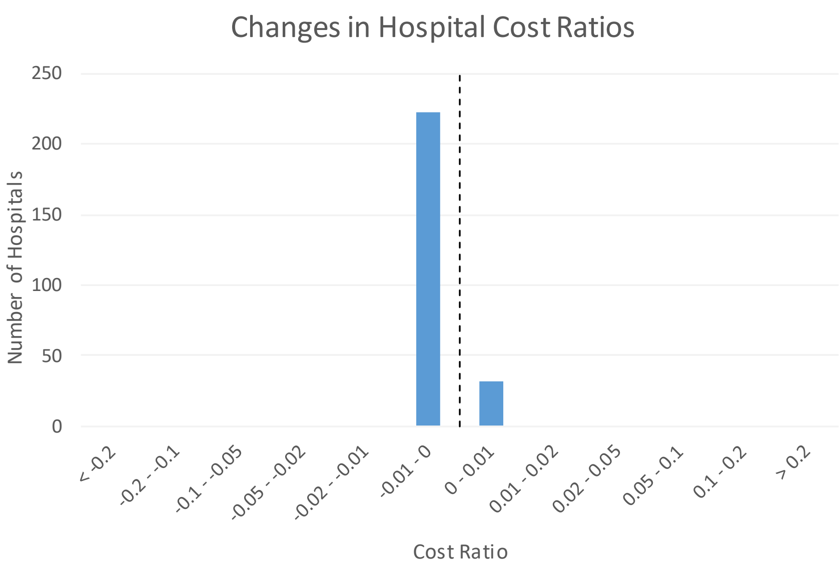
Figure 44: Distribution of hospital cost ratios



	Preferred outcome	Current Approach	Alternative Approach (stabilisation)
Standard Deviation	Lower is more stable	0.23	0.23
% between 0.9 and 1.1	Higher is more stable	57.0%	57.0%
5th Percentile	Closer to 1 is more stable	0.71	0.71
95th Percentile		1.35	1.35

Overall, the spread of hospital cost ratios is almost identical between the current approach and new stabilisation approach (note: the two lines on the chart are overlapped). Individual hospital cost ratios also did not change significantly, as shown in Figure 45 below.

Figure 45: Change in hospital cost ratios



The spread of hospital cost ratios is almost identical between the current approach and the alternative approach which stabilises the same day price weight and specialist paediatric adjustment. There were only minor changes in the distribution and summary statistics; there were also only minor changes in individual hospital cost ratios.

Pricing philosophy

The NEP parameters aim to allow for legitimate and unavoidable variations in the costs of delivering health care services. Stabilisation will reduce the extent to which these cost variations are allowed for as it increases the level of cross-subsidisation.

As documented in IHPA's Stability Policy, the pricing philosophy values both stability in model parameters over time as well as allowing for legitimate and unavoidable cost variations.

We consider that adding stabilisation for the same day price weight and specialist paediatric adjustment provides a marginally better balance between the different objectives of pricing philosophy as it improves consistency across the model.

5.5.1 Summary and Recommendation

On balance, **we recommend that the same day price weight and specialist paediatric adjustment are stabilised to +/- 20%**:

- This additional stabilisation improves consistency across additional parameters of the NEP.
- By definition, it will also improve stability in these parameters.
- There are only minor differences in the models when compared against the other evaluation metrics.

6 Calculation of the NEP

6.1 Background and Purpose

The development of the cost model results in a set of cost parameters which broadly represents an average cost for each type of activity (for example, AR-DRG for Acute Admitted, Tier 2 Clinic for Non-Admitted) and associated adjustments. The final step of the modelling process involves[5]:

i. Identification and exclusion of costs and activity regarded under the National Health Reform Agreement as out of scope for the purpose of ABF.

ii. Derivation of a Reference Cost (or standardised mean) used to transform the cost model into a cost weight model.

iii. Derivation of an annual indexation rate used to inflate the cost model to a level reflective of the estimated cost of delivering hospital services in the year of the pricing model.

iv. Transformation of the cost model to the pricing model using the results of the previous three steps the cost parameters.

For the purposes of the Fundamental Review, the scope of costs specified under the National Health Reform Agreement (NHRA) in (i) above were considered as given, and thus out of scope for this review. The transformation from a cost model to a pricing model in (iv) above is a straightforward mathematical change presented clearly in the Technical Specifications. As such, the following sections document our findings with a focus on stages (ii) and (iii) of the above process.

The evaluation metrics (goodness of fit and hospital cost ratios) considered in the previous sections were tailored more towards evaluating cost model outputs. These measures are less suitable for the components considered in the following sections (Section 6 and Section 7) as they come after the development of the cost models. As such we have focused mainly on how well the current approach and/or alternative approaches align with the underlying pricing philosophy.

Additionally, although the focus of the Fundamental Review is the development of the NEP – a pricing model, the following sections also consider its use from a **funding** perspective. That is because the back-casting process is one that was developed to achieve funding objectives and the NEP, back-casting and funding are all intrinsically linked. Furthermore, the development of the pricing model should consider the end users in mind and thus a consideration of the funding implications is necessary.

6.2 Derivation of the Reference Cost

6.2.1 Objective and pricing philosophy

The Reference Cost is used to transform a series of cost parameters (average costs and adjustments) into cost weights, a set of relativities. Furthermore, it is also the basis from which the National Efficient Price (NEP) is calculated after applying indexation (Section 6.3).

Our literature review findings report identified the following points for consideration:

- There are different ways to measure 'efficiency', with two measures being to compare against some 'standard' or comparison against an average.
- The use of an average price based on historical costs is common in health systems.

[5] Technical Specifications 2019-20 - National Pricing Model, Independent Hospital Pricing Authority, March 2019

- A move away from using an average as the basis for the NEP (to shift towards more 'efficient' target) could come from either:
    a. A decision to send a stronger price signal by adopting a more ambitious target than the average
    b. Estimating some 'standard' that represents efficiency, either from a ground up costing exercise for each type of service, or from identifying a group of providers considered to appropriately represent best practice.

Both options (a) and (b) presented above may have significant implications on the definition of the Reference Cost, the data requirements for a new approach to define the efficient 'standard', comparability between years, and the appetite for change.

Given this, we have carried out the remainder of this review by considering the Reference Cost as an average (mean) cost from which all other cost parameters can be converted into a cost weight.

6.2.2 Current approach

The Reference Cost has a specific definition – it is a standardised mean that is calculated for each year's cost model such that the measure of the National Weighted Activity Unit (NWAU) remains constant over time.

The standardisation process itself has the important implication that the Reference Cost in any given year will be linked to prior years' cost models. This process is described in the IHPA Technical Specifications:

> *The 2009-10 reference cost associated with IHPA's first National Pricing Model is defined as the mean model cost taken across all 2009-10 admitted acute activity in-scope for ABF. This mean model cost is $4,260.*
>
> *From 2010-11 onward, the reference cost is defined so that change in the reference cost over time reflects change in unit costs, excluding any influence of underlying changes in activity profiles between years (i.e. case-mix change). So, the 2010-11 reference cost is defined so that the change from the 2009-10 reference cost represents change in unit costs of an NWAU between the 2009-10 and 2010-11 cost models, excluding the effect of any changes in case-mix between 2009-10 and 2010-11.*

Thus, the 2016-17 Reference Cost is linked to the 2015-16 Reference Cost, which is in turn linked to the 2014-15 Reference Cost and so on. In practice, this is achieved by dividing the 2016-17 cost model by the publicly funded weighted activity units from the 2015-16 cost model (GWAU18).

This makes the Reference Cost different to being purely an average (or mean) cost per separation for activity in that year and the linkage between years is incorporated **intentionally** in order that the underlying unit of activity remains constant over time.

6.2.3 Alternative approach

The alternative approach to calculate an appropriate 'average' is to define the Reference Cost as the average cost per separation, that is, total modelled cost divided by in-scope separations.

We make the following comments on this approach:

- The advantage to this approach is that it is easy to understand what the Reference Cost represents for that activity year, being simply an average cost per separation. This is meaningful even without providing any context around how it fits into funding arrangements.
- Calculating the Reference Cost using this approach would also break the dependency on prior years, making each year standalone.
- On the other hand, this approach would mean that the underlying unit of activity would no longer remain comparable over time, being impacted by changes in case mix. This goes against the objective and pricing philosophy developed at the outset of the NEP approach.

- There would be flow on impacts to the way back-casting is applied for the purposes of calculating efficient growth. This is discussed further in Section 7.

In a stable state, where cost growth, cost relativities and case mix remain constant, this approach will be equivalent to the current approach. However, as case mix and growth changes the two approaches will diverge.

6.2.4 Summary and Recommendation

We recommend no change to the current determination of the Reference Cost.

The current approach is in line with the objective of deriving an average price which also has the benefit of maintaining comparability of NWAU over time, which is an intentional choice. Moving away from the current approach to one based on average cost per separation will break the link between years.

A further consideration may be to 'reset' the process, similar to how inflation indices may be rebased to a new starting year. This could be done to overcome divergence between the two approaches without losing the comparability from the reset point onwards. If this was to be adopted, IHPA would also need to consider how to back-cast effectively to calculate efficient growth.

The Technical Specifications for the 2016-17 cost model shows the 'rebasing' that needs to occur between the mean modelled cost of $4,787 compared to the Reference Cost of $4,866. We currently see no pressing need to reset the Reference Cost. Even if the difference between these two figures diverges further, then resetting the Reference Cost may be considered but only if there was a strong appetite for change to realign the Reference Cost as doing so would require significant adjustments to historical NWAU calculations to maintain the comparability.

6.3 Indexation

6.3.1 Objective and pricing philosophy

The cost models use the historical data to derive the cost parameters. These are ultimately transformed into a pricing model for a future period, thus requiring an indexation adjustment to reflect the increase in costs which are expected over time. Without this indexation adjustment, the pricing model would (generally) understate the expected costs in future periods. For the NEP19 Determination, an indexation rate of 1.8% was required to inflate the 2016-17 cost model over three years to a level reflective of estimated 2019-20 costs.

In reviewing the current approach to deriving the indexation rate, we considered what drivers affect the change in costs per episode of care over time and therefore should be reflected in the indexation rate. These are discussed in greater detail in our evaluation of the current and possible alternative approaches but at a high level we believe it should include:

a) Changes in wage cost/materials cost – which may be thought of as price inflation and measured through appropriate inflation indices

b) Changes in hours' labour required per day in hospital – which could be a measure of operational efficiency or productivity

c) Changes in average length of stay – which may be affected by changing models of care and/or changes in coding practices over time.

Price inflation (a) will generally be positive but changes in efficiency and models of care (b) and (c) may work to offset this, resulting in a lower indexation rate that would be indicated by price inflation alone.

6.3.2 Current approach

The current approach to calculating indexation (using the 2016-17 cost model as an example) is described in detail in the IHPA Technical Specifications. We have not replicated the detail in this report, but at a high level this involves:

i. Applying the 2016-17 cost model retrospectively to the five years of data prior to the current year (in this case, 2011-12 to 2015-16 inclusive)

ii. Generating a time series of (dollar) cost per weighted separation using data for the previous five years which can be used to derive year-on-year growth rates

iii. Estimating the projected annual inflation factor using an exponential line of best fit on the historical five years' growth rates.

The following observations can be made about the current approach:

- It uses historical cost data to derive the indexation rate, making it consistent to the costs it is intended to project.

- By relying on historical data to project the future, it will always be a lagged measure and the number of years of data used will affect how quickly the projected indexation rate responds to the actual underlying changes in costs over time.

- It captures the three drivers of changing cost per episode over time (section 6.3.1), and in doing so implicitly projects future price inflation as well as changes in efficiency in the one indexation rate.

- The method uses aggregate cost data to derive the cost ratios, resulting in a lack of granularity that may dampen or hide underlying trends in different cost categories.

The current approach achieves the objective of capturing all the drivers of changing costs per episode and deriving an indexation rate to enable the pricing model to be reflective of future costs. However, there are some aspects which we tested to understand whether the approach could be refined further – specifically the lack of granularity and lagged nature of the current calculation.

6.3.3 Alternative approaches

We have explored a number of alternatives to understand whether they could enhance the current methodology.

Alternative 1 – Deriving growth rates by cost bucket

Currently, the Acute Admitted cost data from the National Hospital Cost Data Collection (NHCDC) is used at an aggregate level to derive the indexation rate. The cost data can be broken down further into cost buckets for example, salaries and wages, prostheses costs, pathology costs. We have tested whether a growth rate could be derived for each of these separately and combined to form a weighted indexation rate.

Figure 46: Indicative growth rates by cost bucket

Figure 46 shows the indicative year-on-year growth rates for a test set of cost buckets to examine the stability in growth rates and whether an approach using granular cost buckets could be feasible. The charts above show the direct costs by cost bucket, with all overheads combined into one cost bucket. Other combinations were tested but not shown. Each point represents the growth rate to that year, that is, the data point for 2012-13 on each graph represents the growth between 2011-12 and 2012-13 and so on.

The charts indicate that while some cost buckets such as salaries and wages were relatively stable, others such as pharmacy costs and pathology and imaging costs show significant volatility and would not be suitable for deriving a separate growth rate.

This could be a reflection of the low volume in these cost buckets or the poorer quality of costed data in the earlier years. A breakdown of the mappings used the analysis and proportion of costs in each cost bucket are presented in Appendix G.

Based on the results in Figure 46, it would be appropriate to combine some groups to derive a more stable set of cost bucket growth rates. Figure 47 below shows an example calculation of the overall indexation using three cost buckets – salaries and wages, prostheses and all other costs. Direct and overhead costs were combined for the purposes of defining these cost buckets.

Figure 47: Example rate calculation using three cost buckets

Current Year	NHCDC Cost - Salaries and Wages	NHCDC Cost - Prostheses	NHCDC Cost - Other	Total - Overall Projection (Current Approach)	Total - Weighted Average of Cost Buckets
2011-12					
2012-13	4.0%	5.4%	-0.4%	1.69%	1.72%
2013-14	0.3%	-0.3%	-0.4%	-0.11%	-0.04%
2014-15	2.0%	2.1%	2.3%	2.12%	2.12%
2015-16	-2.3%	0.9%	6.4%	1.72%	2.41%
2016-17	3.1%	0.5%	2.6%	2.80%	2.75%
2017-18	**1.1%**	**1.3%**	**2.7%**	**1.80%**	**1.95%**

The same methodology of applying an exponential line of best fit was applied to estimate a growth rate for each of these cost buckets separately. These were then weighted by the average proportion of costs in each cost bucket over the previous five years to derive an overall indexation rate.

Our example calculation shows that using this method results in a higher indexation rate of 1.95%, reflecting the higher growth rates in the “Other” cost bucket. This example shows that projecting the indexation rate using more granular cost buckets may be possible and is discussed further in Section 6.3.4.

