Introduction to the Price Setting Process for Admitted Patients V1.0 26May2015

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HEALTHCARE PRICING OFFICE

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Acronyms and Abbreviations

ABF	Activity based funding
ACHI	Australian Classification of Health Interventions
ACS	Australian coding standards
AFS	Annual Financial Statement
ALOS	Average length of stay
AR-DRG	Australian Refined Diagnosis Related Group
CMI	Casemix Index
CMU	Casemix Unit
CTV	Cost to Value
DoH	Department of Health
ED	Emergency Department
GL	General Ledger
HIPE	Hospital Inpatient Enquiry
HPO	Healthcare Pricing Office
HSE	Health Service Executive
ICD-10-AM	International Classification of Diseases-10-Australian Modification
ICS	Irish coding standards
IQR	Inter-quartile range
LOS	Length of stay
MDC	Major Diagnostic Category
MFTP	Money Follows the Patient
NPRS	National Perinatal Reporting System
PLC	Patient level costing
PPM	Power Performance Manager
RV	Relative Value
Q1	First quartile
Q3	Third quartile

1 INTRODUCTION

The purpose of this document is to provide an introduction to the methodologies used in the setting of prices used in the Activity Based Funding (ABF) process. The document relates specifically to price setting for the acute admitted setting and excludes the outpatient (OPD) and emergency department (ED) settings. The document introduces terminology associated with ABF and Casemix systems and gives worked examples to illustrate the concepts. It then goes on to show how these concepts are used to generate prices for funding activity in the acute admitted setting again with worked examples throughout. The document is aimed at those interested in understanding the concepts and methodologies underpinning the ABF price setting process and should be of particular relevance to healthcare commissioners and managers, financial managers, costing staff, hospital managers and those involved in the provision of healthcare in the acute admitted setting.

1.1 Money Follows the Patient

In 2013 the Department of Health (DoH) published a consultation paper entitled "Money Follows the Patient - Policy Paper on Hospital Funding" which set out a new policy in relation to the funding of healthcare in Ireland.[1] In particular the document outlines a move to activity based funding (ABF) where healthcare providers are funded based on the number and type of patients they treat rather than through a block grant system. The policy objectives of moving to this payment system are to

- ensure a **fairer** system of resource allocation where hospitals are paid for the quality care they deliver,
- drive **efficiency** in the provision of high quality hospital services,
- increase **transparency** in the provision of hospital services, and
- ultimately, support the move to an **equitable**, single-tier universal health insurance system where every patient is insured and has their care financed on the same basis.

The phased implementation of MFTP commenced on 01 January 2014 in 38 publicly funded acute hospitals.

1.2 Activity Based Funding

Activity based funding (ABF) is a general term for the provision of funding to hospitals based on the number and mix of patients that they treat. In an ABF scheme a hospital receives a payment for each patient encounter. The exact payment for a given encounter depends on the type and complexity of the individual case. Typically in such a system the amount of activity that a hospital can carry out, and therefore its maximum available funding, is capped in order to preserve the overall health budget.

ABF offers several advantages over block grant financing of hospitals whereby a hospital is allocated a set budget at the beginning of each year. These advantages include:

[1] Full details of the policy proposals are described in "Money Follows the Patient - Policy Paper on Hospital Funding" which is available at http://www.dohc.ie/publications/pdf/MoneyFollowsthePatient_HFPP.pdf?direct=1.

- Transparency – The allocation of funding to hospitals under ABF is based on the number and type of patients treated along with a set of published prices.
- Equity – Hospitals which carry out similar levels of work can expect similar levels of funding
- Efficiency – The payment mechanisms used in ABF systems are designed to incentivise more efficient provision of care

1.3 The Healthcare Pricing Office

The Healthcare Pricing Office (HPO) is responsible for setting the prices to be used in the MFTP funding process. The HPO was established on 01 January 2014 as a section in the Finance Directorate of the Health Service Executive (HSE) and is comprised of staff from the former Health Research and Information Division (HRID) of the Economic and Social Research Institute (ESRI) and the National Casemix Programme (NCP).

Although the HPO currently sits within the HSE it will become an independent legal entity once legislation has been enacted to affect this change. This independence will ensure that there is full separation of the price setting and purchasing functions within the MFTP framework.

2 DATA SOURCES

There are three key data sources which form the basis for the price setting process. Each of these sources provides vital information for the generation of prices which are suitable for funding of hospitals under MFTP.

2.1 Hospital Activity: Hospital Inpatient Enquiry System (HIPE)

The Hospital Inpatient Enquiry (HIPE) system is the principal source of national data on discharges from acute hospitals in Ireland. It collects demographic, clinical and administrative data on discharges and deaths from acute hospitals nationally.[2] The national HIPE file is managed and administered by the HPO and each annual file contains around 1.5 million records gathered from 56 participating acute hospitals.[3]

Submissions to the national HIPE file are made by hospitals on a monthly basis. The submitted data are subjected to several levels of checks to ensure the quality of the data. Hospitals are expected to have each month’s discharges coded by the end of the following month. Once all queries on the national file have been resolved the file for that year is closed. These closed annual HIPE file are used in the price setting process.

Coding of clinical data on HIPE is carried out using the International Classification of Diseases – Australian Modification (ICD-10-AM) for diagnoses and Australian Coding for Health interventions (CHI) for interventions/procedures. Cases are further grouped into diagnosis related groups (DRGs) using Australian refined Diagnosis Related Groups (AR-DRG) version 6.0. Further information on

[2] Full details of the data fields collected on HIPE can be found in the HIPE data dictionary at http://www.hpo.ie/hipe/hipe_data_dictionary/HIPE_Data_Dictionary_2015_V7.0.pdf.
[3] More details of the HIPE system are available at http://www.hpo.ie.

clinical coding and classification are contained in Section 4.HIPE data are used by the DoH and the HSE in the planning, provision and measurement of acute hospital services and form the basis for setting target activity levels, monitoring current activity levels and invoicing under the MFTP funding process.

2.2 Hospital Costs (1): Specialty Costing Returns

Financial information from all hospitals being funded through ABF is captured in the annual specialty costing returns. The specialty costing process involves the allocation of all in-scope costs in a hospital down to the level of specialty and, in the case of medical pay, down to the level of individual consultant.

The starting points in the specialty costing process are the hospital's General Ledger (GL) and Annual Financial Statement (AFS). From the AFS costs which are in-scope for ABF funding are identified according to guidelines set out in the specialty costing manual. The specialty costing system provides a mechanism for costing staff in hospitals to allocate these costs to service centres and ultimately to specialties.

The specialty costing data provide a picture of the total expenditure for each hospital by treatment area (inpatient, daycase, outpatients department (OPD), emergency department (ED)) and are used in the price setting process to calibrate the prices derived from the patient level costing studies. Further details of this calibration process are contained in Section 5.3.

2.3 Hospital Costs (2): Patient Level Costing (PLC) Returns

Ireland's patient level costing programme has been in operation since 2010. Under this programme participating hospitals undertake an annual study to determine the costs associated with the treatment of each individual patient treated in that hospital over a given time period.

The starting points in the patient level costing process are the same as for the specialty costing process however, ancillary or "feeder" information systems within the hospital are also utilised to determine exactly which services were accessed by each patient. This allows the costs to be allocated down to the patient level.

Patient level costing data can be utilised by hospital management to better understand their costs and how they compare to their peers. They also form the basis for the price setting process as it is from these data that the initial cost estimates for different patient types are generated.

3 DATA QUALITY ASSURANCE

3.1 HIPE

Processes to ensure HIPE data is an accurate reflection of patient and hospital activity are wide ranging and occur before, during and after HIPE data entry. The Healthcare Pricing Office ensures that timely and accurate HIPE data are available for use through a continuous improvement cycle involving;

1. Coder training and support
2. HIPE Portal data entry system
3. Chart based coding audit
4. HIPE data reviews
5. Suite of checks at national level

1. Coder Training and Support

HIPE coders are trained at all levels and many specialities by the HPO. Any issues raised by HIPE data quality activities can be addressed in coder training and education. In addition, the HPO provides coder support in several ways with a coding query helpdesk, a dedicated email for coding queries, hospital visits and Coding Notes[4]. With approximately 250 coders working on HIPE nationally across 56[5] hospitals, coder training and support are major activities for the Coding Section of the HPO and key to the provision of high quality HIPE data.

2. HIPE Portal Data Entry System

Data entry edits and checks ensure a high standard of data before the case can be stored or exported to the HPO. As all HIPE hospitals use the same data entry system all data are subject to the same data entry and edit checks.

Data checks in the HIPE Portal system are implemented over a series of levels to guarantee the high quality of the information keyed and submitted to the national file. Checks are implemented at data field level to ensure that entered information follow specified input rules and formats. Once a complete picture of the discharge is available, a second series of checks is implemented to ensure that there is nothing unusual or non-standard in the case. In the case of diagnosis and procedure codes, checks are made at both the data field and discharge levels.

3. Chart Based Coding Audit

The HIPE Coding Audit Toolkit (HCAT)© was developed by the HPO as a tool for conducting and reporting on chart based coding audits in a standardised format. The HCAT© uses existing HIPE Portal software and is included in the HIPE portal software system. HCAT© enables efficient and consistent chart based audit. Hospitals are supported and trained in the use of this software in order to conduct chart based coding audit at hospital level and these internal audits are critical for hospitals in reviewing their own data and coding practice. The HPO perform chart based audits where and when appropriate.

4. HIPE Data Reviews

The HPO continuously reviews HIPE data at a national level. Hospitals are also encouraged to carry out regular reviews to monitor the quality of their HIPE data. The HPO has developed several tools to assist with data quality activities such as data entry validation checks, chart based audit as described above and also reviews of coded data. HIPE data from all hospitals are routinely passed through a set of standardised checks using the HIPE Checker©. The HIPE Checker© software facilitates hospitals to run these checks in an efficient manner locally and hospitals are expected to run each monthly export through the HIPE Checker© prior to each export. Many hospitals perform regular checks on HIPE data to ensure their own high standards of accuracy. The HPO within the HSE undertakes complementary reviews (see point 5 below) on the data and these checks are constantly reviewed and updated. The HPO provides HIPE training and support with data quality activities to hospitals on an on-going basis.