Alternative 2 – Deriving growth rates with reference to benchmarks

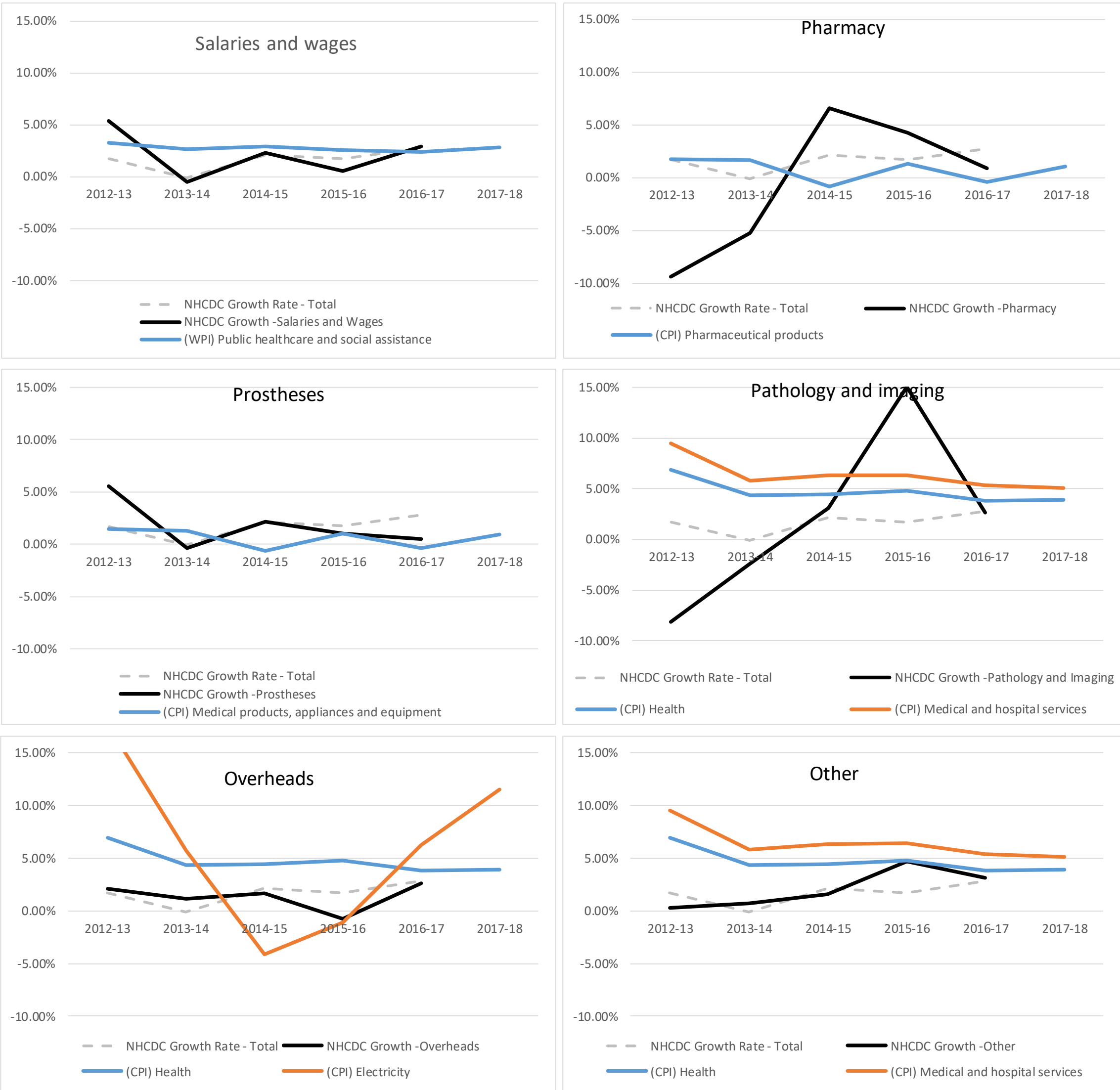
We reviewed whether external inflation indices could be used as suitable benchmarks to assist in deriving the indexation rate. A number of indices including Wage Price Index (WPI), Consumer Price Index (CPI) and Producer Price Index (PPI) were considered and the analysis was carried out at an overall level as well as by costs buckets where indices were available.

The purpose of this analysis was twofold:

- To test whether external inflation indices could be used to validate the observed growth rates, especially at a cost bucket level.
- To understand whether more recent data could be referenced in setting the indexation rate as indices may often be updated more quickly and frequently than the cost data.

Figure 48 shows the growth rates by cost buckets and some selected indices which we tested for comparability.

Figure 48: Growth rates by cost bucket with selected indices



We make the following observations:

- There were some CPI indices which were more closely related to the underlying cost buckets for example CPI Pharmaceutical products and pharmacy costs. However, direct comparisons were generally not available.
- Overall, the inflation indices did not closely align with the observed growth rates (either at an overall level or by cost bucket).

Our analysis indicates that external inflation benchmarks are not appropriate for setting the indexation rate. Firstly, they are not directly comparable with cost changes for public hospital services (or cost buckets for public hospital services) and could only be considered proxies at best, making them less desirable than the current approach.

Secondly, they tended to be higher than the observed growth rates. This is because they only reflect the price/wage changes and do not contain the same implicit changes in efficiency or changes due to changing models of care that are present in the current approach. Therefore the use of inflation indices would be lacking two components of cost changes for in setting the indexation rate (Section 6.3.1).

The difference between price inflation indices and the underlying growth rates, although imperfectly matched, suggests that there may have been efficiency gains in the observed time periods. Although the volatility in the growth rates prevent more robust analysis of the underlying efficiency changes, our literature review findings report identified efficiency gains due to the introduction of ABF in other countries

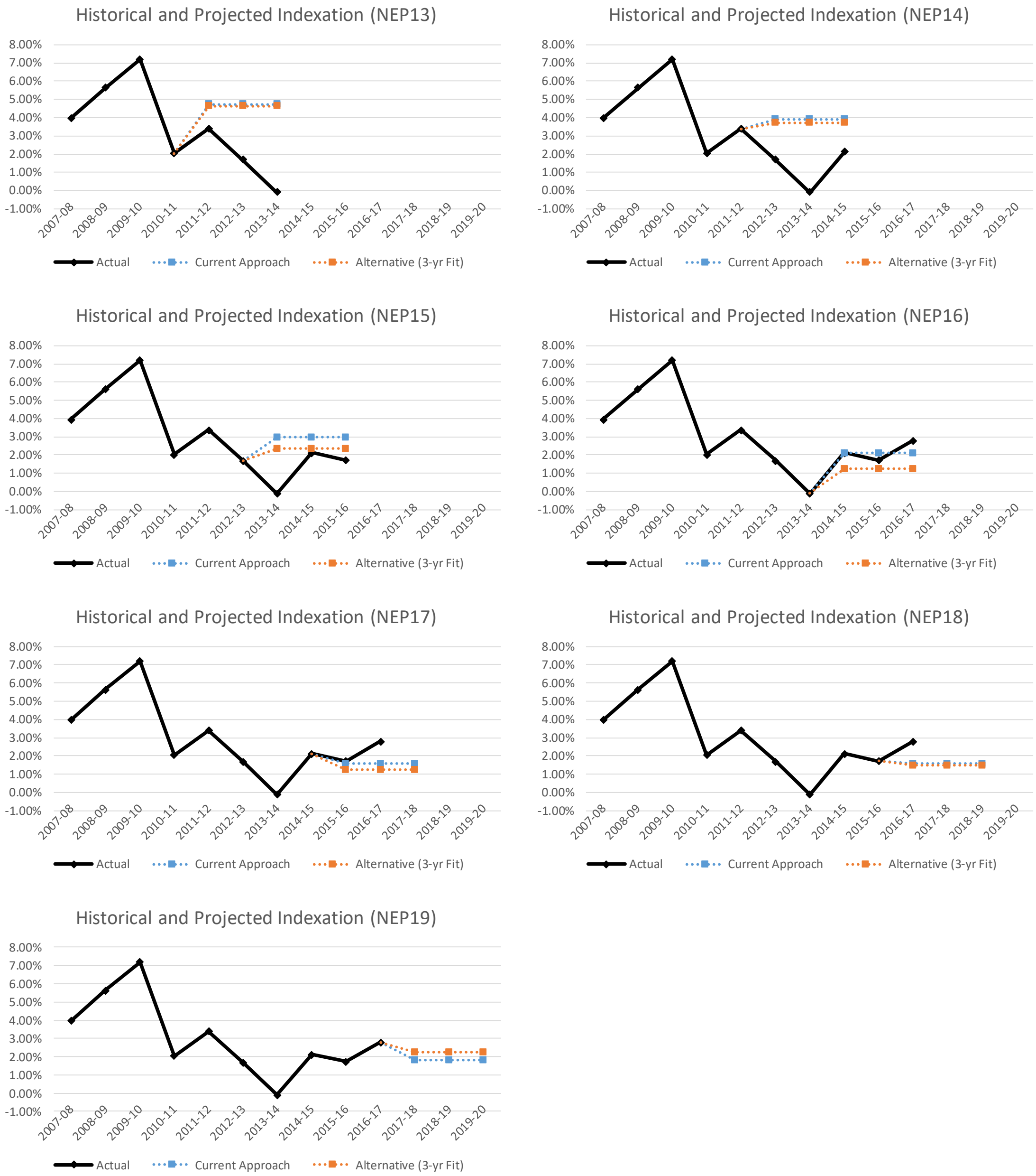
Alternative 3 – Alternative time periods

The current approach uses an exponential regression fit to the latest five years of growth. The mechanics of this calculation means that the adopted growth rate broadly reflects a weighted average of the last five years of actual growth, with more weight being placed on the more recent years.

We explored the possibility of applying the existing regression approach but reducing the time period to three years. This would place even more weight on recent years than the current approach.

The charts below show the actual growth rates and the indexation rates that would have been adopted at each past NEP Determination (since NEP13) under both approaches. As with previous charts, each data point represents the growth to that activity year, with three years of indexation projected at each NEP.

Figure 49: Comparison of historical growth rates against projected indexation



We make the following observations:

- As expected, the alternative approach (3-year fit) is more reactive to changes in growth rates which results in a more accurate projection when the growth rate is trending (e.g. NEP15).
- Conversely, the current approach (5-year fit) is slower to react and this is beneficial when trends are not stable, for example when the growth rate began to increase in 2014-15 (see NEP16 chart) after a sustained decrease over many years.

Overall, there are advantages and disadvantages of both approaches; neither approach has clearly outperformed the other. We note that the indexation rate should:

- Be reactive to recent experience, which is generally more relevant for predicting the growth rate over the next few years
- Reflect that the growth rate (in particular the growth due to price/wage inflation) should naturally revert towards a long term average over time
- Have a reasonable degree of stability, i.e. not overly react to volatility in year-on-year growth rates. This is because stability in the indexation rate has flow on effects to stability in funding (aside from changes in activity volumes).

We note that the initial mismatch between actual and forecasted indexation in the earlier NEPs could also have been due to early efficiency gains from the introduction of ABF, with more recent periods tending towards a more stable state.

Similar to the points raised above regarding changes in price growth, using a five year period will mean the implicit efficiency gains will be projected forward over a longer period of time (compared to using three years which would be more reactive). If it is believed that future improvements in efficiency are different from those in the historical cost data, one approach could be to model and forecast efficiency changes separate to price changes. Although our literature review identified that this was being done in the UK, further work would be required to identify the additional data to develop such a model, which we have considered outside the scope of this review.

Finally, methods that consider some form of mean reversion to a long term average could be considered. However, given the changes in growth since the introduction of ABF, it is unlikely we have enough stable data to allow for such techniques to be robust.

On balance, we consider the current approach to be suitable and therefore we recommend no change to the timeframe for deriving the indexation rate.

6.3.4 Summary and recommendation

The current approach meets the objectives for the indexation rate:

- It is based on historical public hospital cost data and is therefore directly consistent what it is trying to project
- It captures drivers of change in cost – including not just price/wage inflation, but also changes in efficiency and length of stay
- It can be used to convert the cost weight model (Reference Cost and cost weights) into a pricing model reflective of costs in a future projected period.

Although it is still a lagged measure, no appropriate external indices which could be used as a benchmark for forecasting were identified. There is also not enough data to identify a ‘long term’ rate under an ABF environment.

On balance, we consider the current approach to be suitable and therefore **we recommend no change to the existing approach for deriving the indexation rate**.

There is some evidence to indicate growth in underlying cost buckets may differ (for example, salary and wage costs compared to other costs). As the quality of cost data collection continues to improve over the next few years, an approach that projects indexation at a more granular cost bucket level should be considered.

7 Back-casting

7.1 Introduction

As discussed in Section 6.1, while the Fundamental Review of the NEP focuses on a pricing model, pricing and funding under the National Health Reform Agreement are intrinsically linked. Specifically, the back-casting process is one that supports the calculation of the Commonwealth contribution to funding under clauses A34 and A40 in the NHRA.

7.1.1 Objective and pricing philosophy

The main objective of the back-casting is to remove the impact of significant changes to the ABF classification or methodologies on **funding** calculations – including the price adjustment and volume adjustment as defined in clause A34(b) and A34(c) of the NHRA. This is to support the funding of **efficient growth**.

As an illustration, consider a stable system where the volume and case-mix of activity remained constant across two years (Year 1 and Year 2). If the pricing model developed for Year 2 included a new loading then the 'growth' in NWAU would purely be due to the pricing model change, without any underlying change to volume. Back-casting aims to account for this so that only efficient growth is funded by the Commonwealth.

7.1.2 Current back-casting approach

IHPA currently determines the back-cast volume multipliers and back-cast NEP to account for the volume and price adjustments respectively.

Back-cast volume multipliers

The back-cast volume multipliers are calculated by applying the current year's cost model and prior year's cost model to the same activity data. For NEP19, this involved comparing the results from the 2016-17 cost model to the 2015-16 cost model run on the same activity dataset.

We make the following observations:

- Volume multipliers are calculated for each stream (Acute Admitted, Emergency Department etc). As each stream is modelled separately and this will capture the changes to each cost model appropriately.

- Applying the two cost models to one activity year achieves the intended purpose of isolating only changes in model specifications and methodology as the underlying data source doesn't change.

- The back-cast volume multipliers can be applied to prior year NWAUs as these are intended to be comparable units of activity over time, thus giving a back-casted volume from which to calculate the volume adjustment for funding.

Based on this, the current approach is reasonable and we recommend no further changes.

Back-cast NEP

The back-cast NEP is used as the basis for calculating the price adjustment and is currently equivalent to the NEP deflated by one year of indexation. At the NEP19 Determination:

$$\begin{aligned} Back\text{-}cast\ NEP18 &= \frac{NEP19}{(1 + indexation\ rate)} \\ &= \frac{\$5{,}134}{(1 + 1.8\%)} \\ &= \$5{,}043 \end{aligned}$$

The objective of the back-cast NEP18 is to reflect a change in price between 2018-19 and 2019-20 so that this price growth is funded as per the NHRA. Furthermore, as the cost models and classifications may change between two years, it is not appropriate to simply compare the two consecutive NEP figures.

There are a number of considerations for how to develop a back-cast NEP:

- A true measure of the actual change in price between any given two years, for example 2018-19 (NEP18) and 2019-20 (NEP19) can only be done after those years have elapsed. This occurs many years after the requirement to set the NEP Determination and also after the conclusion of the activity year.

- The NEP is still a forecasted result. By deflating the NEP19 by one year of indexation, this uses the best estimate of updated cost for 2016-17 (via the new Reference Cost and indexation rate) to derive an updated view of the expected price change.

- A balance needs to be struck between the time that the back-cast NEP is derived, when it is required to support funding calculations and the complexity/work required to develop a back-cast NEP.

Currently, the starting point for funding growth will be the latest indexation rate. As previously discussed, this is always a lagged measure. If actual cost growth is very low or there is no cost growth compared to indexation, this would result in efficient growth funding that is higher than actual cost growth (with the reverse being true in periods where costs increase over and above the indexation rate).

Extending this further, this means the current approach also has the effect of not penalising jurisdictions to the full extent of cost reductions as they become more efficient. Similarly they are not funded the full extent of increases if costs rise. This aligns with providing pricing incentives to improve efficiency.

Over a longer term the indexation will move to reflect the cost changes and this once again becomes a question of how quickly should the indexation rate react to short term changes, which is a trade-off between stability and reactivity to emerging experience.

7.1.3 Summary and Recommendation

The current approaches to developing the back-cast volume multipliers and back-cast NEP are a simple way to update the back-cast NEP for new information. It accounts for an updated view of indexation and creates a starting point of price indexation for efficient growth. Although this would mean that price adjustments would lag actual changes in cost, it does not introduce perverse incentives such as discouraging efficiency.

On balance, the approaches adopted are reasonable in accounting for model changes and therefore we recommend no changes to the approach.

8 Summary of recommendations

After reviewing the components of the NEP and testing possible alternative approaches outlined in this report against the evaluation metrics we have made the following recommendations.

No.	Component	Recommendations
1	Data preparation	**We recommend** that the matching of pharmaceutical benefits to activity data be enhanced by applying an additional date rule. This would improve the number of unique matches in the data, and it can be implemented with a low amount of effort.
2	Data preparation	**We recommend** that Work-In-Progress episodes where the admission date is within one year of the current financial year be included in the model. This makes better use of the available data and reduces potential biases (such as variations due to seasonal illness) while still excluding genuine outliers
3	Base Model	**We recommend** that the approach to setting inlier bounds be based on percentiles of the Length of Stay distribution. This aligns more closely with the pricing philosophy as it is better able to define inliers that consistently captures both the majority of the episodes and cost for each DRG as well as the “peak” of the Length of Stay distribution. The choice of bounds will need to be set to achieve the right balance of risk sharing implicit between inliers and outliers.
4	Adjustments	**We recommend** that additional age adjustments are added into the NEP models across all the streams: • Acute: adjustment for patients aged 65 years and over • Emergency Department: extended to include an additional adjustment for patients aged 40 to 65 years • Non-admitted: a specialist paediatric adjustment for patients aged 18 years and under in specialist paediatric hospitals This would improve the ability of the NEP to allow for legitimate and unavoidable differences in cost due to a patient’s age.
5	Adjustments	**We recommend** further consultation and investigation regarding the following variables, to determine whether they should also be incorporated as additional adjustments • Acute: mode of admission – investigate the underlying drivers for the cost differences and assess the extent to which these are unavoidable • Acute: mental health legal status - further consultation required to determine whether an adjustment is appropriate given the transition to a new classification system • Emergency Department: mode of transport – investigate the underlying drivers for the cost differences and assess the extent to which these are unavoidable

No.	Component	Recommendations
6	Stabilisation	**We recommend** that the Acute same day price weights and specialist paediatric adjustments are stabilised such that changes do not exceed +/- 20% from year to year. This improves the consistency of stabilisation across the various model components without adversely affecting the model fit.
7	Calculation of the NEP/Indexation	**We recommend no change to the current determination of the Reference Cost**. The current approach is in line with the objective of deriving an average price and also maintains comparability of NWAU over time, which is an intentional choice.
8	Calculation of the NEP/Indexation	**We recommend** that IHPA consider 'resetting' the reference cost in the future if the Reference Cost diverges too far from the average cost of a typical separation. This would require significant adjustments to historical NWAU calculations to maintain comparability and there would need to be a strong appetite for change.
9	Calculation of the NEP/Indexation	**We recommend no change to the existing approach for deriving the indexation rate.** The current approach meets its objectives of capturing public hospital cost growth (including changes in efficiency and length of stay) and is suitable for converting the cost weight model into a pricing model for a future projected period.
10	Calculation of the NEP/Indexation	**We recommend** monitoring the quality of cost data collection and considering an approach that projects indexation at a more granular cost bucket level if the data quality continues to improve over the next few years.
11	Back-casting	**We recommend no change to the existing approach for back-casting.** The current approach is reasonable and meets its objectives of removing the impact of significant changes to the ABF classification or methodologies.

Appendix A Summary of literature review

In Stage 1 of the Fundamental Review, we conducted a comprehensive literature review of modern data analysis and statistical modelling techniques relevant for Activity Based Funding (ABF). This appendix summarises the key findings and recommendations from Stage 1. Further detail is available in our Stage 1 report *Fundamental Review of the National Efficient Price Literature Review Findings*, dated December 2018.

Key findings and recommendations from literature review

Due to the popularity of ABF systems as a funding mechanism globally, we were able to draw from a wide range of examples to arrive at robust findings. Our overarching finding from the literature review is that:

The core methodology of the current ABF model represents good practice, and in many aspects leading practice. However, within this core methodology there are opportunities to enhance individual elements.

Opportunities were classified into four themes, which represent the key steps in the NEP determination – data collection and preparation, development of the base model, adjustments to the base model, and development of an Efficient Price. These are not necessarily fixes required for the system, but alternative approaches to be considered.

In addition to the components identified in the literature review, Stage 2 also considered stabilisation and back-casting. These are features of the Australian ABF system which are either unique to the system or where very little technical detail was available for comparable systems.

These opportunities were discussed and agreed with IHPA and a number of these were prioritised and investigated during Stage 2.

No.	Theme	Opportunity	Priority	Status after Stage 2
3	Data Preparation	Analyse 'work in progress' episodes currently excluded from analysis	High	Done – see section 2.3
4	Data Preparation	Assess impact of including 'work in progress' episodes	High	Done – see section 2.3
10	Base Model	Analyse current proportion of inlier vs outlier episodes by DRG	High	Done – see section 3.2
11	Base Model	Test different approaches to defining outliers	High	Done – see section 3.2
12	Base Model	Analyse the current implicit loadings and discounts for outliers	High	Done – see section 3.2
13	Base Model	Assess the impact of applying explicit loadings and discounts for outliers	High	Not done as superseded by inlier bound recommendations – see section 3.2
17	Efficient Price	Consider and test feasibility of the options for changing the calculation of the Reference Cost	High	Done – see section 6.2; although there remain further opportunities as discussed in the literature review
18	Efficient Price	Analyse historical inflation by cost components	High	Done – see section 6.3

No.	Theme	Opportunity	Priority	Status after Stage 2
19	Efficient Price	Define and analyse historical efficiency improvements	**High**	Considered during indexation analysis (section 6.3) but not done due to limited data available
1	Data Preparation	Analyse volatility of uncapped cost weights over time	**Medium**	Done – see section 5
2	Data Preparation	Assess impact if multiple years of data are used for pricing	**Medium**	Not done due to lower priority
5	Data Preparation	Consider probabilistic linking/machine learning on unmatched records	**Medium**	Done – see section 2.2
6	Data Preparation	Test different approaches to trimming outliers	**Medium**	Not done due to lower priority
8	Base Model	Analyse the volatility of low volume DRGs	**Medium**	Not done due to lower priority
15	Adjustments	Use machine learning techniques to identify adjustment factors	**Medium**	Done – see section 4
7	Base Model	Assess whether the median is more appropriate for some DRGs	**Low**	Not done due to lower priority
14	Base Model	Use a separate test sample for model evaluation	**Low**	Not done due to lower priority
9	Base Model	Explore hierarchical credibility modelling for low volume DRGs	**Low**	Not done due to lower priority
16	Efficient Price	Calculate adjustments using multivariate techniques	**Low**	Not done due to lower priority

Appendix B Further Detail on Matching of Pharmaceutical Benefits

Current Patient-Level Matching Process

In the patient-level matching process, the variables used are Medicare PIN, sex, date of birth, hospital, and state. While these represent all the variables common across both datasets, it is possible (and in fact common) for one pharmaceutical benefit record to be matched to multiple activity records. Business rules currently exist to improve the confidence in the matched records and the correct removal of out of scope costs for pricing purposes.

For each pharmaceutical benefit record and using the matching variables described above:

- If there is only one matching activity record (i.e. a **unique match** was found), the pharmaceutical benefit amount is allocated in its entirety to the matched activity record. This matching step is carried out with and without the Medicare PIN (Match stage 1 and 2 respectively).

- If there are multiple matched activity records, a hierarchical set of rules are applied to exclude some matches that are considered less likely. After these rules are applied, the pharmaceutical benefit amount is **allocated evenly** across all remaining matches. Once again this is done with and without the use of Medicare PIN (Match stage 3 and 4 respectively).

Inclusion of Victoria Data

One key factor in developing the pharmaceutical matching enhancements was the volume and quality of data that was available. This was particularly important for the development of a predictive model for allocation, as only records that were matched using unique patient level matching could be used to develop the predictive model.

In order to increase the volume of data available for testing the pharmaceutical cost allocation, data from Victoria was considered and included in the patient level matching. Previously, Victoria did not submit patient level outpatient data and including them in the matching process would bias the matched data towards the acute stream.

For 2016/17, patient level outpatient data was submitted and we have considered it for testing after performing reasonableness tests on the distribution and average benefit size of submitted pharmaceutical benefits data.

Factors limiting the ability to develop further enhancement models

Notwithstanding, the volume of data was still a limiting factor in the development of the predictive model:

- Apart from the matching variables already used in the patient level matching, there were only a limited number of additional variables which could be used as explanatory variables in the predictive model.

- Ideally, a predictive model would be built at a DRG or Tier2 clinic level. However, some DRGs/Tier2 clinics had very few patient level matches and thus a predictive model was not possible, necessitating the use of a less granular classification level such as MDC.

Appendix C Further Detail on WIP

Proportion of WIP Records by DRG

Table 8 shows the top 20 DRGs by proportion of WIP records and while many of these are low volume DRGs, some such as the mental health DRG U61A have over 1,000 WIP records. A significant number of these DRGs are low volume neonate DRGs.

Table 8: Proportion of total WIP records for top 20 DRGs

DRG		WIP	Non-WIP	% WIP
P07Z	Neonate, AdmWt <750g W Significant GIs	15	36	29.4%
P08Z	Neonate, AdmWt 750-999g W Significant GIs	11	29	27.5%
P61Z	Neonate, AdmWt <750g W/O Significant GI procedure	75	242	23.7%
P62A	Neonate, AdmWt 750-999g W/O Significant GIs, Major Complexity	108	441	19.7%
P05A	Neonate, AdmWt 2000-2499g W Significant GI/Vent>=96hrs, Major Complexity	17	72	19.1%
F22Z	Insertion of Artificial Heart Device	12	55	17.9%
P03A	Neonate, AdmWt 1000-1499g W Significant GI/Vent>=96hrs, Major Complexity	91	427	17.6%
Y01Z	Vent >=96hrs or Trach for Burns or GIs for Severe Full Thickness Burns	24	116	17.1%
A13A	Ventilation >=336hours, Major Complexity	185	913	16.8%
P04A	Neonate, AdmWt 1500-1999g W Significant GI/Vent>=96hrs, Major Complexity	20	100	16.7%
P63A	Neonate, AdmWt 1000-1249g W/O Significant GI/Vent>=96hrs, Major Complexity	17	86	16.5%
R05A	Allogeneic Bone Marrow Transplant, Age <=16 Years or Major Complexity	41	232	15.0%
W01A	Vent, Trac & Cran Procs for Mult Sig Trauma, Major Complexity	55	401	12.1%
R03A	Lymphoma and Leukaemia W Other GIs, Major Complexity	31	232	11.8%
U61A	Schizophrenia Disorders, Major Complexity	1,107	8,466	11.6%
P03B	Neonate, AdmWt 1000-1499g W Significant GI/Vent>=96hrs, Minor Complexity	51	417	10.9%
I02A	Microvascular Tissue Transfers or Skin Grafts, Excluding Hand, Major Complexity	40	330	10.8%
A13B	Ventilation >=336hours, Minor Complexity	31	266	10.4%
P62B	Neonate, AdmWt 750-999g W/O Significant GIs, Minor Complexity	4	36	10.0%
A14A	Ventilation >=96hours & <336hours, Major Complexity	132	1,201	9.9%

Impact of Including WIP by DRG

Table 9 and Table 10 show the top 20 DRGs with the largest increases and decreases in the inlier parameter respectively after WIP records admitted in the previous financial year are included.