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[4] Coding Notes is the quarterly newsletter for coders published by the HPO. Available at www.hpo.ie.

[5] At February 2015.

5. Suite of Checks performed at national level
The HPO also perform continuous review of coded data submitted to the HIPE national file including:

Checker© Software

- Set of standardised checks
- Applied to all HIPE data from all hospitals
- Output sent to hospitals for correction
- Checker Programme is included as standard in the HIPE Portal for hospitals to perform this type of data quality review locally

Complex case checks

- Reviews of coded data (checking lists)
- Review of samples of coded data in each hospital
- Review of random sample of coded data from all new coders

Review of frequency of diagnosis and procedures

- High frequency
- Low frequency
- Between hospitals
- Within each hospital across years

Review by ARDRG

- Error AR DRGs
- Pre MDC AR DRGs
- High cost AR DRGs
- High complexity activity
- Review of each hospitals AR DRG profile
- Review of frequencies of AR DRGs
- Review of change in AR DRG activity
- Review of changes in AR DRG severity
- Chart based coding audit of areas identified as needing further review

3.2 Specialty Costing Returns

Specialty costing returns are made annually to the HPO by participating hospitals on a standard file which has been developed by HPO costing staff specifically for this purpose. The file collects both financial and activity data and allows hospital costing staff to apportion their costs down to the specialty level. The completion of the specialty costing return is supported by the Costing Standards documentation and through an annual workshop run by the HPO, which provides a forum for the exchange of information relating to the specialty costing process.

The specialty costing file contains some self-auditing functionality which allows hospitals to quickly identify any accounting or allocation errors in their file prior to submission to the HPO. Files are not accepted where the file indicates that errors are present.

Each hospital's AFS forms the basis for their specialty costing return. These are based on the final audited annual accounts and as such represent the official picture of the hospital's annual finances.

Any discrepancy between the AFS and the total cost submitted in the specialty costing return must be documented. These reconciling items are reviewed at the beginning of the review process to ensure they are valid.

As part of the review process the HPO costing team assesses each submission in terms of

- Adherence to Irish Costing Standards
- Reconciliation back to AFS
- Reconciliation of external costs (i.e. costs incurred by a hospital that don't relate to the treatment of patients in that hospital
- Year on year changes in total costs per item and patient type (inpatient, day case, outpatient, ED)
- Year on year changes in indirect cost apportionment from radiology, medical services, pathology, overheads etc.
- Year on year changes in cost per case
- Comparison of total costs, apportionments and cost per case versus national figure or similar hospitals as appropriate

Finalisation of the file is an iterative process whereby submissions are reviewed by HPO costing staff, queries are sent to the hospitals and an updated file is submitted for review. Multiple iterations are generally required to ensure the accuracy and consistency of the submission before the file is finalised and accepted by the HPO.

In addition to the annual specialty costing process, the HPO costing team also undertake on-site audits of hospitals in order to ensure adherence to costing standards and to gain insight into the reasons for hospitals' performance under ABF.

3.3 Patient Level Costing Returns

The patient level costing process involves the combination of data from many different sources and as a result there are multiple phases of data checking and validation which are carried out to ensure the integrity and accuracy of the data.

The first check on the PLC data is carried out by an applet which is distributed to hospitals by the HPO. The applet is a piece of software which is used to check the format and content of the activity files prior to submitting them for loading into the costing software. As well as checks on content and format, the applet performs a suite of integrity checks on individual data fields and consistency checks between data fields and activity files. Only when the input files have been deemed to be of sufficient quality from the applet output can they be submitted for loading into the costing software.

The costing software used to process the PLC data is Power Performance Manager (PPM). During the loading process, PPM carries out similar checks to those carried out in the applet and any activity data which returns an error is not loaded into the system. It is therefore vital that hospitals review the output from the applet to ensure that their activity files meet the specifications required by PPM.

The financial data which feeds into the PLC process is derived from each hospital's GL . Once the activity and GL information have been loaded into PPM, several checks are carried out on the GL

information to ensure that the financial data loaded into PPM matches the GL summary and makes sense. Checks include:

- Reconciliation of GL totals by account type
- Reconciliation of GL totals by cost output
- Sum of fixed and variable costs equals the total inscope cost
- Review of excluded costs

Once the reconciliation of the GL data has been carried out the cost allocation process takes place and a further extensive set of checks is applied to the output from this process. The checks carried out at this point include:

- Ensure all areas have direct costs and review items with direct costs < €10K
- Review the % of indirect to direct costs and review items > 85%
- Compare total costs by patient care area year on year
- Review overheads assigned to patient care areas e.g. ensure no catering costs allocated to non-surgical day wards etc.
- Compare patient costing amount by patient care area year on year (and run on run)
- Compare average costs by patient type year on year (and run on run)
- Compare total cost, volume and average cost year on year (and run on run) and investigate significant differences
- Checks for areas with activity but with no costs and vice versa

Queries arising from this step in the process are returned to hospitals for review and amendment as necessary. Only when the costing staff are satisfied that the data is robust and accurate is the hospital's return deemed to be final.

4 CASEMIX CONCEPTS

4.1 What is Casemix?

Casemix is the description of the mix of patients treated in a hospital which takes into account the differing complexity and resource intensity of the treatment of those patients. Describing the activity of a hospital using Casemix allows valid comparisons to be made between hospitals in terms of the cases they treat and their efficiency in treating those cases. Casemix systems rely on the use of clinical coding and of diagnosis related groups which are described in Sections 4.2.1 and 4.2.2 respectively.

4.2 Key Concepts

This Section defines the key concepts and ideas which underpin the use of a DRG system for activity based funding. Where appropriate, examples are given to illustrate the concepts and calculations involved. The data used have been generated to keep the numbers and calculations as straightforward as possible while still illustrating the key points. Throughout the document the tables presented in the examples are colour coded to highlight which data source is being used for each particular step. Blue tables indicate that the figures are based on patient level data as contained in Table A1. Turquoise tables indicate that the figures are based on specialty level data as

contained in Table A2. Green tables indicate that the figures are based on the full ABF dataset set which is a combination of patient level costing data and specialty level costing data.

The full set of data is presented in Appendix A. Unless otherwise stated, this data is used for all of the examples and derivations presented in this document.

4.2.1 Clinical Coding

Clinical coding is the translation of patients' clinical information, as recorded in the medical chart, into a standard terminology using a classification system. Clinical coding of data in Ireland is carried out using ICD-10-AM for diagnoses and ACHI for interventions. The coding of this information is carried out by a dedicated team of clinical coders within each hospital and the coded information is stored on the HIPE system along with other relevant details such as patient demographics and administrative details. This standardised information is used for many purposes including healthcare planning, research, resource allocation and clinical benchmarking.

4.2.2 Diagnosis Related Groups (DRGs)

Diagnosis Related Groups are a means of classifying patient hospital encounters into a manageable number of groups which can be used to describe the mix of cases or Casemix of the activity being carried out by a hospital. The DRGs are designed to group clinically similar cases which are expected to consume similar amounts of resources. DRGs and Casemix systems are widely used internationally to manage and fund healthcare systems as well as for performance and quality monitoring.

The AR-DRG system is used in Ireland to describe hospital activity.[6] The AR-DRG classification has a hierarchical structure. The topmost level is the Major Diagnostic Category (MDC) which categorises cases roughly along body system lines. Within MDC, cases are further partitioned into surgical, medical and other categories depending on whether the case involved an operating room (OR) procedure, a non-OR procedure or neither an OR nor a Non-OR procedure. Within these partitions, cases are assigned to Adjacent DRGs (ADRGs) which contain a number of DRGs which are generally defined by the same diagnosis or procedure lists. The DRG is the lowest level in the classification and it splits out ADRGs by differing complexity levels. Here complexity is an indication of the resource consumption associated with the cases in a DRG which may or may not correspond to a clinical interpretation of the complexity of a case.

In Ireland DRGs are used to classify inpatient activity while ADRGs, i.e. DRGs without any complexity split, are used to classify daycase activity.

There are 399 ADRGs and 698 DRGs within version 6.0 of the AR-DRG classification system. 156 of the ADRGs have no further split by complexity level while the remaining 243 ADRGs are split by complexity to make up 542 DRGs.

The DRGs are identified by a 4-character code followed by a description of the DRGs content. The first character in the code is alphabetic and refers to the MDC that the DRG belongs to. The second and third characters are numeric and they identify both the partition and the ADRG to which the DRG belongs. The fourth character identifies the complexity level associated with the DRG.

[6] More details of the AR-DRG classification can be obtained from the IHPA website at http://www.ihpa.gov.au/internet/ihpa/publishing.nsf/Content/admitted-acute.

Partitions are identified in the DRG code as follows:

- DRGs numbered 01-39 indicate that they are surgical
- DRGs numbered 40-59 indicate that they are “other”
- DRGs numbered 60-99 indicate that they are medical

Complexity levels are identified as A, B, C, D or Z where A indicates the DRG with the highest complexity level, D the DRG with the lowest complexity level and Z indicates that there is no complexity split within the ADRG. Not all ADRGs will contain DRGs corresponding to all 4 complexity levels. The precise meaning of the complexity level is specific to each ADRG and is given in the DRG description.

4.2.3 DRG Grouper

A DRG grouper is a software package which assigns episodes of care to DRGs based on the clinical and demographic information contained in the patient record. It is a software implementation of the algorithms outlined in the DRG manuals which allows for automatic allocation of cases to DRGs.