Table 9: Top 20 DRGs with the largest increase in inlier parameter

DRG	Description	Inlier separations	DRAFT NEP19 inlier	Restricted WIP inlier	% change in inlier
P04A	Neonate, AdmWt 1500-1999g W Significant GI/Vent>=96hrs, Major Complexit	100	107,185.65	121,008.05	12.9%
Y01Z	Vent >=96hrs or Trach for Burns or GIs for Severe Full Thickness Burns	85	186,786.26	205,769.76	10.2%
P63A	Neonate, AdmWt 1000-1249g W/O Significant GI/Vent>=96hrs, Major Comple	100	60,501.54	66,592.98	10.1%
J09Z	Perianal and Pilonidal Procedures	2,022	3,396.52	3,684.95	8.5%
B83A	Acute Paraplegia and Quadriplegia and Spinal Cord Conditions, Major Complexi	224	33,626.37	35,377.08	5.2%
P08Z	Neonate, AdmWt 750-999g W Significant GIs	29	246,504.76	255,087.12	3.5%
X04A	Other Procedures for Injuries to Lower Limb, Major Complexity	370	19,614.20	20,140.16	2.7%
R05A	Allogeneic Bone Marrow Transplant, Age <=16 Years or Major Complexity	254	121,326.81	124,437.07	2.6%
E01A	Major Chest Procedures, Major Complexity	794	35,715.14	36,533.43	2.3%
J01A	Microvas Tiss Transf for Skin, Subcut Tiss & Breast Dsrds, Major Complexity	127	52,824.47	53,973.38	2.2%
H05A	Hepatobiliary Diagnostic Procedures, Major Complexity	217	22,482.85	22,970.30	2.2%
F11B	Amputation, Except Upper Limb and Toe, for Circulatory Disorders, Minor Com	285	27,950.86	28,553.42	2.2%
U61A	Schizophrenia Disorders, Major Complexity	2,345	49,703.09	50,671.16	1.9%
U61B	Schizophrenia Disorders, Minor Complexity	5,740	23,521.53	23,960.05	1.9%
I07Z	Amputation	321	38,455.42	39,159.56	1.8%
E72Z	Respiratory Problems Arising from Neonatal Period	298	2,384.04	2,427.53	1.8%
B63A	Dementia and Other Chronic Disturbances of Cerebral Function, Major Comple:	3,643	19,310.01	19,650.55	1.8%
B06B	Procedures for Cerebral Palsy, Muscular Dystrophy and Neuropathy, Interm Co	277	12,298.44	12,505.25	1.7%
L09A	Other Procedures for Kidney and Urinary Tract Disorders, Major Complexity	479	29,735.90	30,160.55	1.4%
U68A	Childhood Mental Disorders, Major Complexity	215	18,135.01	18,392.80	1.4%

Table 10: Top 20 DRGs with the largest decrease in inlier parameter

DRG	Description	Inlier separations	DRAFT NEP19 inlier	Restricted WIP inlier	% change in inlier
I11Z	Limb Lengthening Procedures	124	17,539.71	16,514.11	-5.8%
R62C	Other Neoplastic Disorders, Minor Complexity	322	3,579.76	3,375.94	-5.7%
K62C	Miscellaneous Metabolic Disorders, Minor Complexity	3,752	2,196.36	2,130.85	-3.0%
A13B	Ventilation >=336hours, Minor Complexity	170	90,309.75	87,820.04	-2.8%
K63A	Inborn Errors of Metabolism, Major Complexity	621	5,936.68	5,779.15	-2.7%
P03B	Neonate, AdmWt 1000-1499g W Significant GI/Vent>=96hrs, Minor Complexit	431	78,505.23	76,501.10	-2.6%
X07C	Skin Grafts for Injuries Excluding Hand, Minor Complexity	732	8,064.04	7,876.86	-2.3%
W01A	Vent, Trac & Cran Procs for Mult Sig Trauma, Major Complexity	368	99,914.58	97,641.70	-2.3%
Z65Z	Congenital Anomalies and Problems Arising from Neonatal Period	270	3,580.53	3,499.72	-2.3%
B68B	Multiple Sclerosis and Cerebellar Ataxia, Minor Complexity	16,884	1,130.32	1,105.31	-2.2%
B81B	Other Disorders of the Nervous System, Minor Complexity	8,266	3,576.80	3,510.95	-1.8%
U68B	Childhood Mental Disorders, Minor Complexity	81	8,609.71	8,454.10	-1.8%
C12A	Other Corneal, Scleral and Conjunctival Procedures, Major Complexity	378	7,135.28	7,007.30	-1.8%
P03A	Neonate, AdmWt 1000-1499g W Significant GI/Vent>=96hrs, Major Complexit	387	138,136.99	135,700.36	-1.8%
P05A	Neonate, AdmWt 2000-2499g W Significant GI/Vent>=96hrs, Major Complexi	40	129,981.68	127,863.27	-1.6%
F02Z	Other AICD Procedures	217	12,639.39	12,433.42	-1.6%
P62A	Neonate, AdmWt 750-999g W/O Significant GIs, Major Complexity	515	168,138.57	165,462.77	-1.6%
R05B	Allogeneic Bone Marrow Transplant, Age >=17 Years and Minor Complexity	306	63,722.20	62,764.30	-1.5%
B42A	Nervous System Disorders W Ventilator Support, Major Complexity	257	34,635.92	34,132.56	-1.5%
Z01A	Other Contacts W Health Services W GIs, Major Complexity	297	18,841.99	18,581.77	-1.4%

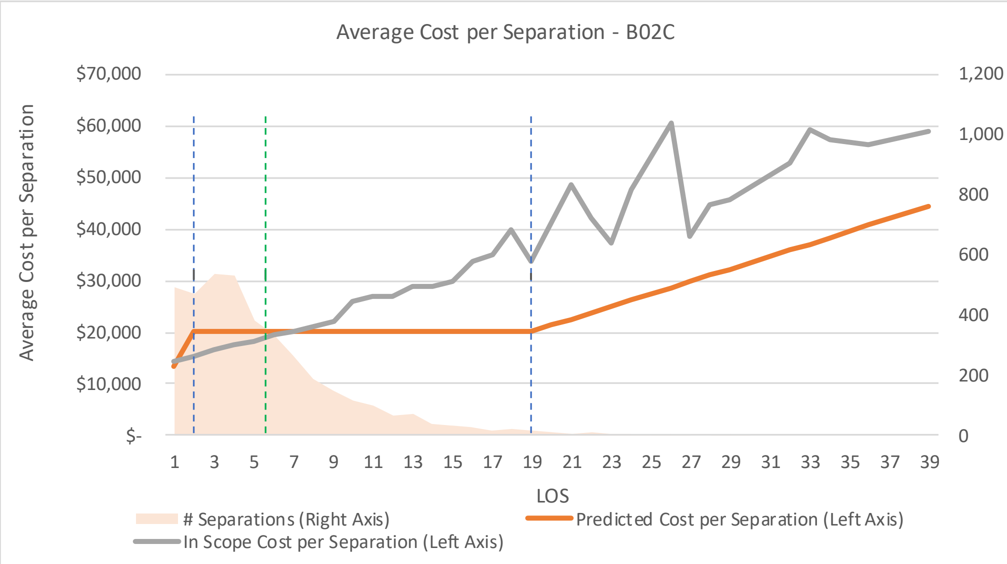
Appendix D Further Detail on Inlier Bounds

Variation by DRG

We previously observed that there is significant variation by DRG in both the proportion of separations classified as inliers and the inlier cost ratio. The following are some examples of how the average cost and Length of Stay distributions, and therefore the resulting inlier bounds and pricing parameters, can vary by DRG.

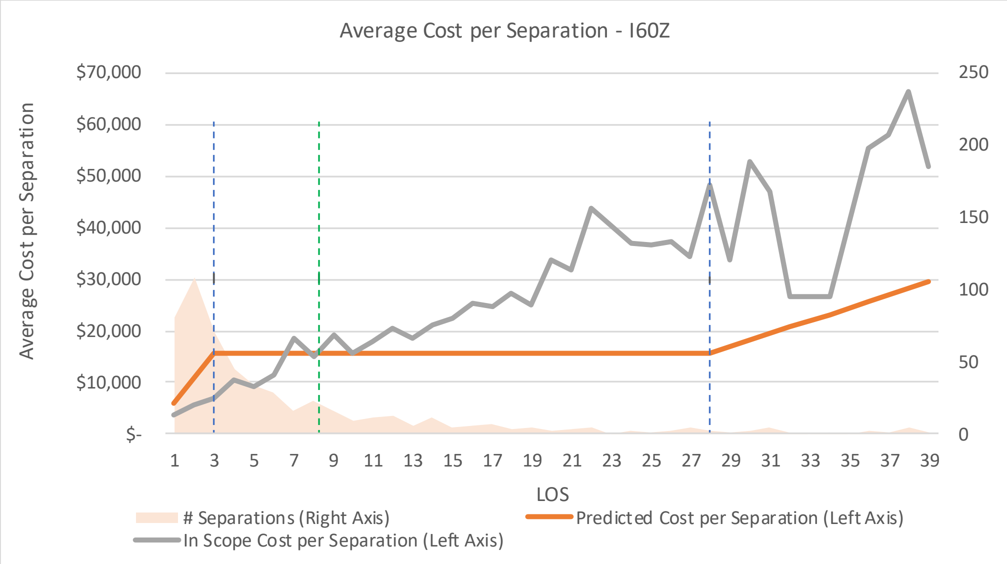
Each of the four charts below show the number of separations, average cost per separation, and predicted cost per separation (as per the base model) by Length of Stay. The vertical dotted lines represent the inlier bounds and the average Length of Stay.

B02C (Cranial Procedures, Minor Complexity)



This is a 'typical' DRG where we can observe an average cost that increases with Length of Stay and a skewed distribution of separations by LOS. The average Length of Stay is 5.6 days, resulting in calculated inlier lower and upper bounds of 2 and 18 days respectively. The majority of separations are classified as inliers, including a significant component of the tail of the skewed distribution. The inlier cost ratio is 0.975, a slight overpricing which is offset by under-priced long-stay outliers.

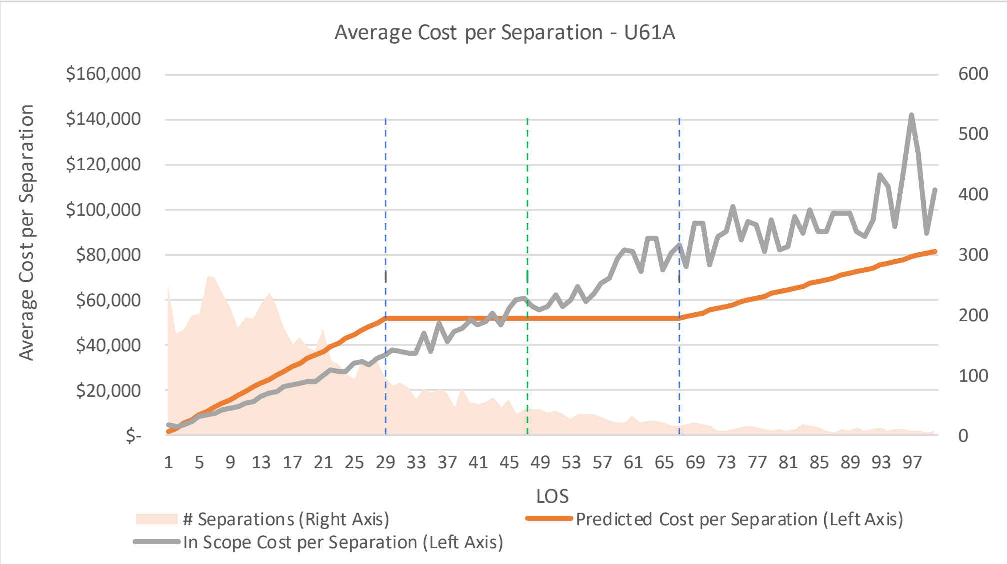
I60Z (Femoral Shaft Fractures)



In contrast, the I60Z shows a more highly skewed distribution of separations by LOS. The average Length of Stay is 8.3 days, with a corresponding inlier lower and upper bound of 3 and 28 days respectively. However, the peak of the distribution of separations actually occurs where the LOS = 2, outside of the inlier category.

As a result, the inlier category (and resulting cost parameter) comprises predominantly of separations in the tail. The cost ratio for the inlier separation category is 0.969 for this DRG.

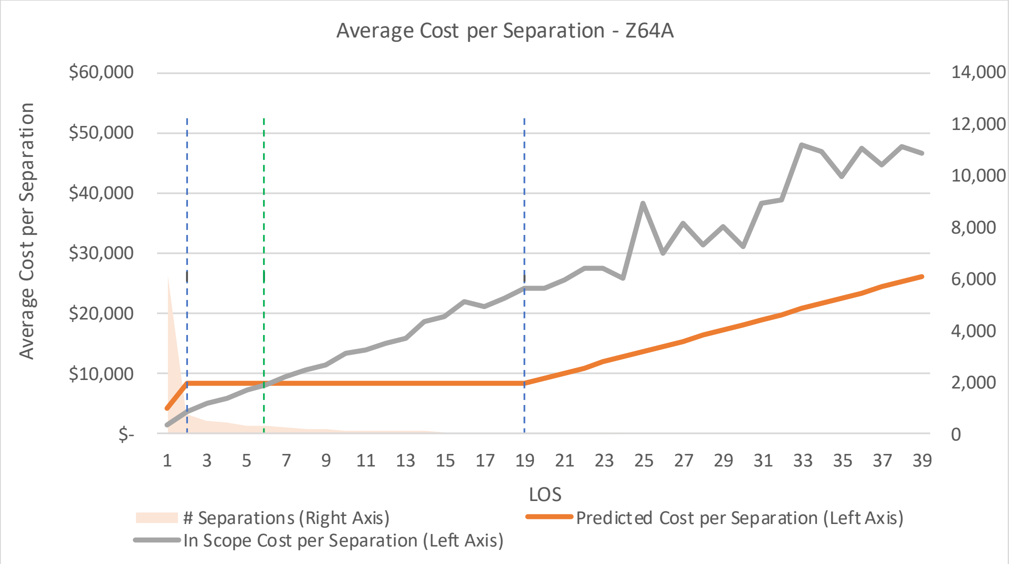
U61A (Schizophrenia Disorders, Major Complexity)



4. This is an example of a mental health DRG with a high volume of separations. The distribution of separations by LOS is skewed and there is a large spread of separations with higher lengths of stay compared to the two previous DRGs.

5. The average LOS is 47.4 days with an inlier lower and upper bound of 29 and 67 days respectively. Note that the L1.5H1.5 methodology is used for mental health DRGs. Similar to I60Z, the inlier category predominantly comprises of separations in the tail, and as a result the majority (65%) of episodes are classified as short-stay outliers. The cost ratio for inliers in this DRG is equal to 1.030, indicating a slight under-pricing which is offset by the short stay outliers.

6. **Z64A (Other Factors Influencing Health Status, Major Complexity)**



This is a DRG with a large proportion (57%) of separations that have a Length of Stay of one (i.e. one night stay), although it is a highly skewed distribution with an average LOS = 5.9 days. The inlier category Z64A also predominantly comprises of separations in the tail, with the 57% of one night episodes being classified as short-stay outliers.

Alternative Approach – detailed results

Below we present further detail on the impact of the alternative approach after considering the impact on inlier bounds, change in inlier proportions and change in price weights (see Section 3.2.2).

Impact on inlier bounds

The charts below show the number of DRGs by their changes in the inlier lower and upper bounds after applying the percentile approach.