A DRG grouper is generally specific to a particular version of a clinical coding system and a particular version of the DRG system. For instance AR-DRG grouper version 6.0 is specifically designed to group cases coded using ICD-10-AM and ACHI 6th edition to AR-DRG version 6.0.

4.2.4 Average DRG Cost

The average cost per DRG is the total cost associated with the cases falling into a DRG divided by the number of cases falling within that DRG (see Table 1). As costs at the DRG level are only available from PLC data the average DRG costs are derived from this data source. We are generally concerned with setting a national DRG price based on a national average cost per DRG therefore we assess the cost by averaging across all PLC hospitals. However, average DRG costs at the hospital level are extremely useful for hospitals in understanding their own costs versus their peers. This is one of the advantages for hospitals who participate in PLC studies.

Table 1: Average DRG Cost

	DRG 1	DRG 2	All Cases
Cases	20	40	60
Total Cost	€100,000	€800,000	€900,000
Average Cost	€5,000 $=\left(\frac{€100,000}{20}\right)$	€20,000$=\left(\frac{€800,000}{40}\right)$	€15,000$=\left(\frac{€900,000}{60}\right)$

4.2.5 Relative Value (RV)

The relative value of a DRG is the average cost per case for the DRG expressed as a proportion of the average cost per case across all DRGs. RVs give us an immediate measure of the costliness of cases falling within a particular DRG relative to the average across all DRGs. As cost is a proxy for complexity it is also an indication of the relative complexity of the cases in each DRG. In Table 2 DRG 1 costs 33% of the average across all cases while DRG2 costs 133% of the average across all cases in the system.

Table 2: Relative Value

	DRG 1	DRG 2	All Cases
Average Cost	€5,000	€20,000	€15,000
Relative Value (RV)	$.33 = \left(\frac{€5,000}{€15,000}\right)$	$1.33=\left(\frac{€20,000}{€15,000}\right)$	$1 = \left(\frac{€15,000}{€15,000}\right)$

4.2.6 Weighted Units

The number of weighted units associated with a DRG is the sum of the relative values associated with the cases within that DRG. In its simplest form it is the RV multiplied by the number of cases however, there are additional complexities involved when dealing with outlier cases. This additional complexity is discussed in detail in Section 6.

The weighted unit value takes into account the number of cases along with the complexity (through the RV) and so is a complexity adjusted measure of activity. Summed up to the hospital level the weighted unit value allows us to compare the complexity adjusted activity levels in hospitals without having to explicitly reference the different mix of cases in those hospitals.

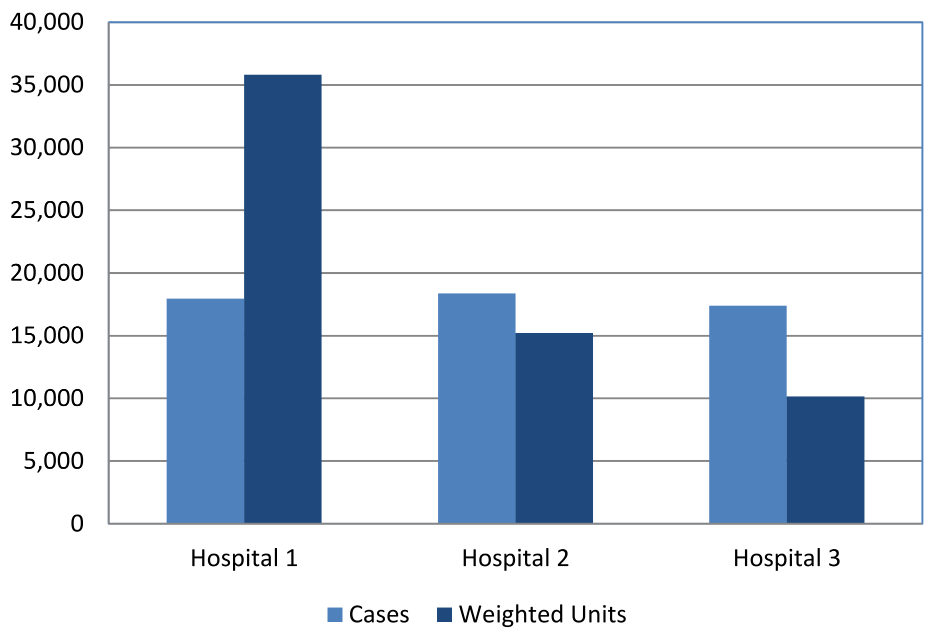
Weighted units were referred to Casemix Units (CMU) in the Irish Casemix Programme prior to the introduction of ABF.

Table 3: Weighted Units

	DRG 1	DRG 2	All Cases
Cases	20	40	60
Relative Value (RV)	.33	1.33	1
Weighted Units	6.67= $(20 * .33)$	53.33 = $(40 * 1.33)$	60 = $(60 * 1)$

Figure 1 shows the activity levels of three hospitals in terms of cases and in terms of weighted units. While the three hospitals treat very similar numbers of cases, the average complexity of the cases in hospital 1 is more than double that in the other 2 hospitals. This figure illustrates the importance of considering weighted activity levels when assessing hospital throughput.

Figure 1: Case Numbers and Weighted Activity Levels



4.2.7 Casemix Index (CMI)

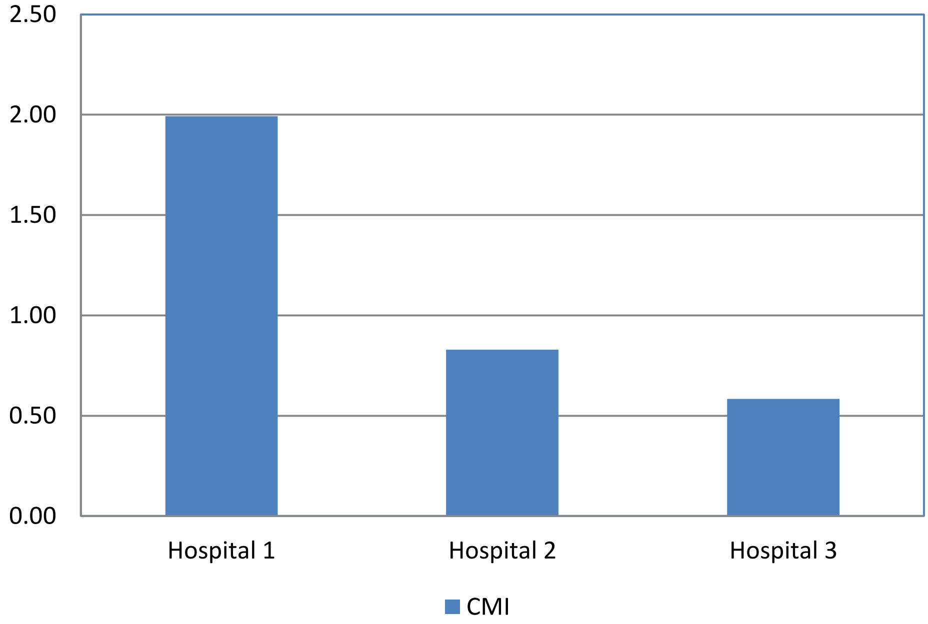
The casemix index is defined as the number of weighted units divided by the number of cases and is a measure of the average complexity of cases. It is usually computed at the hospital level to compare the average complexity of cases being treated in those hospitals. In Table 4 below, the average complexity of cases in hospital 1 is a lot higher than that in hospital 2.

Table 4: Casemix Index

	Hospital 1			Hospital 2		
	DRG 1	DRG 2	**Total**	DRG 1	DRG 2	**Total**
Cases	5	30	**35**	15	10	**25**
RV	.33	1.33	**N/A**	.33	1.33	**N/A**
Wgt Units	1.67	40	**41.67**	5	13.33	**18.33**
CMI			**1.19**$=\left(\frac{41.67}{35}\right)$			**0.73**$=\left(\frac{18.33}{25}\right)$

Figure 2 illustrates the differences in average complexity of patients treated in the same three hospitals as shown in Figure 1.

Figure 2: Casemix Index



4.2.8 Base Cost

The base cost is defined as the total cost across all hospitals divided by the total weighted units across all hospitals. It is the average cost of treating a patient across all case types and hospitals in the system or alternatively the national average cost per weighted unit.

Table 5: Base Cost

	All Cases
Wtd. Units	60
Total Cost	€900,000
Base Cost	€15,000=$\left(\frac{€900,000}{60}\right)$

A hospital level base cost can also be calculated. Comparing the hospital level base cost versus the overall base cost tells us whether the hospital is more or less expensive than the national average. In Table 6 hospital 1 seems more expensive based on cost per case but when we take complexity into account (i.e. look at base cost or cost per weighted unit) we see that in fact hospital 2 is more expensive.

Table 6: Hospital Level Base Cost

	Hospital 1	Hospital 2	Total
Cases	35	25	60
Weighted Units	41.67	18.33	60
CMI	1.19	0.73	1
Total Cost	€567,500	€332,500	€900,000
Avg Cost / Case	€16,214=$\left(\frac{€567,500}{35}\right)$	€13,300=$\left(\frac{€332,500}{25}\right)$	€15,000=$\left(\frac{€900,000}{60}\right)$
Base Cost	€13,619=$\left(\frac{€567,500}{41.67}\right)$	€18,140=$\left(\frac{€332,500}{18.33}\right)$	€15,000=$\left(\frac{€900,000}{60}\right)$

4.2.9 Base Price

Very closely related to the base cost is the base price. The base price is defined similarly to the base cost except that any part of the cost which is not going to be funded using ABF is removed prior to carrying out the calculation. For instance additional costs associated with tertiary referral centres and specialist paediatric hospitals are included in the PLC returns from hospitals and therefore form part of the base cost (see Section 5.6 for more details). However, currently these items are funded through the block grant to hospitals rather than on an activity basis. This results in the base price being less than the base cost.