Figure 50: Change in inlier lower bound (days) using the percentile method

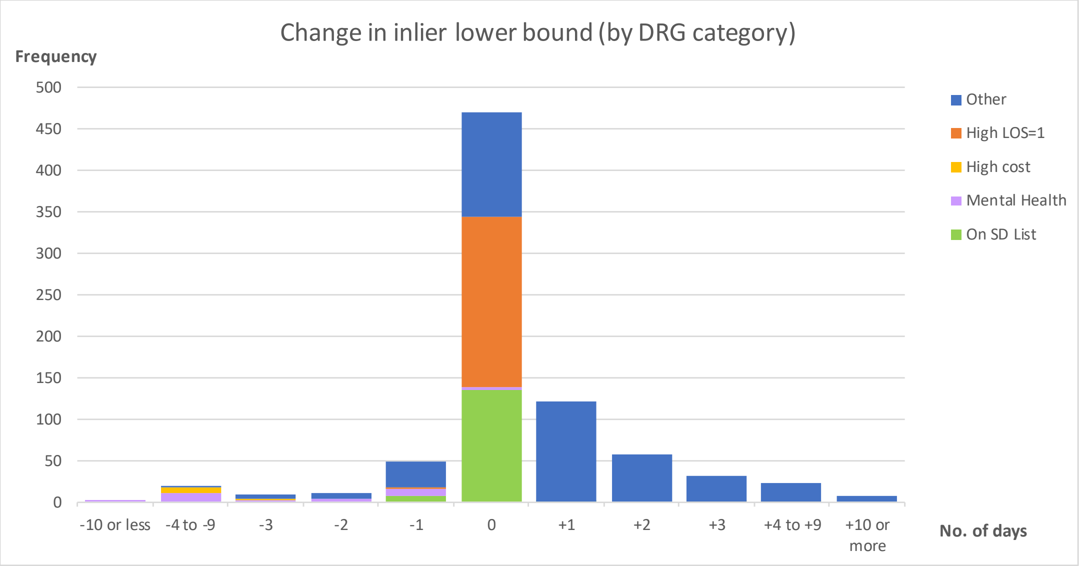
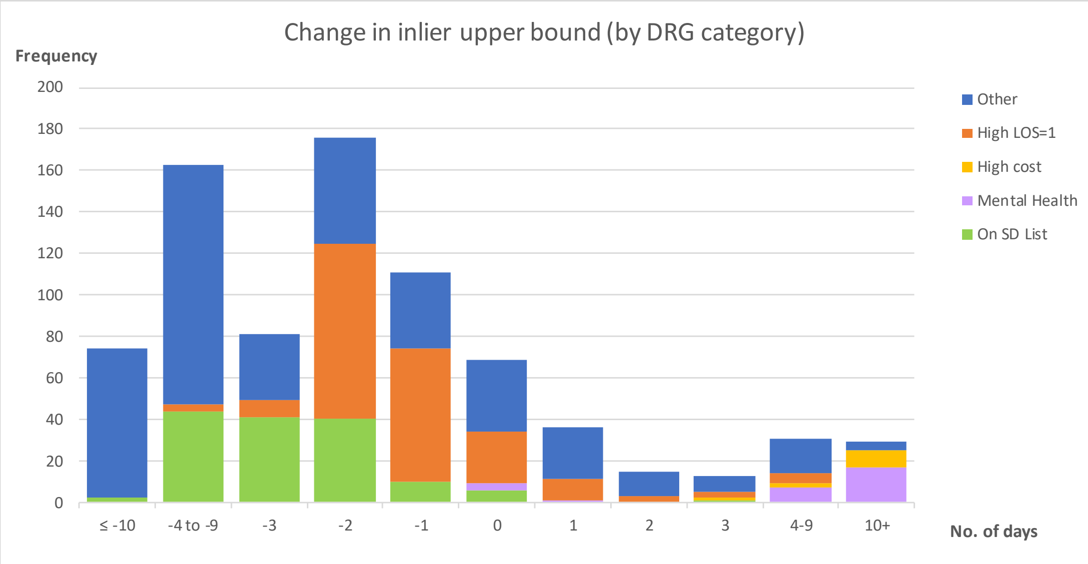


Figure 51: Change in inlier upper bound (days) using the percentile method



The majority of lower bounds do not change, however there are large changes in the upper bounds which is to be expected given these bounds are well into the tail of the LOS distribution. We observe that using the 95th percentile, more DRGs had a decrease in the upper bound compared with the current approach, although mental health and high cost DRGs generally had an increase in their upper bound.

Change to inlier proportion

The following charts compare the inlier proportions of separations and in-scope cost under the two approaches.

Figure 52: Comparison of inlier proportion for old vs new inlier bounds

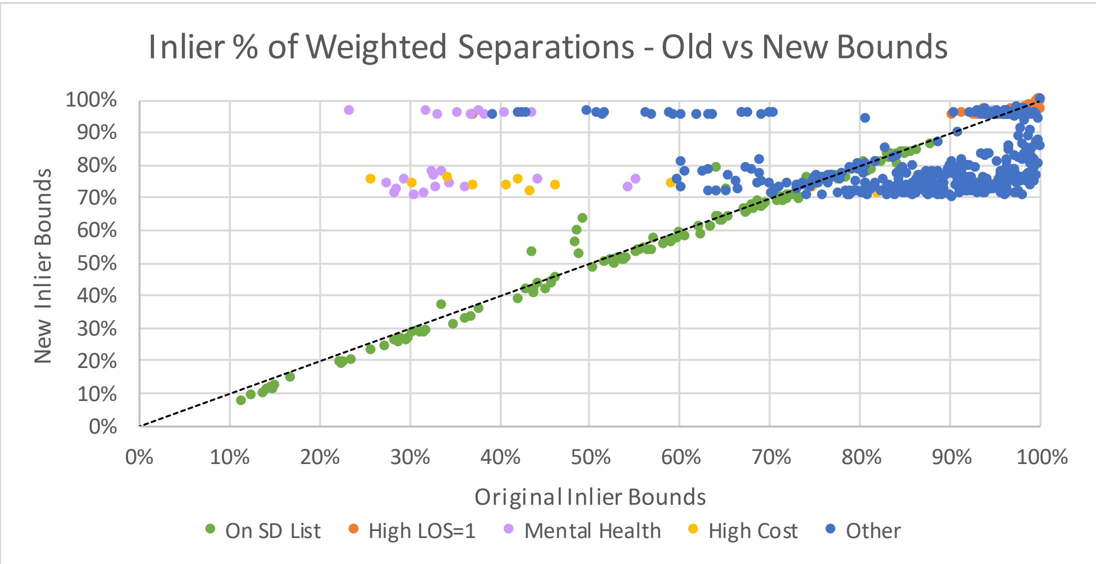
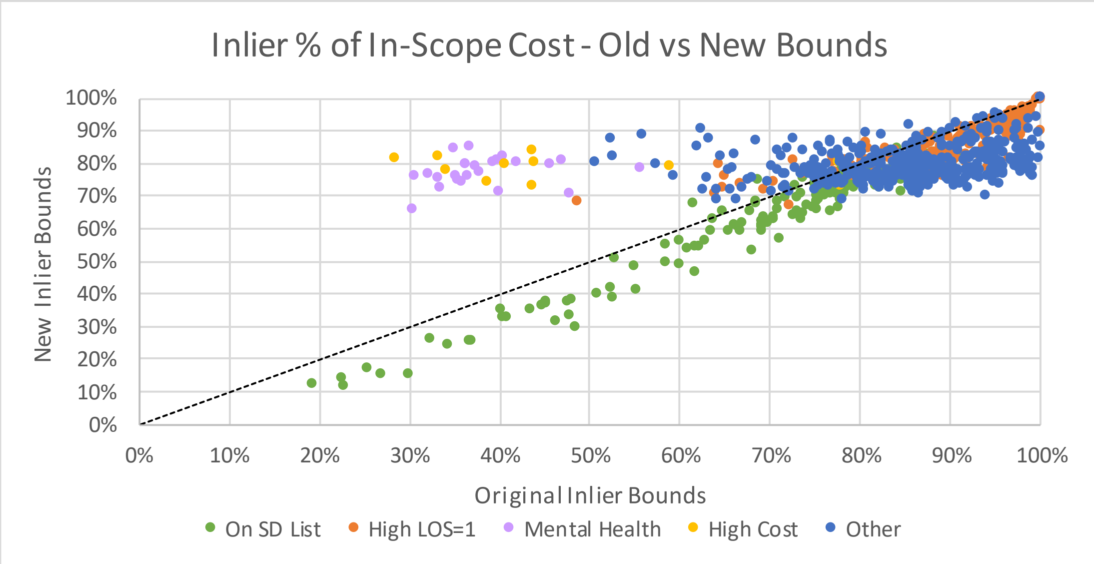


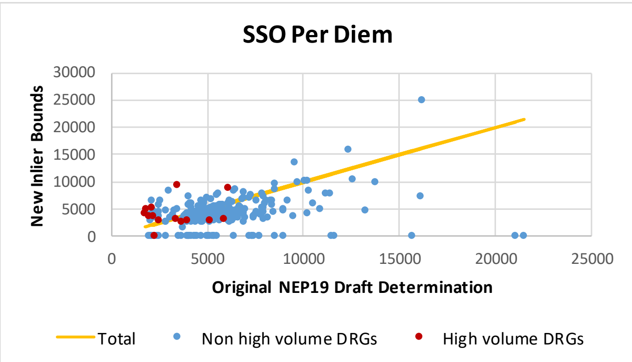
Figure 53: Comparison of inlier proportion of in-scope cost for old vs new inlier bounds

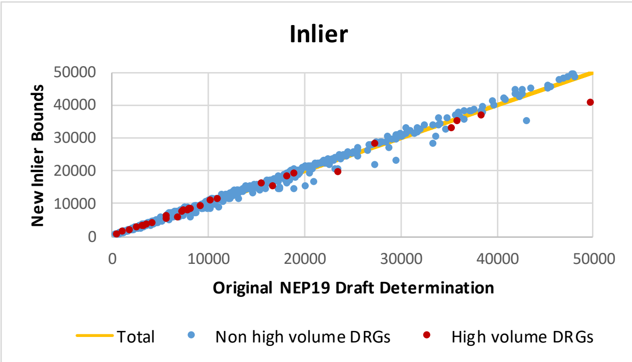


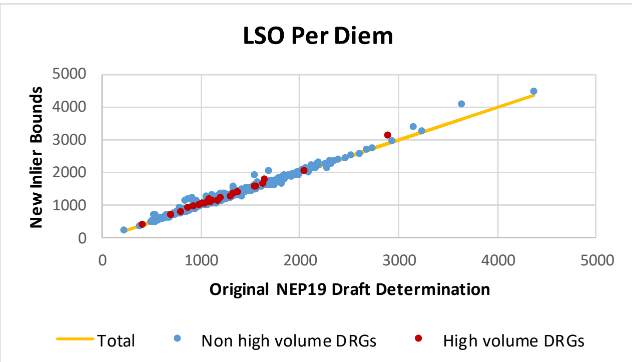
The inlier proportions become more consistent across DRGs; they are generally within a much narrower range of 80% to 90%. This is one advantage of the percentile based method.

Change to price weights

Figure 54: Change in pricing parameters – comparison of old and new method







While most of the inlier and long-stay outlier per diem price weights do not change significantly, there are significant changes in the short-stay outlier per diem price weights. This means there would be a significant one-off shift in these parameters if there was a change in the adopted approach for setting inliers

Appendix E LHN Cost ratios – Adjustments

This appendix contains cost ratios for Local Hospital Networks (LHNs), comparing them under the current NEP models and after applying the proposed adjustments.

Age Adjustment (Acute)

	2016/17 Data		Predicted Cost (prior to stabilisation)		Cost Ratio		
Local Hospital Network	Number of Separations	In Scope Cost	NEP19	Alternative	NEP19	Alternative	Difference
LHN101 - South Eastern Sydney	155,763	887,043,230	908,283,906	909,866,989	97.7%	97.5%	-0.2%
LHN102 - Sydney	152,444	837,689,804	897,951,752	898,670,139	93.3%	93.2%	-0.1%
LHN103 - South Western Sydney	210,936	980,617,644	983,423,998	984,049,324	99.7%	99.7%	-0.1%
LHN104 - Western Sydney	156,311	863,205,330	847,005,850	846,720,206	101.9%	101.9%	0.0%
LHN105 - Nepean Blue Mountains	80,482	379,340,506	394,031,499	393,826,510	96.3%	96.3%	0.1%
LHN106 - Northern Sydney	133,627	796,170,581	781,480,861	783,105,233	101.9%	101.7%	-0.2%
LHN107 - Central Coast	82,225	404,094,858	380,513,383	381,827,574	106.2%	105.8%	-0.4%
LHN108 - Illawarra Shoalhaven	81,949	439,654,771	455,689,934	457,242,740	96.5%	96.2%	-0.3%
LHN109 - Hunter New England	202,684	1,022,744,048	1,026,577,812	1,027,656,710	99.6%	99.5%	-0.1%
LHN110 - Mid North Coast	68,064	305,402,814	308,437,741	309,418,855	99.0%	98.7%	-0.3%
LHN111 - Northern NSW	88,992	387,182,491	401,019,865	401,988,719	96.5%	96.3%	-0.2%
LHN112 - Western NSW	65,698	296,455,342	307,773,015	308,168,243	96.3%	96.2%	-0.1%
LHN113 - Southern NSW	43,895	185,656,752	168,702,722	169,127,822	110.0%	109.8%	-0.3%
LHN114 - Murrumbidgee	47,105	225,495,256	219,794,430	220,154,099	102.6%	102.4%	-0.2%
LHN115 - Far West	7,777	42,366,549	36,668,096	36,727,871	115.5%	115.4%	-0.2%
LHN117 - Sydney Children's Hospitals Network	47,856	378,149,645	387,693,507	383,805,612	97.5%	98.5%	1.0%
LHN118 - St Vincent's Health Network	39,912	281,380,274	260,757,226	261,171,771	107.9%	107.7%	-0.2%
LHN202 - East Grampians Health Service	5,231	16,871,367	16,827,777	16,910,724	100.3%	99.8%	-0.5%
LHN203 - Ballarat Health Services	40,854	153,048,502	180,386,133	180,494,902	84.8%	84.8%	-0.1%
LHN204 - Stawell Regional Health	3,954	15,188,946	14,750,518	14,827,033	103.0%	102.4%	-0.5%
LHN207 - Maryborough District Health Service	5,320	12,997,845	17,668,916	17,744,654	73.6%	73.2%	-0.3%
LHN209 - Western Health (Vic)	123,434	394,717,243	485,209,165	485,885,805	81.3%	81.2%	-0.1%
LHN210 - Bendigo Health Care Group	41,041	166,685,827	188,241,219	188,527,546	88.5%	88.4%	-0.1%
LHN212 - Swan Hill District Health	6,627	26,438,948	29,600,085	29,717,503	89.3%	89.0%	-0.4%
LHN221 - Castlemaine Health	4,478	15,923,909	18,365,486	18,388,421	86.7%	86.6%	-0.1%
LHN223 - Royal Children's Hospital (Melbourne)	48,775	353,774,141	339,202,241	335,775,123	104.3%	105.4%	1.1%
LHN224 - Royal Women's Hospital (Melbourne)	26,496	167,929,874	164,179,900	162,457,699	102.3%	103.4%	1.1%
LHN225 - Melbourne Health	95,577	462,087,520	499,106,505	499,413,273	92.6%	92.5%	-0.1%
LHN226 - Northern Health (Vic)	86,382	258,694,484	316,530,760	316,856,667	81.7%	81.6%	-0.1%
LHN231 - Barwon Health	82,575	314,100,499	358,924,534	359,467,456	87.5%	87.4%	-0.1%
LHN234 - Eastern Health (Vic)	153,756	503,770,294	589,565,510	590,483,150	85.4%	85.3%	-0.1%
LHN235 - Goulburn Valley Health	29,959	102,239,310	107,029,751	107,171,370	95.5%	95.4%	-0.1%
LHN236 - Kyabram and District Health Service	4,642	14,427,678	13,944,878	14,041,738	103.5%	102.7%	-0.7%
LHN243 - Northeast Health Wangaratta	17,546	63,712,150	69,543,831	69,746,042	91.6%	91.3%	-0.3%
LHN247 - Benalla and District Memorial Hospital	3,752	16,492,262	18,855,690	19,057,495	87.5%	86.5%	-0.9%
LHN249 - Albury Wodonga Health	18,632	66,880,877	63,331,894	63,167,196	105.6%	105.9%	0.3%
LHN252 - West Gippsland Healthcare Group	11,547	44,049,094	51,356,198	51,430,643	85.8%	85.6%	-0.1%
LHN253 - Bass Coast Regional Health	7,690	23,031,089	26,455,922	26,633,252	87.1%	86.5%	-0.6%
LHN254 - Gippsland Southern Health Service	3,521	17,886,608	15,114,252	15,176,913	118.3%	117.9%	-0.5%
LHN256 - Bairnsdale Regional Health Service	15,515	40,405,002	50,787,030	51,063,259	79.6%	79.1%	-0.4%
LHN259 - Central Gippsland Health Service	12,150	51,088,614	46,727,540	46,782,592	109.3%	109.2%	-0.1%
LHN260 - Latrobe Regional Hospital	33,760	117,898,996	131,373,850	131,553,205	89.7%	89.6%	-0.1%
LHN262 - St Vincent's Hospital (Melbourne) Limited	58,958	291,252,935	329,978,418	330,650,448	88.3%	88.1%	-0.2%
LHN263 - Royal Victorian Eye and Ear Hospital	15,049	63,717,824	66,328,092	66,527,126	96.1%	95.8%	-0.3%
LHN264 - Peter MacCallum Cancer Institute (Vic)	34,805	141,410,220	112,247,091	112,321,254	126.0%	125.9%	-0.1%
LHN266 - Austin Health (Vic)	103,164	437,946,347	478,476,723	479,429,541	91.5%	91.3%	-0.2%
LHN267 - Mercy Public Hospital Inc. (Vic)	47,749	218,775,903	238,494,045	236,619,015	91.7%	92.5%	0.7%
LHN268 - Alfred Health (Vic)	107,868	543,174,732	642,036,278	642,841,865	84.6%	84.5%	-0.1%
LHN269 - Monash Health	245,130	859,908,419	1,029,934,673	1,028,602,005	83.5%	83.6%	0.1%
LHN270 - Peninsula Health (Vic)	78,500	315,730,795	339,368,316	340,122,948	93.0%	92.8%	-0.2%
LHN275 - Wimmera Health Care Group	11,172	51,542,271	52,908,433	53,170,650	97.4%	96.9%	-0.5%
LHN279 - Mildura Base Hospital	19,276	69,910,555	71,889,157	71,961,479	97.2%	97.1%	-0.1%
LHN282 - Western District Health Service (Vic)	6,598	34,405,332	33,130,162	33,218,547	103.8%	103.6%	-0.3%
LHN284 - South West Healthcare (Vic)	21,295	90,794,585	82,700,656	82,780,832	109.8%	109.7%	-0.1%
LHN288 - Portland District Health	4,799	22,951,192	20,626,004	20,690,127	111.3%	110.9%	-0.3%
LHN312 - Cairns and Hinterland	88,833	367,637,178	383,999,558	383,384,504	95.7%	95.9%	0.2%
LHN313 - Townsville	75,793	378,122,030	406,521,466	405,949,489	93.0%	93.1%	0.1%
LHN314 - Mackay	43,610	156,745,714	170,176,777	169,944,020	92.1%	92.2%	0.1%
LHN315 - North West (Qld)	7,439	51,538,080	38,921,811	38,722,448	132.4%	133.1%	0.7%
LHN316 - Central Queensland	55,975	195,369,228	196,922,001	196,815,880	99.2%	99.3%	0.1%
LHN318 - Wide Bay	68,165	260,688,613	235,748,730	236,295,807	110.6%	110.3%	-0.3%
LHN319 - Sunshine Coast	86,272	342,446,935	330,491,575	330,871,874	103.6%	103.5%	-0.1%
LHN320 - Metro North (Qld)	249,187	1,273,353,452	1,322,731,984	1,322,362,183	96.3%	96.3%	0.0%
LHN321 - Children's Health Queensland	39,930	307,773,834	277,796,592	274,997,758	110.8%	111.9%	1.1%
LHN322 - Metro South (Qld)	236,576	1,104,745,483	1,015,721,889	1,015,187,804	108.8%	108.8%	0.1%
LHN323 - Gold Coast	149,650	693,704,458	636,955,361	636,956,416	108.9%	108.9%	0.0%
LHN324 - West Moreton	53,413	214,196,234	202,913,257	202,721,599	105.6%	105.7%	0.1%
LHN325 - Darling Downs	64,733	240,338,533	257,814,264	257,669,427	93.2%	93.3%	0.1%
LHN326 - South West (Qld)	3,184	7,337,034	10,741,294	10,761,333	68.3%	68.2%	-0.1%
LHN328 - Mater Misericordiae Health	57,725	260,147,278	272,619,498	271,592,602	95.4%	95.8%	0.4%
LHN401 - Northern Adelaide	65,315	267,500,933	307,685,439	308,126,627	86.9%	86.8%	-0.1%
LHN402 - Central Adelaide	124,550	807,486,871	719,696,797	722,075,880	112.2%	111.8%	-0.4%
LHN403 - Southern Adelaide	94,507	518,384,531	512,011,189	513,088,201	101.2%	101.0%	-0.2%
LHN404 - Country Health SA	76,703	246,922,898	247,777,730	248,225,556	99.7%	99.5%	-0.2%
LHN405 - Women's and Children's Health Network (SA)	32,157	198,810,577	198,212,885	196,058,604	100.3%	101.4%	1.1%
LHN501 - North Metropolitan Health Service (WA)	120,960	777,074,513	618,685,838	618,547,343	125.6%	125.6%	0.0%
LHN502 - South Metropolitan Health Service (WA)	142,118	904,189,667	686,237,096	686,795,316	131.8%	131.7%	-0.1%
LHN503 - WA Country Health Service	120,082	482,894,299	429,286,146	428,433,939	112.5%	112.7%	0.2%
LHN504 - East Metropolitan Health Service (WA)	103,138	628,124,438	527,389,478	527,494,747	119.1%	119.1%	0.0%
LHN580 - Child Adolescent Health Service (WA)	27,614	199,605,628	165,553,549	163,787,011	120.6%	121.9%	1.3%
LHN604 - Tasmanian Health Service	109,861	603,085,489	599,133,809	599,727,962	100.7%	100.6%	-0.1%
LHN701 - Top End (NT)	87,895	381,806,356	352,187,409	350,475,858	108.4%	108.9%	0.5%
LHN702 - Central Australia (NT)	68,098	176,277,599	202,776,307	201,469,617	86.9%	87.5%	0.6%
LHN801 - Australian Capital Territory	110,902	620,088,639	537,195,644	537,130,588	115.4%	115.4%	0.0%

Age Adjustment (Emergency Department)

	2016/17 Data		Predicted Cost (pre stabilisation)		Cost Ratio		
Local Hospital Network	Number of Separations	In Scope Cost	NEP19	Alternative	NEP19	Alternative	Difference
LHN101 - South Eastern Sydney	219,522	136,129,604	137,768,341	137,894,730	98.8%	98.7%	-0.1%
LHN102 - Sydney	160,059	105,847,578	103,963,914	104,016,966	101.8%	101.8%	-0.1%
LHN103 - South Western Sydney	270,944	168,560,062	179,307,102	179,312,266	94.0%	94.0%	0.0%
LHN104 - Western Sydney	180,963	129,338,681	130,262,166	130,597,766	99.3%	99.0%	-0.3%
LHN105 - Nepean Blue Mountains	97,499	70,582,028	61,307,998	61,417,209	115.1%	114.9%	-0.2%
LHN106 - Northern Sydney	209,033	127,396,302	138,214,539	138,005,417	92.2%	92.3%	0.1%
LHN107 - Central Coast	130,976	81,391,277	85,007,160	84,922,533	95.7%	95.8%	0.1%
LHN108 - Illawarra Shoalhaven	132,031	96,395,895	84,977,252	84,929,823	113.4%	113.5%	0.1%
LHN109 - Hunter New England	330,091	194,479,183	189,714,614	189,704,142	102.5%	102.5%	0.0%
LHN110 - Mid North Coast	114,985	67,022,718	71,074,634	71,107,719	94.3%	94.3%	0.0%
LHN111 - Northern NSW	188,617	111,877,206	112,740,472	112,912,079	99.2%	99.1%	-0.2%
LHN112 - Western NSW	124,533	81,106,701	71,931,946	71,841,871	112.8%	112.9%	0.1%
LHN113 - Southern NSW	90,111	51,871,548	50,098,160	50,198,267	103.5%	103.3%	-0.2%
LHN114 - Murrumbidgee	69,736	48,738,049	42,380,935	42,345,230	115.0%	115.1%	0.1%
LHN115 - Far West	22,516	9,967,324	9,736,040	9,764,656	102.4%	102.1%	-0.3%
LHN117 - Sydney Children's Hospitals Network	94,370	49,272,660	48,500,873	47,213,654	101.6%	104.4%	2.8%
LHN118 - St Vincent's Health Network	47,635	34,867,348	33,172,036	33,367,325	105.1%	104.5%	-0.6%
LHN203 - Ballarat Health Services	54,681	30,523,185	33,214,339	33,267,400	91.9%	91.8%	-0.1%
LHN209 - Western Health (Vic)	140,005	99,466,158	88,020,168	88,133,131	113.0%	112.9%	-0.1%
LHN210 - Bendigo Health Care Group	49,993	29,191,162	31,991,159	31,983,318	91.2%	91.3%	0.0%
LHN212 - Swan Hill District Health	12,707	7,479,273	7,030,503	7,022,219	106.4%	106.5%	0.1%
LHN223 - Royal Children's Hospital (Melbourne)	78,120	37,955,910	40,939,318	39,854,229	92.7%	95.2%	2.5%
LHN224 - Royal Women's Hospital (Melbourne)	27,741	9,676,824	12,947,122	12,728,800	74.7%	76.0%	1.3%
LHN225 - Melbourne Health	74,013	53,900,763	54,021,720	54,289,237	99.8%	99.3%	-0.5%
LHN226 - Northern Health (Vic)	91,654	64,160,722	64,388,169	64,491,769	99.6%	99.5%	-0.2%
LHN231 - Barwon Health	69,701	41,846,842	46,946,742	46,946,609	89.1%	89.1%	0.0%
LHN234 - Eastern Health (Vic)	166,446	105,843,698	111,870,021	111,928,109	94.6%	94.6%	0.0%
LHN235 - Goulburn Valley Health	31,743	24,372,950	20,387,561	20,397,361	119.5%	119.5%	-0.1%
LHN243 - Northeast Health Wangaratta	24,418	7,357,556	14,809,326	14,829,248	49.7%	49.6%	-0.1%
LHN249 - Albury Wodonga Health	28,516	11,472,447	15,158,235	15,124,927	75.7%	75.9%	0.2%
LHN252 - West Gippsland Healthcare Group	21,950	14,688,367	12,569,377	12,550,311	116.9%	117.0%	0.2%
LHN253 - Bass Coast Regional Health	15,255	9,880,084	9,143,294	9,147,586	108.1%	108.0%	-0.1%
LHN256 - Bairnsdale Regional Health Service	20,662	14,491,211	12,390,940	12,417,913	117.0%	116.7%	-0.3%
LHN259 - Central Gippsland Health Service	15,967	6,759,533	9,187,087	9,199,466	73.6%	73.5%	-0.1%
LHN260 - Latrobe Regional Hospital	33,844	17,827,008	20,389,641	20,427,434	87.4%	87.3%	-0.2%
LHN262 - St Vincent's Hospital (Melbourne) Limited	46,120	28,940,838	31,154,801	31,314,935	92.9%	92.4%	-0.5%
LHN263 - Royal Victorian Eye and Ear Hospital	40,711	10,073,731	15,309,968	15,492,817	65.8%	65.0%	-0.8%
LHN266 - Austin Health (Vic)	83,616	51,266,750	56,507,580	56,594,604	90.7%	90.6%	-0.1%
LHN267 - Mercy Public Hospital Inc. (Vic)	54,326	25,551,117	30,205,135	30,120,631	84.6%	84.8%	0.2%
LHN268 - Alfred Health (Vic)	99,076	77,766,806	69,892,658	70,134,864	111.3%	110.9%	-0.4%
LHN269 - Monash Health	220,884	118,314,568	153,095,227	152,964,598	77.3%	77.3%	0.1%
LHN270 - Peninsula Health (Vic)	94,791	41,293,113	65,986,527	66,078,514	62.6%	62.5%	-0.1%
LHN275 - Wimmera Health Care Group	14,289	5,479,161	8,072,142	8,063,361	67.9%	68.0%	0.1%
LHN279 - Mildura Base Hospital	32,068	9,580,952	17,492,291	17,506,052	54.8%	54.7%	0.0%
LHN282 - Western District Health Service (Vic)	7,053	2,985,474	4,190,281	4,197,717	71.2%	71.1%	-0.1%
LHN284 - South West Healthcare (Vic)	24,438	9,894,798	14,651,288	14,641,264	67.5%	67.6%	0.0%
LHN312 - Cairns and Hinterland	130,090	85,562,551	81,738,658	82,077,352	104.7%	104.2%	-0.4%
LHN313 - Townsville	78,957	53,849,246	52,610,951	52,753,806	102.4%	102.1%	-0.3%
LHN314 - Mackay	57,142	35,106,260	36,424,506	36,492,033	96.4%	96.2%	-0.2%
LHN315 - North West (Qld)	29,042	18,997,128	18,870,154	18,897,606	100.7%	100.5%	-0.1%
LHN316 - Central Queensland	99,270	49,925,610	61,327,955	61,348,043	81.4%	81.4%	0.0%
LHN318 - Wide Bay	105,709	46,745,237	67,287,961	67,351,507	69.5%	69.4%	-0.1%
LHN319 - Sunshine Coast	96,089	80,666,050	66,487,067	66,490,624	121.3%	121.3%	0.0%
LHN320 - Metro North (Qld)	286,191	202,441,737	193,538,473	193,549,666	104.6%	104.6%	0.0%
LHN321 - Children's Health Queensland	66,028	44,106,545	40,631,946	39,562,846	108.6%	111.5%	2.9%
LHN322 - Metro South (Qld)	274,060	182,166,509	192,440,692	192,970,467	94.7%	94.4%	-0.3%
LHN323 - Gold Coast	157,051	108,312,784	115,955,076	115,973,327	93.4%	93.4%	0.0%
LHN324 - West Moreton	61,854	32,140,284	43,382,555	43,400,505	74.1%	74.1%	0.0%
LHN325 - Darling Downs	99,009	56,137,535	59,253,883	59,250,372	94.7%	94.7%	0.0%
LHN326 - South West (Qld)	8,879	4,720,693	4,586,039	4,578,496	102.9%	103.1%	0.2%
LHN328 - Mater Misericordiae Health	41,741	25,590,286	27,137,930	27,226,140	94.3%	94.0%	-0.3%
LHN401 - Northern Adelaide	105,682	72,032,860	74,450,035	74,481,598	96.8%	96.7%	0.0%
LHN402 - Central Adelaide	121,352	94,023,092	91,137,797	91,695,305	103.2%	102.5%	-0.6%
LHN403 - Southern Adelaide	124,827	77,303,152	88,266,848	88,244,638	87.6%	87.6%	0.0%
LHN404 - Country Health SA	88,762	39,187,239	49,459,426	49,478,795	79.2%	79.2%	0.0%
LHN405 - Women's and Children's Health Network (SA)	45,986	27,585,025	27,207,131	26,490,075	101.4%	104.1%	2.7%
LHN501 - North Metropolitan Health Service (WA)	79,096	67,586,820	58,129,904	58,311,811	116.3%	115.9%	-0.4%
LHN502 - South Metropolitan Health Service (WA)	154,288	120,058,690	100,717,956	100,673,209	119.2%	119.3%	0.1%
LHN503 - WA Country Health Service	248,391	199,790,188	150,360,947	150,630,541	132.9%	132.6%	-0.2%
LHN504 - East Metropolitan Health Service (WA)	126,005	110,789,676	84,488,141	84,728,270	131.1%	130.8%	-0.4%
LHN580 - Child Adolescent Health Service (WA)	58,780	34,086,852	32,245,471	31,390,615	105.7%	108.6%	2.9%
LHN604 - Tasmanian Health Service	130,698	91,919,404	80,140,894	80,268,127	114.7%	114.5%	-0.2%
LHN701 - Top End (NT)	85,937	62,850,462	58,344,660	58,774,152	107.7%	106.9%	-0.8%
LHN702 - Central Australia (NT)	59,070	35,993,036	44,809,191	45,228,242	80.3%	79.6%	-0.7%
LHN801 - Australian Capital Territory	143,783	100,939,218	89,823,834	89,721,724	112.4%	112.5%	0.1%