4.2.10 Estimated Total Cost

The estimated total cost is the total cost estimate we get by applying the RVs and base cost to our data. Comparing our estimated total cost to our actual total cost gives us a test of our estimation

process. If the two are not equal then we have either added or removed cost in the estimation process.

Table 7: Estimated Total Cost

	DRG 1	DRG 2	Total
Cases	20	40	60
Wtd. Units	6.67	53.33	60
Base Cost			€15,000
Est. Total Cost	€100,000 =(6.67 * €15,000)	€800,000 =(53.33 * €15,000)	€900,000 =(90 * €15,000)
Total Cost	€100,000	€800,000	€900,000

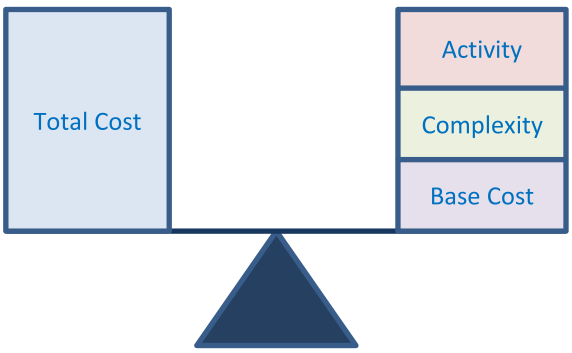
4.2.11 The Cost-Volume Relationship

Understanding the relationship between the cost and volume of activity is vital in understanding activity based funding. Understanding this relationship allows us to correctly determine how much it will cost to carry out any given level of activity which is a fundamental cornerstone of any sustainable healthcare funding system. The relationship between cost and activity can be written as

Total Cost = Activity * Complexity * Base Cost

The components *activity* and *complexity* taken together give the weighted units of activity as described in Section 4.2.6 however it is worthwhile looking at each one separately in this equation to understand the role of each one in isolation. This equation can be visualised as a scales as depicted in Figure 3.

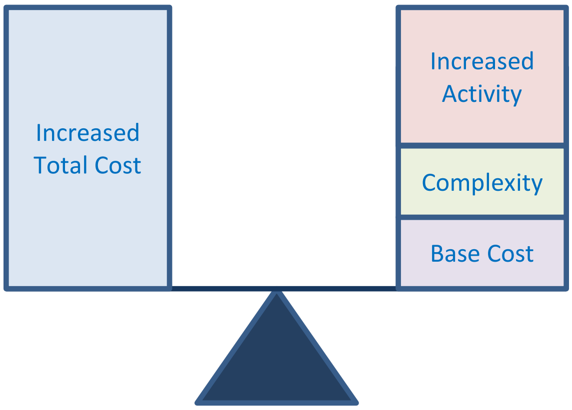
Figure 3: The Cost-Volume Scales



On one side we have the total cost and on the other side we have the three components - activity, complexity and base cost. If any of these components change then at least one of the others will also have to change in order for the scales to balance.

This is of particular importance in an ABF system where you typically have to estimate the future weighted activity levels in order to estimate the corresponding budgetary requirements. If weighted activity levels are projected to increase and further cost reduction is not possible then the budget needs to increase to meet the additional cost. If on the other hand the available budget is fixed and further cost reduction is not possible then the system cannot afford to treat any patients above the current levels of weighted activity.

Figure 4 Balancing the Cost-Volume Scales



Although the paragraphs above have focused on the relationship between total cost and volume, in theory, any one of the factors in the equation can be used to offset changes in another factor. For example we could choose to fix both the total cost and the unweighted activity level (i.e. number of cases treated) and alter the relationship between base cost and complexity and in fact this is done in the price setting process as detailed in Section 5.

5 OVERVIEW OF THE PRICE SETTING PROCESS

5.1 Data Preparation and Reconciliation

The annual price setting process begins with the latest available patient level costing dataset. This dataset contains a record for each admitted patient, ED attendance, and OPD attendance from the participating hospitals. This document is only concerned with the admitted patient portion of the PLC data.

Each record on this dataset contains much of the clinical, demographic and administrative information which is contained on the HIPE file but it also contains a number of fields which describe the cost associated with each treated case. The cost of each case is broken down into a number of cost buckets which give more detail on how the total cost of each case is made up. Each cost bucket is further broken down by whether the cost has been directly or indirectly apportioned. A higher proportion of directly allocated cost is generally a sign of better quality data.

Medical Salaries
Nursing Salaries
Non-Clinical Salaries
Imaging
Pathology
Prosthetics
Theatre
Special Procedure Units
Blood Products
Allied Health
ICU
CCU
Hotel Services
Ward and Medical Supplies

Once the finalised PLC dataset has been received by the HPO it is compared to the corresponding national HIPE file and a number of checks are carried out in order to validate the data. The basic checks include:

- Each PLC record should have a corresponding HIPE record
- Each HIPE record from hospitals participating in the PLC studies should have a corresponding record on the PLC dataset
- There should be no overlap of inpatient and day cases for any patient
- There should not be more than 1 day case per patient on a given date
- There should be no negative costs
- Out of scope records (i.e. records which are no eligible for funding) are flagged

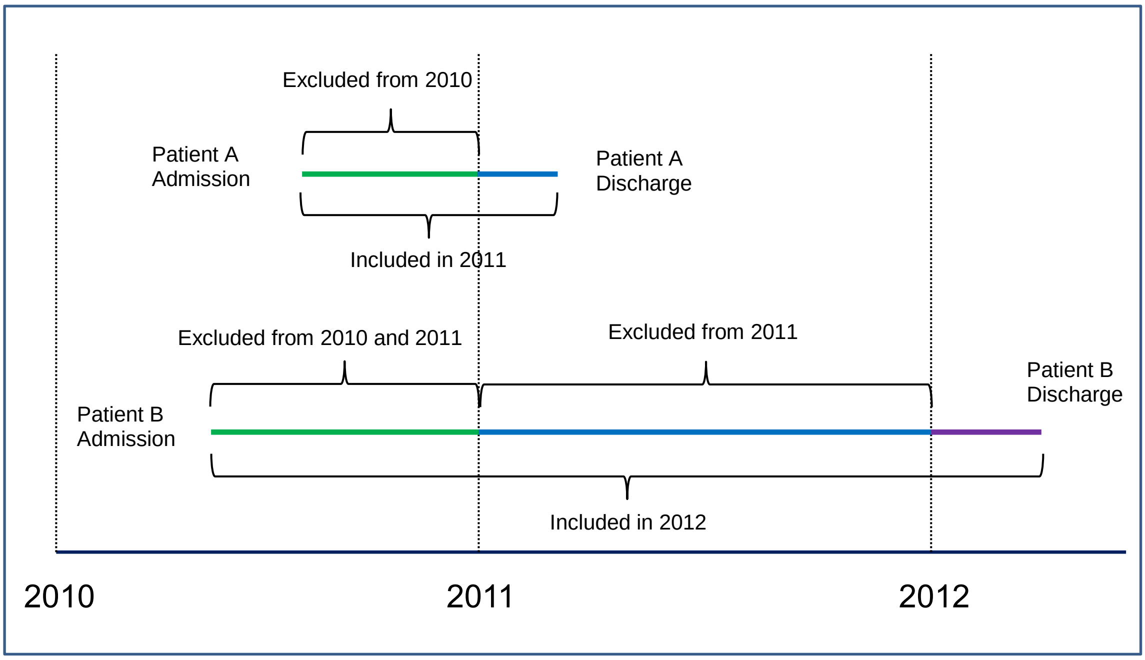
In addition to these basic checks additional processing is required to accommodate the fact that patient level costing is based on a calendar year (i.e. all cases treated either in whole or in part within the year are costed) whereas the national HIPE file is based on discharge date (i.e. only cases which are discharged within the year are contained on HIPE). What this means is that cases where the treatment spans a year boundary are only partially costed and these must be handled appropriately to ensure that the full cost of treating each case is included in the price setting process.

In order to account for this, cases which cross a year boundary are flagged. Cases which are admitted in the current year and are not discharged by the 31st of December are flagged and excluded from the current analysis. Cases which were admitted in a previous year and discharged in the current year are matched with the relevant costed portion from the prior year and the two are combined to give the true full cost of the case. This combined record is then included in the current years analysis.

Figure 5 gives an illustration of this process. Patient A was admitted in 2010 and discharged in 2011. Although the portion of their hospital stay from admission up to 31st December 2010 is costed and included in the PLC data for 2010, it is excluded from the pricing process as the cost relates only to a

portion of their stay. The portion of their hospital stay from 01 January 2011 until discharge is costed and included in the 2011 PLC data. This is also only a partial cost, however instead of excluding it we can now combine it with the 2010 portion of the stay so that we have a fully costed hospital stay. A similar approach is taken to patient B except that we need to combine 3 separate portions of the stay to arrive at the full cost of the hospital stay

Figure 5: Matching Cases Across Year Boundaries



5.2 Generation of Initial Cost Estimates

The initial estimates of average DRG costs are derived directly from the data provided by the hospitals participating in the PLC studies. In its simplest form, the average cost per DRG is calculated by pooling the cases for each DRG across PLC hospitals and taking the mean (see Figure 6). This represents an over simplification of the process, however it is useful to work through this simplified model in order to understand the key steps. Throughout the rest of Section 5, this simplified model is used to illustrate the main stages in the process. The technical details of how to deal with differing lengths of stay and outliers are described in Section 6. Section 6 also demonstrates that only a simple modification of the process described in Section 5 is required to describe the actual ABF price setting process.

Figure 6 shows a diagram of the simplified process. The average cost, base cost, CMI and RV which were introduced in Section 4 are all represented in this diagram.

Figure 6: Schematic of the Simplified Process

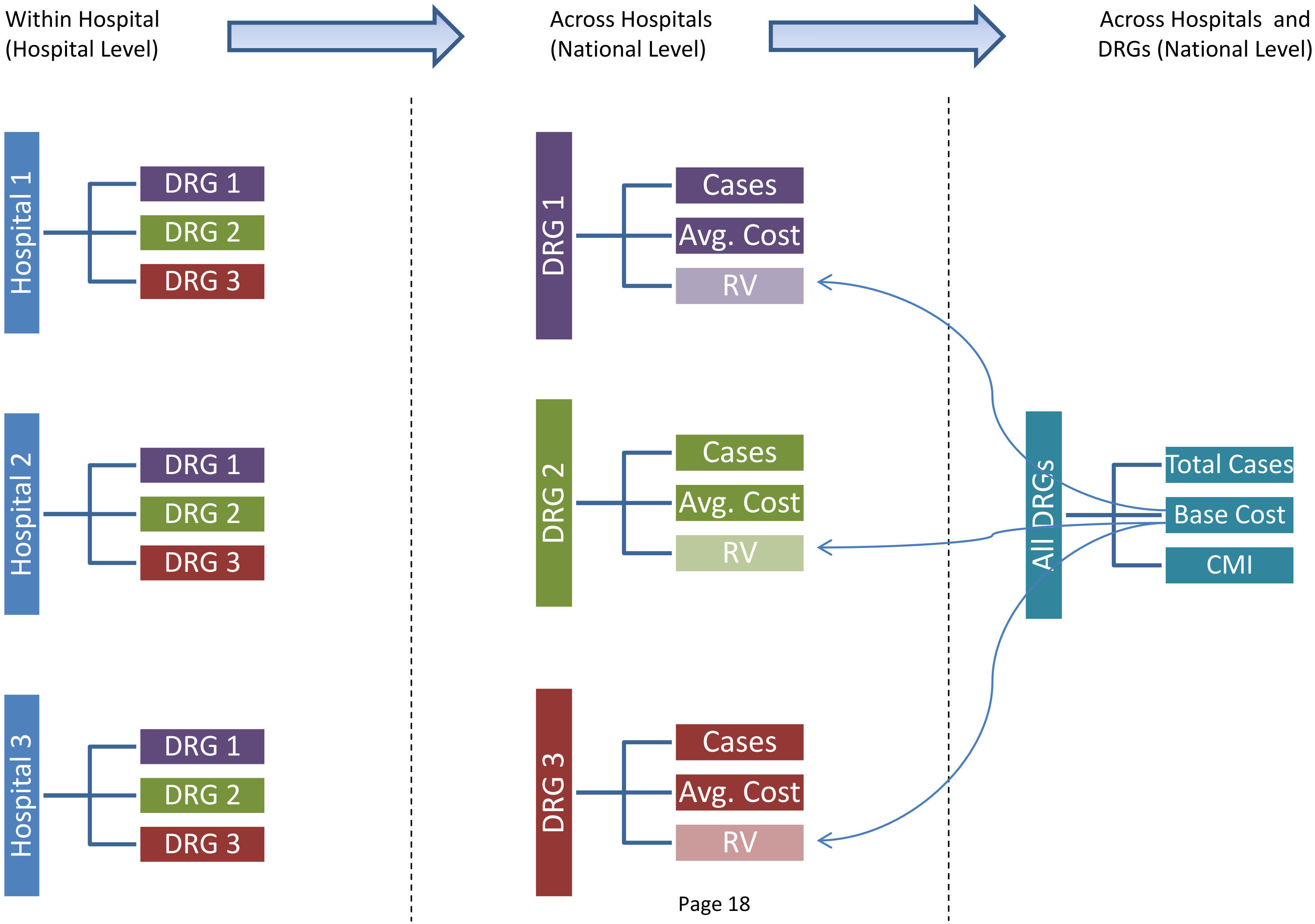


Table 8 illustrates the derivation of the initial cost estimates based on the data contained in table A1 of Appendix A. This is the same data which was used in the examples throughout Section 4 so some of the figures should be familiar. The initial cost estimate is the average cost per case.

Table 8: Initial Cost Estimates (PLC Hospitals)

	DRG 1	DRG 2	Total
Case	20	40	60
Total Cost	€100,000	€800,000	€900,000
Avg. Cost per Case	€5,000	€20,000	€15,000 (BC)
Relative Value (RV)	0.33	1.33	1 (CMI)
Weighted Units	6.67	53.33	60
Estimated Total Cost	€100,000	€800,000	€900,000

There are 3 key features of the data presented in Table 8 which form the basis for the correct calibration of the funding system.

1. The base cost (BC) is equal to the average cost per case across all cases and is also equal to the average cost per weighted unit across all cases.
2. The CMI for all cases equals 1.
3. The estimated total cost equals the actual total cost.

If the cost estimates are applied only to the dataset from which they have been derived then the 3 features above will hold by definition. However if the estimates are applied to a different set of data then they will have to be calibrated to that dataset to ensure that the relationships above are maintained.

5.3 Calibration of Estimates

At this point we have generated a set of RVs and a base price which we can use to describe costs in the PLC hospital sample. We know that the estimated total cost = the actual cost for the PLC sample so by using our estimates we neither add nor take anything away in terms of overall cost. However we don't know whether these estimates are representative of costs in a wider group of hospitals.

At this point we introduce data from another 2 hospitals which don't have PLC data available. These data are presented in table 9 below.

Table 9 shows what happens when we apply our estimates to the data from the full set of ABF hospitals which is given in table A3 of Appendix A. In this example the total cost across DRGs is known however as the data now includes 2 hospitals without patient level costing the total cost per DRG is unknown. The average cost per case and the relative values presented below are those derived from the PLC hospitals as presented in Table 8.

Table 9: Applying Initial Estimates to the Full ABF Set

	DRG 1	DRG 2	Total
Cases	80	60	140
Actual Total Cost	Unknown	Unknown	€1,550,000
Base Cost			€15,000
Relative Value (RV)	0.33	1.33	0.76=$\left(\frac{106.67}{140}\right)$
Wtd. Units	26.67=(0.33*80)	80=(1.33*60)	106.67=(26.27+80)
Estimated Total Cost	€400,000 =(26.67*€15,000)	€1,200,000 =(80*€15,000)	€1,600,000 =(106.67*€15,000)

If we examine the features that we identified in Table 8 we see that:

1. Base Cost (BC) ≠ Cost per case across all DRGs (€11,071) ≠ Cost per CMU across all Cases (€14,531).
2. CMI ≠ 1. In fact the CMI indicates that on average the cases in the ABF sample are less complex than those in the PLC sample alone. CMI is usually set so that it equals 1 for the full sample to be funded.
3. Total estimated cost is greater than total cost therefore using the values from PLC sample to fund all hospitals would result in overfunding.

In order to re-establish the relationships as outlined in Section Generation of Initial Cost Estimates5.2 a number of steps need to be taken.

5.3.1 Calibrate Overall Cost

The first step in the calibration process is to adjust the base cost so that the estimated total cost is equal to the actual total cost. This is done by calculating the ratio of estimated total cost to actual total cost and dividing the base cost by the result.

In our example the ratio of estimated to actual cost is $\frac{€1,600,000}{€1,550,000}$ = 1.032

This ratio of 1.032 indicates that using our cost estimates as derived from the PLC sample would overfund the full ABF set of hospitals by around 3.2% if we didn't adjust them. To carry out the adjustment we simply divide each cost per case figure in Table 9 by 1.032 to yield the figures shown in Table 10.

Our base cost is now a deflated version of the PLC base cost and our RVs and CMI are still relative to the average across the PLC sample.

Table 10: Calibration of Overall Cost

	DRG 1	DRG 2	Total	
Cases	80	60	140	
Actual Total Cost	Unknown	Unknown	€1,550,000	
Avg. Cost per Case	€4,844	€19,375	€14,531 (BC)	1 ✗
Relative Value (RV)	0.33	1.33	0.76 (CMI)	2 ✗
Casemix Units (CMU)	26.67	80	106.67	
Estimated Total Cost	€387,500	€1,162,500	€1,550,000	3 ✓

At this point in the process, our base cost is now a deflated version of the PLC base cost and our RVs and CMI are still relative to the average across the PLC sample. However we would like our base cost to be the average across all cases in our ABF sample and the CMI to be 1 for the ABF sample. Therefore some further adjustment is required.

5.3.2 Adjust RVs so That CMI = 1

$\frac{1}{0.76} = 1.32$ therefore multiplying all of the RVs by 1.32 will result in a CMI of 1. However, if we do this without also adjusting the base cost then the estimated total cost will no longer equal the actual cost. Therefore when adjusting the RVs we must also divide the base cost by 1.32 to compensate.

Table 11: Setting CMI to 1

	DRG 1	DRG 2	Total	
Cases	80	60	140	
Actual Total Cost	Unknown	Unknown	€1,550,000	
Avg. Cost per Case	€4,844	€19,375	€11,071 (BC)	1 ✓
Relative Value (RV)	0.44	1.75	1 (CMI)	2 ✓
Casemix Units (CMU)	35	105	140	
Estimated Total Cost	€387,500	€1,162,500	€1,550,000	3 ✓

At this point we have a set of RVs and a base cost which are fully calibrated to the ABF hospital sample. Note that in the final step the overall CMI was changed but the relative complexity/costliness of the DRGs remained unchanged. Similarly the relative efficiency of the hospitals will not have been altered.

The adjustments carried out in the previous 3 sections illustrate the point that while data from the PLC hospitals are used to generate initial cost estimates per DRG, these should really be viewed as a set of cost relativities. It is not until these relativities are applied and calibrated to the total cost of all hospitals in the ABF sample using the Specialty Costing Returns that they can be regarded as true cost estimates for the full sample.

5.4 The Results

At this point we have a fully calibrated set of cost estimates which could be used to fund hospitals through ABF. There may be reasons why further adjustment would be carried out prior to using the average cost estimates to fund hospitals (see following Sections) however it is useful to examine the results at this point so we can compare them with further adjusted values later on.

Table 12 shows what the outcome would be if the calibrated average DRG costs as outlined in Table 11 were used to fund the 4 hospitals in our sample datasets. In each case the total revenue is the number of cases multiplied by the average cost per case as presented in Table 11.