Specialist paediatric adjustment (Non-Admitted)

	2016/17 Data		Predicted Cost (pre stabilisation)		Cost Ratio		
Local Hospital Network	Number of Separations	In Scope Cost	NEP19	Alternative	NEP19	Alternative	Difference
LHN101 - South Eastern Sydney	484,605	105,695,478	121,782,394	119,546,006	86.8%	88.4%	1.6%
LHN102 - Sydney	420,046	110,248,770	112,809,030	110,737,427	97.7%	99.6%	1.8%
LHN103 - South Western Sydney	682,875	132,341,188	173,945,161	170,750,867	76.1%	77.5%	1.4%
LHN104 - Western Sydney	678,644	149,876,128	175,658,908	172,433,142	85.3%	86.9%	1.6%
LHN105 - Nepean Blue Mountains	348,330	70,922,374	81,714,459	80,213,871	86.8%	88.4%	1.6%
LHN106 - Northern Sydney	475,509	110,648,050	114,134,038	112,038,103	96.9%	98.8%	1.8%
LHN107 - Central Coast	398,507	79,179,434	92,792,473	91,088,450	85.3%	86.9%	1.6%
LHN108 - Illawarra Shoalhaven	287,182	75,558,427	80,539,627	79,060,613	93.8%	95.6%	1.8%
LHN109 - Hunter New England	859,997	187,150,193	219,156,583	221,192,858	85.4%	84.6%	-0.8%
LHN110 - Mid North Coast	211,012	38,259,362	50,987,147	50,050,829	75.0%	76.4%	1.4%
LHN111 - Northern NSW	152,841	30,987,622	36,097,456	35,434,569	85.8%	87.5%	1.6%
LHN112 - Western NSW	298,766	62,984,897	79,102,551	77,649,927	79.6%	81.1%	1.5%
LHN113 - Southern NSW	66,313	11,610,833	13,085,912	12,845,605	88.7%	90.4%	1.7%
LHN114 - Murrumbidgee	85,550	15,467,707	17,937,350	17,607,952	86.2%	87.8%	1.6%
LHN115 - Far West	36,317	6,968,181	8,346,746	8,193,468	83.5%	85.0%	1.6%
LHN117 - Sydney Children's Hospitals Network	296,265	83,723,804	77,895,490	97,589,386	107.5%	85.8%	-21.7%
LHN118 - St Vincent's Health Network	140,390	29,874,470	40,485,102	39,741,641	73.8%	75.2%	1.4%
LHN203 - Ballarat Health Services	68,828	13,177,678	18,457,760	18,118,806	71.4%	72.7%	1.3%
LHN209 - Western Health (Vic)	239,158	47,722,207	57,752,966	56,692,402	82.6%	84.2%	1.5%
LHN210 - Bendigo Health Care Group	80,410	13,769,164	19,017,065	18,667,840	72.4%	73.8%	1.4%
LHN223 - Royal Children's Hospital (Melbourne)	188,220	49,612,365	49,987,543	62,702,858	99.2%	79.1%	-20.1%
LHN224 - Royal Women's Hospital (Melbourne)	163,254	41,993,448	39,020,482	38,303,918	107.6%	109.6%	2.0%
LHN225 - Melbourne Health	165,291	30,982,485	45,599,764	44,762,379	67.9%	69.2%	1.3%
LHN226 - Northern Health (Vic)	189,444	33,279,320	46,872,272	46,011,519	71.0%	72.3%	1.3%
LHN231 - Barwon Health	130,179	24,290,320	28,994,880	28,462,423	83.8%	85.3%	1.6%
LHN234 - Eastern Health (Vic)	252,818	40,364,101	64,373,193	63,191,057	62.7%	63.9%	1.2%
LHN235 - Goulburn Valley Health	38,604	4,805,871	8,201,398	8,050,789	58.6%	59.7%	1.1%
LHN249 - Albury Wodonga Health	8,780	1,664,609	1,671,487	1,640,792	99.6%	101.5%	1.9%
LHN262 - St Vincent's Hospital (Melbourne) Limited	111,753	11,798,171	31,438,664	30,861,330	37.5%	38.2%	0.7%
LHN263 - Royal Victorian Eye and Ear Hospital	103,188	26,002,965	21,082,119	20,694,971	123.3%	125.6%	2.3%
LHN266 - Austin Health (Vic)	256,022	52,194,871	65,763,530	64,555,861	79.4%	80.9%	1.5%
LHN267 - Mercy Public Hospital Inc. (Vic)	83,018	13,863,290	20,560,999	20,183,421	67.4%	68.7%	1.3%
LHN268 - Alfred Health (Vic)	198,629	24,188,667	51,823,179	50,871,508	46.7%	47.5%	0.9%
LHN269 - Monash Health	381,484	114,295,888	97,980,900	99,126,010	116.7%	115.3%	-1.3%
LHN270 - Peninsula Health (Vic)	103,019	23,776,887	24,523,333	24,072,991	97.0%	98.8%	1.8%
LHN312 - Cairns and Hinterland	245,649	66,902,519	65,394,379	64,193,490	102.3%	104.2%	1.9%
LHN313 - Townsville	234,658	60,673,710	62,632,683	64,047,779	96.9%	94.7%	-2.1%
LHN314 - Mackay	162,007	34,972,549	36,963,615	36,284,823	94.6%	96.4%	1.8%
LHN315 - North West (Qld)	31,951	4,987,237	9,350,879	9,179,162	53.3%	54.3%	1.0%
LHN316 - Central Queensland	157,553	34,327,005	45,111,754	44,283,330	76.1%	77.5%	1.4%
LHN318 - Wide Bay	206,748	51,268,098	51,657,985	50,709,348	99.2%	101.1%	1.9%
LHN319 - Sunshine Coast	207,991	60,516,206	50,713,293	49,782,004	119.3%	121.6%	2.2%
LHN320 - Metro North (Qld)	852,624	248,769,801	227,683,957	223,502,814	109.3%	111.3%	2.0%
LHN321 - Children's Health Queensland	210,607	79,480,888	53,160,928	66,745,263	149.5%	119.1%	-30.4%
LHN322 - Metro South (Qld)	709,760	139,343,440	195,202,969	191,618,300	71.4%	72.7%	1.3%
LHN323 - Gold Coast	542,252	157,881,217	138,650,018	136,103,877	113.9%	116.0%	2.1%
LHN324 - West Moreton	173,732	44,731,730	37,267,486	36,583,113	120.0%	122.3%	2.2%
LHN325 - Darling Downs	202,744	33,947,503	48,999,737	48,099,916	69.3%	70.6%	1.3%
LHN326 - South West (Qld)	17,186	7,205,461	3,838,206	3,767,722	187.7%	191.2%	3.5%
LHN328 - Mater Misericordiae Health	74,349	14,798,354	19,055,233	18,705,306	77.7%	79.1%	1.5%
LHN401 - Northern Adelaide	193,305	62,979,265	52,945,812	51,973,525	119.0%	121.2%	2.2%
LHN402 - Central Adelaide	455,418	224,167,783	135,759,146	133,266,092	165.1%	168.2%	3.1%
LHN403 - Southern Adelaide	383,728	101,846,214	98,287,201	96,482,275	103.6%	105.6%	1.9%
LHN404 - Country Health SA	163,046	30,791,936	47,116,464	46,251,227	65.4%	66.6%	1.2%
LHN405 - Women's and Children's Health Network (SA)	203,995	59,127,266	47,932,237	50,447,628	123.4%	117.2%	-6.2%
LHN501 - North Metropolitan Health Service (WA)	478,709	126,351,171	119,304,505	117,113,621	105.9%	107.9%	2.0%
LHN502 - South Metropolitan Health Service (WA)	485,966	121,207,970	125,029,679	122,733,659	96.9%	98.8%	1.8%
LHN503 - WA Country Health Service	297,093	72,395,327	73,844,818	72,488,746	98.0%	99.9%	1.8%
LHN504 - East Metropolitan Health Service (WA)	317,347	84,935,321	77,283,711	75,864,488	109.9%	112.0%	2.1%
LHN580 - Child Adolescent Health Service (WA)	156,869	69,987,361	43,301,609	54,336,398	161.6%	128.8%	-32.8%
LHN604 - Tasmanian Health Service	333,143	75,582,888	73,133,897	71,790,881	103.3%	105.3%	1.9%
LHN701 - Top End (NT)	198,033	82,910,495	60,039,676	58,937,119	138.1%	140.7%	2.6%
LHN702 - Central Australia (NT)	58,718	32,014,616	20,921,925	20,537,719	153.0%	155.9%	2.9%
LHN801 - Australian Capital Territory	558,693	171,266,508	134,213,777	131,749,102	127.6%	130.0%	2.4%

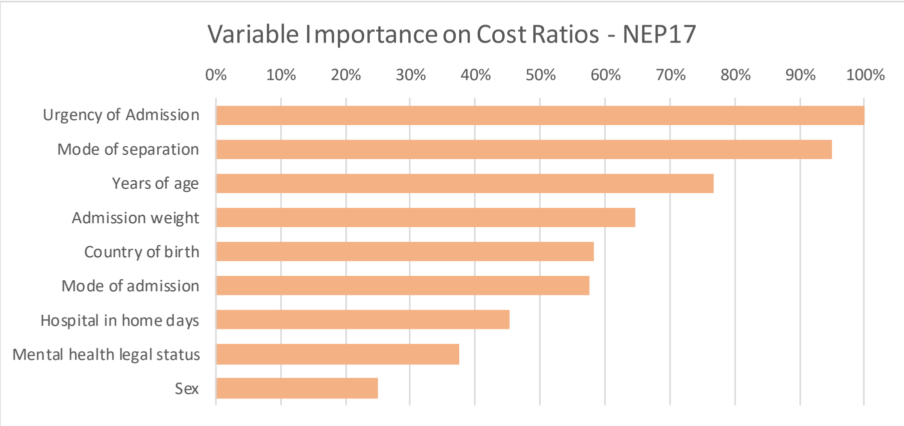
Stabilisation of Same Day Price Weight and Specialist Paediatric Adjustment (Acute)