At the overall level we see that 3 of the 4 hospitals would make a profit based on these DRG payments while 1 of the hospitals would make a sizeable loss.

Also notable from this table is the fact that hospitals who have PLC data available are able to break down their profit/loss to the DRG and even the patient level whereas hospitals without PLC data available cannot do this. This illustrates the key benefit for hospitals participating in PLC studies of being able to really understand the relationship between cost and ABF revenue within their hospital.

Table 12: Result of Funding Based on Average DRG Costs

	Hospital 1 (PLC)			Hospital 2 (PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	5	30	35	15	10	25
Total Cost	€27,500	540,000	€567,500	€72,500	€260,000	€332,500
Total Revenue	€24,219	€581,250	€605,469	€72,656	€193,750	€266,406
Profit	-€3,281	€41,250	**€37,969**	€156	-€66,250	**-€66,094**

	Hospital 3 (Non PLC)			Hospital 4 (Non PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	40	5	45	20	15	35
Total Cost	unknown	unknown	€275,000	unknown	unknown	€375,000
Total Revenue	€193,750	€96,875	€290,625	€96,875	€290,625	€387,500
Profit	unknown	unknown	**€15,625**	unknown	unknown	**€12,500**

5.5 Cost vs Price

So far in this process we have dealt directly with the average cost across hospitals of providing different types of care. However there may be reasons why a funder would want to set a price which is different to the average cost. For instance they may want to build cost efficiency into the price as they believe that expected activity levels can be delivered at a cheaper price or there may be costs which are covered by other funding mechanisms but which were not clearly identifiable for removal at the start of the estimation process.

Because of this there is often a distinction between the average cost for a DRG and the price eventually paid for that DRG. For this reason it is important to be aware of any adjustments made to the average cost to arrive at the price. This is especially true when a hospital is comparing their patient level costs to the DRG price where failure to understand the adjustments can lead to incorrect conclusions being drawn.

5.6 Tertiary and Specialist Paediatric Hospital Adjustments

It is generally recognised that payment of a single price by DRG tends to underfund tertiary hospitals due to activities such as teaching and training or organ harvesting which are specific to that type of hospital. Similarly the costs associated with the treatment of children in a specialist paediatric hospital tend to be higher than those associated with the provision of care in a general hospital setting. Because of this, adjustments must be made to the DRG payment for patients being treated within these 2 care settings in order to correctly reimburse the hospitals for the patients treated.

Although some of the costs mentioned above could be identified from hospital accounts, not all of them can and so an estimation process is used to adjust for all factors, known and unknown, which would result in higher costs in tertiary and paediatric specialist hospitals than in the general hospital population.

In order to adjust for these factors the following approach is taken.

1. The hospitals are grouped into 3 groups – those deemed to be eligible for a tertiary adjustment, specialist paediatric hospitals and other hospitals.
2. A group base cost is calculated for each of these groups by dividing the total cost for each group by the total weighted units for that group using the calibrated RVs as derived in Section 5.3.2.
3. Calculate the ratio of the other hospital group base cost to the tertiary hospital group base cost and use this ratio to adjust the tertiary group total cost so that the 2 base costs are equalised.
4. Similarly take the ratio of the other hospital group base cost to the specialist paediatric hospital group base cost and use this ratio to adjust the paediatric group total cost so that the 2 base costs are equalised.
5. Recalibrate the estimates to the adjusted total cost for the full set of hospitals as per Section 5.3.

When reimbursing the hospitals based on the recalibrated estimates the payment for tertiary and specialist paediatric hospitals now consists of 2 components; The DRG based payment and the adjustment which is paid as part of the block granted portion of the hospital's funding.

For illustration purposes let us suppose that hospitals 2 and 4 from our sample data are tertiary hospitals. This example considers only the tertiary hospital adjustment however the paediatric adjustment would be calculated in the same way. Grouping the hospitals into tertiary and other hospitals yields the data as shown in Table 13.

Table 13: Tertiary Hospital Adjustment

	Tertiary Hospitals	Other Hospitals	Total
Total CMU	59	81	140
Total Cost	€707,500	€842,500	€1,550,000
Base Cost	€11,979	€10,409	€11,071
Base Cost Ratio	0.869		
Adjusted Base Cost	€10,409	€10,409	€10,409
Tertiary Adjustment	€92,703	€0	€92,703

Note: CMU figures presented in this table have been rounded to integer values for easy reading. The actual CMU figures are 59.06 and 80.94 respectively.

In this step of the process, no change has been made to the number of cases or the RVs therefore the hospital CMI and CMU figures are unaffected. The adjustment is made purely on the base cost. The 3 key features are still maintained after making this adjustment however the adjusted base cost is now the average cost across all cases having first removed the tertiary adjustment amount.

The tertiary adjustment given in Table 13 is the total adjustment for the 2 tertiary hospitals in our sample. Table 14 shows how this figure is broken down between the 2 hospitals. The adjustment for each individual hospital is derived by multiplying each of the hospitals costs by the base cost ratio.

Table 14: Tertiary Adjustment by Hospital

	Hospital 2	Hospital 4	
Total Cost	€332,500	€375,000	€707,500
Base Cost Ratio	0.869		
Tertiary Adjustment	€43,657	€49,136	€92,703
Adjusted Total Cost	€250,473	€364,324	€614,797

Table 15 shows the final position for each hospital after the tertiary adjustment has been made. In this table the value paid in relation to each DRG has decreased from that presented in Table 12 as a result of the reduced base cost as illustrated in Table 13. The effect of applying the tertiary

adjustment has been to benefit hospitals 2 and 4 as we have essentially reduced their ABF costs to reflect the fact that they initially included a non-ABF component.

Table 15: Final Hospital Positions Including Tertiary Adjustment

	Hospital 1 (PLC)			Hospital 2 (PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	5	30	35	15	10	25
Wtd Units	2.19	52.50	54.69	6.56	17.50	24.06
Total Cost	€27,500	540,000	€567,500	€72,500	€260,000	€332,500
Total Revenue	€22,770	€546,468	€569,257	€68,311	€182,162	€250,473
Tertiary Adjustment	€0	€0	€0	€9,500	€34,076	€43,567
Profit	-€4,730	€6,486	**€1,757**	€5,310	-€43,770	**-€38,460**

	Hospital 3 (Non PLC)			Hospital 4 (Non PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	40	5	45	20	15	35
Wtd Units	17.5	8.75	26.25	8.75	26.25	35
Total Cost	unknown	unknown	€275,000	unknown	unknown	€375,000
Total Revenue	€182,162	€91,081	€273,243	€91,081	€273,243	€364,324
Tertiary Adjustment	0	0	0	unknown	unknown	€49,136
Profit	unknown	unknown	**-€1,757**	unknown	unknown	**€38,460**

Notes: Total revenue is calculated as weighted units multiplied by the adjusted base cost of €10,409.27. Values presented in this table have been rounded for ease of reading therefore multiplying the figures as presented may not yield the exact results as presented.

6 TECHNICAL DETAILS

As mentioned in Section 5.2, thinking of the DRG prices as being the average cost per case across all hospitals is a useful but simplified way of thinking about the process. Although illuminating, this description doesn't take into account the fact that length of stay is a factor in determining the cost for treating a particular case. In our reimbursement model we would like our prices to reflect this fact while still incentivising hospitals to reduce length of stay. This Section describes the additional complexities of taking length of stay into account and how they can be incorporated into the process described in Section 5. It also describes the process for assessing both the cost and activity data for suitability for inclusion in the price setting process.

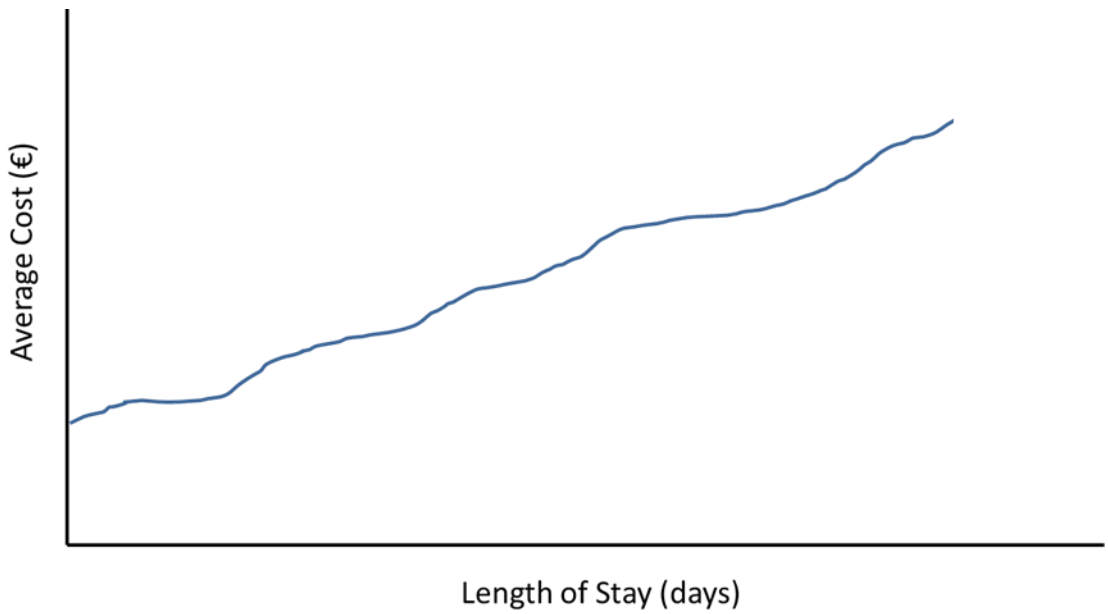
Note that in the Irish funding model inpatient cases and day cases are treated separately. As day cases by definition are admitted and discharged on the same day length of stay is not relevant when driving a DRG price. Therefore, apart from the consideration of cost outliers, the price derivation process as outlined in Section 5 can be applied directly in this case.