Local Hospital Network	2016/17 Data Number of Separations	In Scope Cost	Predicted Cost (prior to stabilisation) NEP19	Alternative	Cost Ratio NEP19	Alternative	Difference
LHN101 - South Eastern Sydney	155,763	887,043,230	908,283,906	908,396,175	97.7%	97.6%	0.0%
LHN102 - Sydney	152,444	837,689,804	897,951,752	898,054,279	93.3%	93.3%	0.0%
LHN103 - South Western Sydney	210,936	980,617,644	983,423,998	983,549,847	99.7%	99.7%	0.0%
LHN104 - Western Sydney	156,311	863,205,330	847,005,850	847,087,816	101.9%	101.9%	0.0%
LHN105 - Nepean Blue Mountains	80,482	379,340,506	394,031,499	394,084,992	96.3%	96.3%	0.0%
LHN106 - Northern Sydney	133,627	796,170,581	781,480,861	781,550,665	101.9%	101.9%	0.0%
LHN107 - Central Coast	82,225	404,094,858	380,513,383	380,548,569	106.2%	106.2%	0.0%
LHN108 - Illawarra Shoalhaven	81,949	439,654,771	455,689,934	455,732,474	96.5%	96.5%	0.0%
LHN109 - Hunter New England	202,684	1,022,744,048	1,026,577,812	1,026,623,900	99.6%	99.6%	0.0%
LHN110 - Mid North Coast	68,064	305,402,814	308,437,741	308,469,822	99.0%	99.0%	0.0%
LHN111 - Northern NSW	88,992	387,182,491	401,019,865	401,053,250	96.5%	96.5%	0.0%
LHN112 - Western NSW	65,698	296,455,342	307,773,015	307,796,132	96.3%	96.3%	0.0%
LHN113 - Southern NSW	43,895	185,656,752	168,702,722	168,724,834	110.0%	110.0%	0.0%
LHN114 - Murrumbidgee	47,105	225,495,256	219,794,430	219,809,790	102.6%	102.6%	0.0%
LHN115 - Far West	7,777	42,366,549	36,668,096	36,671,139	115.5%	115.5%	0.0%
LHN117 - Sydney Children's Hospitals Network	47,856	378,149,645	387,693,507	387,096,510	97.5%	97.7%	0.2%
LHN118 - St Vincent's Health Network	39,912	281,380,274	260,757,226	260,770,030	107.9%	107.9%	0.0%
LHN202 - East Grampians Health Service	5,231	16,871,367	16,827,777	16,830,771	100.3%	100.2%	0.0%
LHN203 - Ballarat Health Services	40,854	153,048,502	180,386,133	180,397,799	84.8%	84.8%	0.0%
LHN204 - Stawell Regional Health	3,954	15,188,946	14,750,518	14,752,270	103.0%	103.0%	0.0%
LHN207 - Maryborough District Health Service	5,320	12,997,845	17,668,916	17,670,509	73.6%	73.6%	0.0%
LHN209 - Western Health (Vic)	123,434	394,717,243	485,209,165	485,265,964	81.3%	81.3%	0.0%
LHN210 - Bendigo Health Care Group	41,041	166,685,827	188,241,219	188,263,298	88.5%	88.5%	0.0%
LHN212 - Swan Hill District Health	6,627	26,438,948	29,600,085	29,604,098	89.3%	89.3%	0.0%
LHN221 - Castlemaine Health	4,478	15,923,909	18,365,486	18,369,041	86.7%	86.7%	0.0%
LHN223 - Royal Children's Hospital (Melbourne)	48,775	353,774,141	339,202,241	338,719,460	104.3%	104.4%	0.1%
LHN224 - Royal Women's Hospital (Melbourne)	26,496	167,929,874	164,179,900	164,162,173	102.3%	102.3%	0.0%
LHN225 - Melbourne Health	95,577	462,087,520	499,106,505	499,120,147	92.6%	92.6%	0.0%
LHN226 - Northern Health (Vic)	86,382	258,694,484	316,530,760	316,567,244	81.7%	81.7%	0.0%
LHN231 - Barwon Health	82,575	314,100,499	358,924,534	358,962,739	87.5%	87.5%	0.0%
LHN234 - Eastern Health (Vic)	153,756	503,770,294	589,565,510	589,627,148	85.4%	85.4%	0.0%
LHN235 - Goulburn Valley Health	29,959	102,239,310	107,029,751	107,032,922	95.5%	95.5%	0.0%
LHN236 - Kyabram and District Health Service	4,642	14,427,678	13,944,878	13,946,943	103.5%	103.4%	0.0%
LHN243 - Northeast Health Wangaratta	17,546	63,712,150	69,543,831	69,553,932	91.6%	91.6%	0.0%
LHN247 - Benalla and District Memorial Hospital	3,752	16,492,262	18,855,690	18,858,552	87.5%	87.5%	0.0%
LHN249 - Albury Wodonga Health	18,632	66,880,877	63,331,894	63,334,001	105.6%	105.6%	0.0%
LHN252 - West Gippsland Healthcare Group	11,547	44,049,094	51,356,198	51,367,340	85.8%	85.8%	0.0%
LHN253 - Bass Coast Regional Health	7,690	23,031,089	26,455,922	26,457,819	87.1%	87.0%	0.0%
LHN254 - Gippsland Southern Health Service	3,521	17,886,608	15,114,252	15,116,871	118.3%	118.3%	0.0%
LHN256 - Bairnsdale Regional Health Service	15,515	40,405,002	50,787,030	50,794,185	79.6%	79.5%	0.0%
LHN259 - Central Gippsland Health Service	12,150	51,088,614	46,727,540	46,728,162	109.3%	109.3%	0.0%
LHN260 - Latrobe Regional Hospital	33,760	117,898,996	131,373,850	131,392,662	89.7%	89.7%	0.0%
LHN262 - St Vincent's Hospital (Melbourne) Limited	58,958	291,252,935	329,978,418	330,018,731	88.3%	88.3%	0.0%
LHN263 - Royal Victorian Eye and Ear Hospital	15,049	63,717,824	66,328,092	66,352,539	96.1%	96.0%	0.0%
LHN264 - Peter MacCallum Cancer Institute (Vic)	34,805	141,410,220	112,247,091	112,200,145	126.0%	126.0%	0.1%
LHN266 - Austin Health (Vic)	103,164	437,946,347	478,476,723	478,536,371	91.5%	91.5%	0.0%
LHN267 - Mercy Public Hospital Inc. (Vic)	47,749	218,775,903	238,494,045	238,512,316	91.7%	91.7%	0.0%
LHN268 - Alfred Health (Vic)	107,868	543,174,732	642,036,278	642,096,627	84.6%	84.6%	0.0%
LHN269 - Monash Health	245,130	859,908,419	1,029,934,673	1,029,874,581	83.5%	83.5%	0.0%
LHN270 - Peninsula Health (Vic)	78,500	315,730,795	339,368,316	339,405,815	93.0%	93.0%	0.0%
LHN275 - Wimmera Health Care Group	11,172	51,542,271	52,908,433	52,914,991	97.4%	97.4%	0.0%
LHN279 - Mildura Base Hospital	19,276	69,910,555	71,889,157	71,892,708	97.2%	97.2%	0.0%
LHN282 - Western District Health Service (Vic)	6,598	34,405,332	33,130,162	33,133,388	103.8%	103.8%	0.0%
LHN284 - South West Healthcare (Vic)	21,295	90,794,585	82,700,656	82,711,731	109.8%	109.8%	0.0%
LHN288 - Portland District Health	4,799	22,951,192	20,626,004	20,628,854	111.3%	111.3%	0.0%
LHN312 - Cairns and Hinterland	88,833	367,637,178	383,999,558	384,046,976	95.7%	95.7%	0.0%
LHN313 - Townsville	75,793	378,122,030	406,521,466	406,526,373	93.0%	93.0%	0.0%
LHN314 - Mackay	43,610	156,745,714	170,176,777	170,193,842	92.1%	92.1%	0.0%
LHN315 - North West (Qld)	7,439	51,538,080	38,921,811	38,930,373	132.4%	132.4%	0.0%
LHN316 - Central Queensland	55,975	195,369,228	196,922,001	196,941,037	99.2%	99.2%	0.0%
LHN318 - Wide Bay	68,165	260,688,613	235,748,730	235,752,925	110.6%	110.6%	0.0%
LHN319 - Sunshine Coast	86,272	342,446,935	330,491,575	330,513,656	103.6%	103.6%	0.0%
LHN320 - Metro North (Qld)	249,187	1,273,353,452	1,322,731,984	1,322,808,510	96.3%	96.3%	0.0%
LHN321 - Children's Health Queensland	39,930	307,773,834	277,796,592	277,185,499	110.8%	111.0%	0.2%
LHN322 - Metro South (Qld)	236,576	1,104,745,483	1,015,721,889	1,015,878,904	108.8%	108.7%	0.0%
LHN323 - Gold Coast	149,650	693,704,458	636,955,361	637,004,125	108.9%	108.9%	0.0%
LHN324 - West Moreton	53,413	214,196,234	202,913,257	202,935,796	105.6%	105.5%	0.0%
LHN325 - Darling Downs	64,733	240,338,533	257,814,264	257,861,786	93.2%	93.2%	0.0%
LHN326 - South West (Qld)	3,184	7,337,034	10,741,294	10,741,705	68.3%	68.3%	0.0%
LHN328 - Mater Misericordiae Health	57,725	260,147,278	272,619,498	272,655,931	95.4%	95.4%	0.0%
LHN401 - Northern Adelaide	65,315	267,500,933	307,685,439	307,698,940	86.9%	86.9%	0.0%
LHN402 - Central Adelaide	124,550	807,486,871	719,696,797	719,753,806	112.2%	112.2%	0.0%
LHN403 - Southern Adelaide	94,507	518,384,531	512,011,189	512,042,019	101.2%	101.2%	0.0%
LHN404 - Country Health SA	76,703	246,922,898	247,777,730	247,800,574	99.7%	99.6%	0.0%
LHN405 - Women's and Children's Health Network (SA)	32,157	198,810,577	198,212,885	198,012,716	100.3%	100.4%	0.1%
LHN501 - North Metropolitan Health Service (WA)	120,960	777,074,513	618,685,838	618,739,065	125.6%	125.6%	0.0%
LHN502 - South Metropolitan Health Service (WA)	142,118	904,189,667	686,237,096	686,248,508	131.8%	131.8%	0.0%
LHN503 - WA Country Health Service	120,082	482,894,299	429,286,146	429,325,823	112.5%	112.5%	0.0%
LHN504 - East Metropolitan Health Service (WA)	103,138	628,124,438	527,389,478	527,412,830	119.1%	119.1%	0.0%
LHN580 - Child Adolescent Health Service (WA)	27,614	199,605,628	165,553,549	165,158,520	120.6%	120.9%	0.3%
LHN604 - Tasmanian Health Service	109,861	603,085,489	599,133,809	599,206,052	100.7%	100.6%	0.0%
LHN701 - Top End (NT)	87,895	381,806,356	352,187,409	352,240,497	108.4%	108.4%	0.0%
LHN702 - Central Australia (NT)	68,098	176,277,599	202,776,307	202,802,564	86.9%	86.9%	0.0%
LHN801 - Australian Capital Territory	110,902	620,088,639	537,195,644	537,294,182	115.4%	115.4%	0.0%

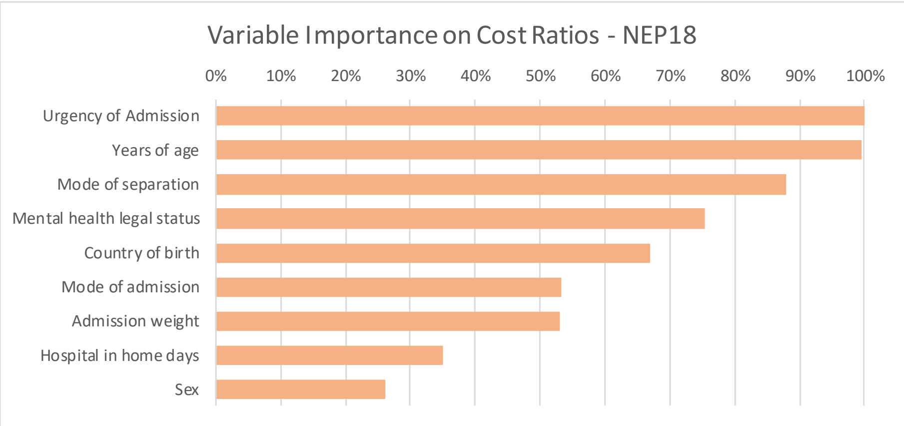
Appendix F Variable Importance Results

This appendix shows the variable importance results from the regression tree analysis. These charts show the relative importance of each variable in explaining the cost ratio (i.e. variation that is currently unexplained). These are expressed as percentages of the most important variable, so the most important variable will always have an importance score of 100%.

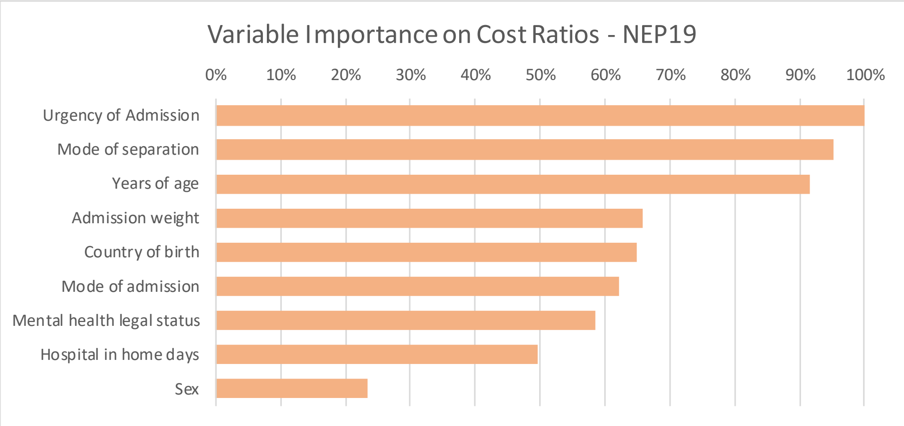
Acute Model – NEP17 Data



Acute Model – NEP18 Data



Acute Model – NEP19 Data


Variable Importance on Cost Ratios - NEP19
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Urgency of Admission
Mode of separation
Years of age
Admission weight
Country of birth
Mode of admission
Mental health legal status
Hospital in home days
Sex

Appendix G Cost Bucket Groups for Indexation

This appendix contains a listing of the cost bucket groups used in the indexation analysis, and the proportion of costs in each group (based on NHCDC 2016-17 data).

			NHCDC Cost (2016/17)	
Cost Bucket	**Cost Bucket Description**	**Cost Bucket Group**	**$M**	**%**
WardMedDir	Ward Medical Direct Cost	Salaries and Wages	3,046.0	11.6%
WardNursDir	Ward Nursing Direct Cost	Salaries and Wages	4,985.7	18.9%
NonClinicalDir	Non-clinical Salaries Direct Cost	Salaries and Wages	600.1	2.3%
PathDir	Pathology Direct Cost	Other	851.9	3.2%
ImagDir	Imaging Direct Cost	Other	576.1	2.2%
AlliedDir	Allied Health Direct Cost	Salaries and Wages	680.1	2.6%
PharmDir	Pharmacy Direct Cost	Other	996.9	3.8%
CriticalDir	Critical Care Direct Cost	Other	1,682.0	6.4%
ORDir	Operating Rooms Direct Cost	Other	3,265.7	12.4%
WardSuppliesDir	Ward Supplies and Other Overheads Direct Cost	Other	931.1	3.5%
SPSDir	Specialist Procedure Suites Direct Cost	Other	260.7	1.0%
ProsDir	Prostheses Direct Cost	Prostheses	838.3	3.2%
OncostsDir	On-costs Direct Cost	Other	1,608.5	6.1%
HotelDir	Hotel Direct Cost	Other	341.4	1.3%
WardMedOhd	Ward Medical Overhead Cost	Salaries and Wages	173.4	0.7%
WardNursOhd	Ward Nursing Overhead Cost	Salaries and Wages	377.6	1.4%
NonClinicalOhd	Non-clinical Salaries Overhead Cost	Salaries and Wages	1,201.7	4.6%
PathOhd	Pathology Overhead Cost	Other	131.0	0.5%
ImagOhd	Imaging Overhead Cost	Other	96.0	0.4%
AlliedOhd	Allied Health Overhead Cost	Salaries and Wages	245.7	0.9%
PharmOhd	Pharmacy Overhead Cost	Other	68.7	0.3%
CriticalOhd	Critical Care Overhead Cost	Other	399.4	1.5%
OROhd	Operating Rooms Overhead Cost	Other	745.5	2.8%
WardSuppliesOhd	Ward Supplies and Other Overheads Direct Cost	Other	1,192.1	4.5%
SPSOhd	Specialist Procedure Suites Overhead Cost	Other	49.9	0.2%
ProsOhd	Prostheses Overhead Cost	Prostheses	2.4	0.0%
OncostsOhd	On-costs Overhead Cost	Other	503.1	1.9%
HotelOhd	Hotel Overhead Cost	Other	519.8	2.0%
		Salaries and Wages	11,310.3	42.9%
		Prostheses	840.8	3.2%
		Other	14,219.7	53.9%
		Total	26,370.7	100.0%

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