The discussion for the remainder of Section 6 will apply to inpatient cases only.

6.1 Cost and Payment Curves

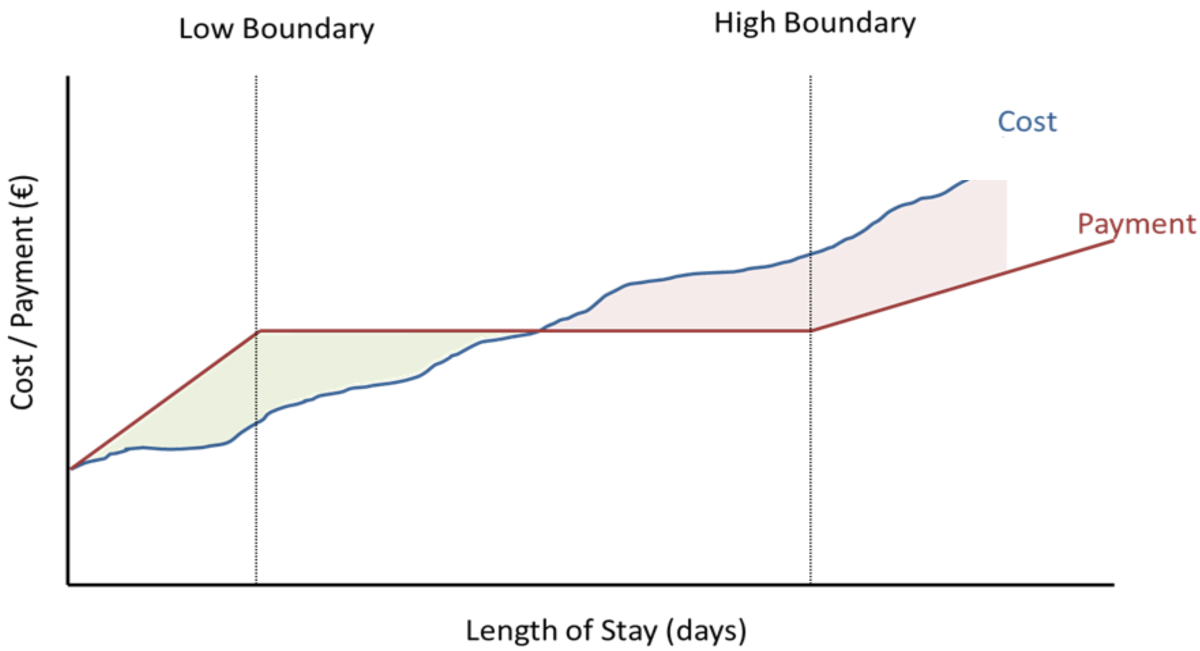
Fundamental to the understanding of activity based funding are the notions of a cost curve and a payment curve. For each DRG a graph can be plotted of the average cost per case versus length of stay. This graph will intersect the y axis at some point above zero reflecting the fact that there is a "baseline" cost associated with treating a patient regardless of their eventual length of stay. The graph will then show an increase in cost as length of stay increases reflecting the additional daily cost of providing care for a patient in hospital. Figure 6 illustrates a DRG cost curve.

Figure 7: DRG Cost Curve



As well has having a cost curve each DRG has an associated payment curve. The payment curve indicates what the funding model would pay for a case falling into that particular DRG with any given length of stay. The form of the payment curve varies from country to country depending on the funding policies in place. Figure 8 shows a typical payment curve as generated in the Irish ABF process overlaid onto the cost curve shown in Figure 7.

Figure 8: DRG Cost and Payment Curve



6.2 Features of the Payment Curve

The form of the payment curve as shown in Figure 8 is quite distinct and is typical of all DRG payment curves in the Irish ABF system.

The first feature to note on the curve is the plateau between the lines indicated as the low boundary and the high boundary. These boundaries mark the lower and upper points of a range of length of stay values which could be described as being typical for this DRG. The area between the low and high boundaries is called the inlier area and as the graph illustrates any cases with a length of stay falling within this area receive the same payment. It also shows that in the lower Section of the inlier area the payment is higher than the average cost while in the upper portion the payment is less than the average cost. The reason for this is that although we want to recognise the fact the length of stay affects cost we don't want to incentivise longer lengths of stay in our ABF model. (Having a payment curve that followed the cost curve would do just that!) By setting an inlier area similar to that shown above, hospitals are incentivised to try and keep length of below the ALOS where they will on average make a profit for treating a patient rather than above the ALOS where they will on average make a loss.

The second feature of the payment curve is the point at which it crosses the y axis. This point represents the payment for treating a patient falling into a particular DRG who did not spend a night

in hospital i.e. a patient who was admitted and discharged on the same day. As the graph indicates this payment is set at the average cost of treating these patients.

From this point the curve ramps up linearly to the inlier payment level at the low boundary point. This part of the payment curve is set so that there is an incremental increase up to the inlier payment and there is no “gap” at the low boundary point.

The last feature of the payment curve is the rising portion which commences at the high boundary point. Cases with a length of stay beyond the high boundary attract an incremental payment for each day they are in hospital above that boundary. This feature of the payment curve is in place in recognition of the fact that cases with a length of stay greater than the high boundary are atypical and there are likely factors at play which are beyond the hospitals control. The additional per diem payment in this area of the curve is set at the average cost per day of treating these patients however you should note that because of the fixed payment in the inlier area these cases will on average be paid less than their average cost so as not to incentivise longer lengths of stay.

6.3 Case Types

Associated with the different portions of the DRG payment curve are the various case types which are defined according to their length of stay in relation to the payment curve for their assigned DRG.

Sameday	Cases where the patient is admitted as an emergency and discharged on the same day as determined by the midnight census.
Oneday	Cases where the patient is admitted and discharged on the following day. These patients have spent a single night in hospital as an admitted patient as determined by the mid night census.
Low Outlier	Cases where the patient spends a minimum of 2 nights in hospital as an admitted patient and the low boundary for their assigned DRG is greater than 2.
Inlier	Cases where the patient’s length of stay is between or equal to the lower and upper boundary points for their assigned DRG.
High outlier	Cases where the patient’s length of stay is greater than the upper boundary point for their assigned DRG.

Section 6.7 shows how to use the price list to determine the case type for any case within a particular DRG and the price to be paid for that case.

6.4 Calculating Length of Stay Boundaries

As mentioned in Section 6.2, the inlier area of the DRG payment curve is set so that it covers a range of length of stay values which could be described as being typical for that DRG. In order to ensure that the inlier area truly represents the length of stay range for a typical case within the DRG, steps need to be taken to minimise the effect of extremely short or long length of stay values in the data. In order to achieve this, a 3 step process is employed.

As LOS data tend to be highly skewed it needs to be log transformed in an attempt to normalise the distribution prior to performing boundary calculations.

Step 1 – Analyse the data for each DRG using statistical techniques to identify cases with extreme lengths of stay

1.1 Log transform the LOS data
1.2 Calculate the mean and standard deviation (SD) of the log transformed LOS data
1.3 Calculate lower and upper trim points as ALOS +/- 3*SD
1.4 Back transform the trim points to the original scale using the exponential function
1.5 Apply the transformed trim points to the original data to identify extreme outliers

Step 2 – Generate the boundary points based in the dataset having excluded the extreme cases as identified in step 1

2.1 Calculate the mean and standard deviation of the log transformed LOS data with extreme outliers removed
2.2 Calculate lower and upper boundary points as ALOS +/- 2*SD
2.3 Back transform the boundary points to the original scale using the exponential function
2.4 Apply the transformed boundary points to the original data top identify the different case types as defined in Section 6.3

Step 3 – Apply 17 day rule to restrict the width of the inlier area as calculated in step 2

Steps 1 and 2 of the boundary calculation process deal with the statistical considerations of identifying LOS boundaries. However, the resulting boundaries may still not be suitable for funding purposes. In particular, the high level of variation in the LOS data for some DRGs can result in an excessively wide (from a funding perspective) inlier area. Restricting the width of the inlier area prevents the payment curve diverging too far from the cost curve.

To achieve this, an additional restriction is applied so that neither the low or high boundary can be more than 17 days from the ALOS. This is referred to as the “17 day rule”.

This methodology results in around 5% to 10% of cases across the system as outliers however this % can vary a great deal from one DRG to another.

6.5 Equivalencing

Although we identify and remove atypical outlier cases when determining our low and high boundaries we still need to fund these cases through our DRG system. Examination of the cost curve illustrated in Section 6.1 shows that the inlier payment plays an important role in the payment made in respect of low and high outlier cases. The inlier payment determines the slope of the ramp on the lower end of the payment curve and it also determines the start point of the ramp at the end of the payment curve. Therefore the inlier payment level impacts the low and high outlier payments.

The simplest way of setting an inlier payment level is to simply identify the inlier cases and set the price to be equal to the average cost of treating those cases. This would be equivalent to applying the process as outlined in Section 5 to inlier cases only and would be ideal if we could assume that the proportion of outlier cases in each DRG was relatively small and that the cost per day for outlier

cases was the same as for the inlier cases. However as mentioned in Section 6.5 the proportion of outliers can vary greatly from one DRG to another and the costs associated with outlier cases can often be quite different from those associated with inlier cases.

Given that the inlier payment plays such a key role in the outlier payment levels and that the proportion of outlier cases may be quite significant for some DRGs, it seems reasonable to also allow the outlier cases to influence the inlier payment level. This is achieved through including the cost of treating low and high outlier cases into the model in a process called equivalencing.

The equivalencing process involves 2 steps:

1. Estimation of the average cost per case for inlier cases only
2. Expression of the modelled value of all cases (including outliers) in terms of the average cost of inlier cases or “inlier equivalents”

Once equivalencing has been carried out, the price setting process as set out in Section 5 can be applied substituting the number of inlier equivalents for the number of cases.

Therefore we can incorporate outlier cases into our model by simply taking the average cost per inlier equivalent case rather than the average cost per case.

Table 16 shows some data for a DRG indicating the number of inlier and high outlier cases, their respective ALOS, and the components of their average cost per case. Unlike the other tables in this document, the data in Table 16 is not derived from tables A1 or A2 in the appendix. In the example the low boundary is assumed to be 2 days and the high boundary is assumed to be 18 days. The fixed cost per case refers to theatre and prosthetic costs which are generally unrelated to length of stay.

Table 16: Equivalencing Example

	Inlier Cases	High Outlier Cases
Cases	100	5
ALOS	10 (inlier area 2 – 18 days)	40
Beddays	1000	200
Beddays Above Boundary	0	110 (=200-5*18)
Average Cost per Case	€10,000	€23,600
Fixed Cost per Case	€6,000	€6,000
Daily Cost per Case	€400	€440
Total Cost	€1,000,000	€118,000

Under an initial model using the inlier average cost as the inlier payment the total funding is

100*€10,000 + 5*€10,000 + 110*440 = €1,098,400

Inliers High Outliers

The number of inlier equivalents based on the above is €1,098,400/ €10,000 = 109.84 and the cost per inlier equivalent= €1,118,000/109.84 = €10,178. This cost per inlier equivalent becomes our inlier payment.

In order to appreciate the effect of equivalencing it is useful to look at the cost to value (CTV) ratio for inlier cases, outlier cases and for all cases.

- The CTV for inlier cases= €1,000,000/100* €10,178 = .983 which indicates that we are slightly over funding these cases to accommodate the outliers.

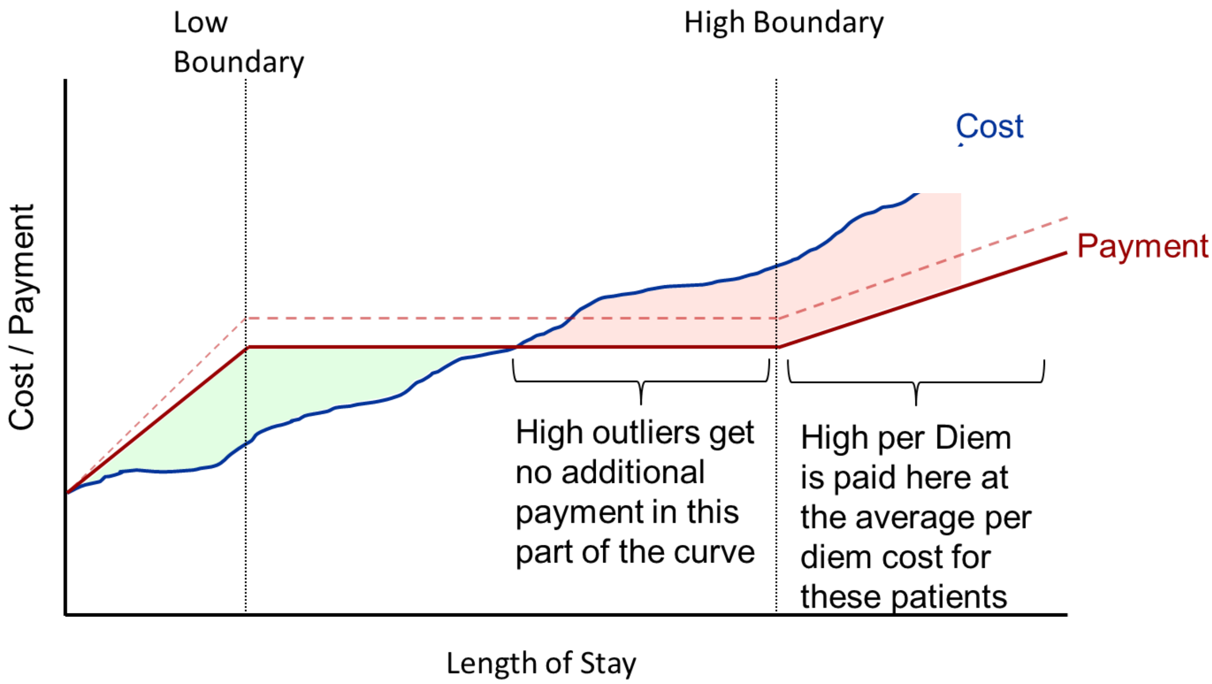
- The CTV ratio for high outliers = €118,000/(5* €10,178 + 110*€440) = 1.19 which indicates that we are underfunding these cases to discourage excessive length of stay.

- The CTV for all cases = €1,118,000/(105* €10,178 + 110*€440) = 1 which indicates that taken as a whole this DRG is being funded at exactly the total cost.

The above example only deals with the case of high outliers however similar calculations can be carried out for low outlier cases. The effect of the equivelancing of low outlier cases is to reduce the inlier price. When there are both low and high outlier cases present for a DRG then there is essentially a tug of war going on between the with the low outliers pulling the inlier price down and the high outliers pulling it up .

Figure 9 illustrates the effect of the equivalencing process as outlined above. The solid red line indicates the original payment curve while the dotted red line indicates the payment curve after equivalencing. Note that in this example only high outlier cases were considered however in reality both low and high outliers are included in this process.

Figure 9: The Effect of Equivalencing



6.6 Identifying Cost Outliers

As well as LOS outliers there may also be cost outliers in the PLC data which could adversely affect the estimates of the average cost if not taken into account. As for length of stay outliers, cost outliers are identified using statistical methodologies and these outliers are removed from the data prior to estimating the average costs. When determining cost outliers the analysis is carried out on the average cost per inlier equivalent case per DRG and hospital combination rather than on the cost per case. As for the length of stay trimming process, a 2 stage process is used to identify and remove cost outliers from the data however a different statistical methodology is employed to ensure that only very extreme costs are removed.

The first stage in the process is called the pruning stage where a non-parametric methodology is used to determine the cases which are atypical in terms of cost per equivalent. In this first step atypical cases are defined as those which are outside of the range Q1-0.3*IQR and Q3+1.5*IQR where Q1 is the first quartile, Q3 is the third quartile and IQR is the inter quartile range. Values outside of this range are pruned (i.e. temporarily omitted) from the dataset and a new average cost per equivalent and associated standard deviation is estimated.

In the second stage of the process, a formal t-test is carried out of the average cost per inlier equivalent for each DRG by hospital combination versus the estimates resulting from stage 1. The decision value is set to 5 for this test so that only very extreme costs are excluded from the data prior to re-estimating the cost per inlier equivalent case.

6.7 Process Iteration

The steps outlined in Sections 6.5 and 6.6 (i.e. equivalencing and identification of cost outliers) both involve the re-estimation of values which have already been estimated in an earlier stage. An updated estimate of the average cost per inlier equivalent case can affect the data points which are trimmed due to outlying costs and vice versa. Therefore, the whole process is iterated a number of times to allow for convergence on a final estimate. Note that no formal convergence are applied as DRGs occurring in only a small number of hospitals can result in the process alternating between a couple of distinct estimates in which case convergence would never occur.

6.8 Generating the Price List

Once the iterative process has been completed we are in a position to create the final price list. The individual payments for each case type per DRG are derived as follows.

Same day payment	This is set equal to the average cost of treatment for these cases. *(This payment comprises a component for theatre and prosthesis which is deemed to be "fixed" and ½ of the low per diem payment)*
One day payment	This is set equal to the same day payment + ½ of the low per diem payment.
Low per diem	This is set as (inlier payment – the "fixed" component of the same day payment) divided by the low boundary
Inlier payment	This is set as the average cost per inlier equivalent case as derived during the iterative process
High per diem	This is set equal to the average daily cost of treating high outlier patients once the "fixed" portion as outlined above has been removed.

Where there are not enough outlier cases to reliably estimate an average cost a weighted average is taken with the equivalent inlier cost to ensure a better estimate. Table 17 below shows how to determine the payment for a case with any given length of stay for a particular DRG.

Table 17: Determining the Payment

Case Type	Short Description	Payment
Day Case	Planned, elective, in and out on same day. No overnight bed use.	Day Case
Same Day	Non elective, in and out on same day. No overnight bed use.	Same Day
One Day	LOS = 1 (discharge date – admission date =1)	One Day
Low Outlier	LOS > 1 but less than low boundary	One Day + (LOS-1)*Low per Diem
Inlier	LOS within inlier area	Inlier
High Outlier	LOS > high boundary	Inlier + (LOS-High Boundary)*High per Diem

APPENDIX A – DATASETS USED IN THE EXAMPLES

The datasets presented in this appendix have been constructed to illustrate the methodology presented in this document. They do not reflect true data. Throughout the document the tables presented in the examples are colour coded to highlight which data source is being used for each particular step. Blue tables indicate that the figures are based on patient level data as contained in Table A1. Torquoise tables indicate that the figures are based on specialty level data as contained in Table A2. Green tables indicate that the figures are based on the full ABF dataset set which is a combination of patient level costing data and specialty level costing data.

Table A1: Summary of Patient Level Costing Data

	Hospital 1 (PLC)			Hospital 2 (PLC)			Total (PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	5	30	35	15	10	25	20	40	60
Total Cost	€27,500	540,000	€567,500	€72,500	€260,000	€332,500	€100,000	€800,000	€900,000

Table A2: Summary of Specialty Costing Data

	Hospital 3 (Non PLC)			Hospital 4 (Non PLC)			Total (Non PLC)		
	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total	DRG 1	DRG 2	Total
Cases	40	5	45	20	15	35	60	20	80
Total Cost	unknown	unknown	€275,000	unknown	unknown	€375,000	unknown	unknown	€650,000

Table A3: Summary of Total ABF Data

	MFTP Total		
	DRG 1	DRG 2	Total
Cases	80	60	140
Total Cost	unknown	unknown	€1,550,000